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TRADABLE WATER RIGHTS

Experiences in Reforming Water Allocation Policy

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TRADABLE WATER RIGHTS

Experiences in Reforming Water Allocation Policy

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and
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EXECUTIVE SUMMARY

Water policy in developing countries faces a number of serious challenges: to increase water efficiency in all uses; to preserve and sustain the natural resources involved in water management; to reduce sharply the enormous amounts of financial resources invested in and expended on state-managed water policies; and to increase the flexibility and responsiveness of resource allocation. This paper explores the potential for and constraints against the development of markets in tradable water rights to help meet these challenges. Tradable water rights are rights to use water that can be transferred all or in part, separately from the transfer of land. While tradable water rights themselves should be permanent or very long term, to ensure their security, the *transfer* of water rights need not be permanent: water rights can be leased for a season, a year, or many years.

METHODOLOGY

This paper uses a comparative case study approach, drawing lessons for developing countries from experiences with tradable water rights in California, Chile, and Mexico. These three locations provide important insights: Chile has had nearly 20 years of experience with markets in tradable water rights, following a fundamental restructuring of its water laws; Mexico is in the early stages of implementing comprehensive legal reform establishing tradable water rights; and California has undertaken more gradual reforms to increase the flexibility of water marketing and trading within a long-established water law tradition that is in some ways inimical to water markets.

The primary focus of this paper is on the laws, institutions, and policies that condition the success of allocating water through markets in tradable water rights. The study relies largely on interviews with participants in and observers of water policy in the study areas, analysis of secondary data, and synthesis of existing literature. A limited amount of primary data collection beyond the interviews was also undertaken.

OBJECTIVES

In addition to examining the potential benefits of and constraints to establishing tradable water rights, the objectives of this paper are to examine the underlying incentives that induce institutional and legal reform bodies to establish tradable water rights; to assess appropriate policies for successful implementation of tradable water rights; to determine the impact of water market allocation in practice; and to develop lessons about the potential of tradable water rights as a key component of water allocation policy in developing countries.

TRADABLE WATER RIGHTS: POTENTIAL BENEFITS AND CONSTRAINTS

Establishing markets in tradable water rights offers many benefits, including the following:

- empowerment of water users,
- provision of investment incentives,
- improved water use efficiency,
- reduced incentives to degrade the environment,
- acceptability to farmers,
- improved equity in the provision and financing of water services, and
- increased flexibility in resource allocation.

Despite these potential benefits, the use of market-based water allocation mechanisms has been limited by concerns over the possible political, institutional, and technological constraints to managing such a system, and possible inequities that might arise from market-based allocations. Laws, institutions, and physical water systems must be reformed or developed to assign water rights equitably, to deal with the variability of water supply, to protect against damage to others or the environment, and to resolve conflicts. Despite these apparently formidable challenges, incentives for water policy reform have been strong enough to induce policy changes in California, Chile, and Mexico to develop markets in tradable water rights.

INCENTIVES FOR MARKETS IN TRADABLE WATER RIGHTS

The forces behind reform of water allocation to create or expand markets in tradable water rights in California, Chile, and Mexico derive from three related incentives: (1) the increasing economic value of water due to scarcity caused by rapid growth in demand for delivered water, depletion of new supply sources, and competition for water among agricultural, industrial, urban, and instream uses; (2) rising budgetary costs of maintaining centralized control of irrigation and urban water delivery due to increasingly expensive and highly subsidized capital development and operations and maintenance of water systems; and (3) broad economic liberalization, which increases the economic cost of maintaining inflexible and inefficient water allocation systems that cannot respond rapidly to changing incentives and comparative advantages.

These incentives are filtered through the three geographic areas' existing political systems. The gradual approach to reform undertaken in California has been largely the result of long-standing water law, developed under varying historical and economic conditions, which in many ways constrains water trading. It has also evolved in response to the complexity of balancing the interests of agricultural, urban, and environmental stakeholders in water.

Political conditions in Chile and Mexico, which are more representative of developing countries, have been more conducive to comprehensive reform than in California. Prior to reform in Chile and Mexico, the main stakeholders in water—the farmers—did not have a strong interest in the

status quo; to the contrary, the old system of water law and management gave them only precarious rights to water and very little say in its distribution and management. Consequently, farmers in Chile and Mexico have strongly supported comprehensive legal reform to establish tradable water rights, because they have enjoyed its benefits. Support for comprehensive reform has also been strong in the broader government ministries dealing with agricultural, financial, and economic planning, which have had to cope with the adverse economic and fiscal consequences of previous water policies. The main proponents of more limited reform of water rights have been the bureaucracies directly controlling water management.

POLICIES FOR SUCCESSFUL IMPLEMENTATION OF TRADABLE WATER RIGHTS

Within the context of reform to create markets in tradable water rights, whether wholesale or incremental, a number of complex implementation issues arise. These include the following:

- the method to use to allocate water rights initially,
- the definition of rights as prior or proportional,
- the consumptive use and treatment of return flows in water trading,
- negative indirect economic effects,
- protection of the environment,
- the role of water user associations,
- infrastructural requirements, and
- the role of public and private institutions.

Appropriate policies must implement water rights fairly, protecting the interests of all participants, while at the same time maintaining low enough transactions costs to ensure that water markets operate efficiently. Transactions costs include the cost of identifying profitable opportunities for transferring water, the cost of negotiating or administratively deciding on water transfers, the infrastructural cost of conveying water and monitoring transfers, and the infrastructural and institutional cost of monitoring, mitigating, or eliminating possible third-party effects.

Fairness in Initial Allocation of Water Rights

The first condition for success in developing tradable water rights is fairness in the initial assignment of the rights. The fairness objective seems to have been met in Chile and Mexico by basing initial allocation largely on historical water use, combined (in Chile) with the redistribution of concentrated rights holdings. The assignment of rights is formalized through their registration in public registries in both countries.

Prior versus Proportional Water Rights

A key distinction between water rights in California on one hand and Chile and Mexico on the other is that the former defines rights on a priority basis, while the latter two effectively define water rights as proportional to stream flow or canal flow. The priority rights system allows different degrees of water supply reliability to be purchased, but the heterogeneous nature of the rights makes it difficult to organize the market. With proportional rights, some inefficiencies may be introduced because users must hold more shares to reach any given level of assurance of water supply due to the variable supply of water, but the homogeneity of proportional rights makes it much easier to create markets. The proportional rights system is also more flexible and equitable in allocating water deficits than a prior rights approach. Overall, the advantages of the proportional rights approach in facilitating market creation and in allocating deficits equitably outweigh the possible market inefficiencies from the need to hold extra shares.

Consumptive Use and Return Flows

A second key distinction between water rights in California and in Chile and Mexico lies in the definition of the tradable portion of the water right. In California, the transferable portion of the appropriative water right is limited to consumptive use, with protection of third-party rights to return flows. This system protects prior rights to return flows, but significantly increases the transaction costs of water trading because of the difficulty of measuring consumptive use and return flows. Chile and Mexico define tradable rights as full diversion rights, which are proportional to stream or canal flow; rights to return flow do not exist under their systems.

The decision on which approach to use is ultimately an empirical one. If benefits lost from failure to undertake water trades due to the high transactions costs of enforcing return flows exceed the net cost of adverse impacts resulting from lost return flows, the full diversion right approach is preferable. To the extent that real losses do occur from loss of return flows, innovative methods could be used to compensate those who are hurt by them. Under developing country conditions, Chile's and Mexico's approach of tradable shares with no rights to return flows is preferable as a general principle because enforcing consumptive rights following the California model would be extraordinarily costly and would likely prevent market development. Nevertheless, within many countries, hydrological conditions in some river basins, where return flows are very large and traditional rights to these flows exist, will require additional protection of return flows.

A hybrid approach could be used where return flows are significant. A determination could first be made of areas where return flows are lost to beneficial use, making restrictions unnecessary. In these areas, any trades could be made of the fully diverted share. In all other sections of the river basin, intersectoral water trades (which would affect beneficial use of return flows) would be subject to a uniform presumptive return flow allowance.

Protection against Negative Indirect Economic Effects

Water transfers can hurt business activities, local government fiscal capacity, and the quality of public services in areas from which water is being transferred because reductions in irrigated area or production cause associated reductions in agriculturally linked economic activities in the area of origin and in the property tax base. In addition, permanent transfer of water rights may limit future economic development in the area of origin. However, the experiences of California and Chile suggest that negative indirect economic effects from water trading are small or nonexistent; in Chile, on the contrary, tradability of water has contributed to diversification and rapid growth of the agricultural sector. Broad-based area-of-origin protection against intraregional or intrabasin trade on vague grounds of "unreasonable impact" can suppress otherwise effective water markets, providing excessive discretionary power to regulatory agencies. Given the generally small impacts of these indirect costs of trade, it would be better to make explicit what is unreasonable, and to place the burden of proof on the area of origin to demonstrate negative impacts.

Protection of the Environment

The evidence from the Chile, Mexico, and California case studies shows that allocation of water by markets is compatible with environmental protection. Implementation of environmental protection in a market system is no more difficult than in an administrative allocation system. The general approach to environmental protection can be regulatory or market oriented, but the regulatory approach has been used in the countries studied. In Mexico, for example, the quality of discharge for nonagricultural uses must be specified in the granting of a water right, and the government can invoke restrictions on water use in the event of damage to ecosystems, overexploitation of aquifers, and other environmental impacts. California has a rigorous set of environmental laws and regulations that explicitly protect fish and wildlife and mandate stream flows. In Chile, strong environmental protection is lacking in the country's Water Code, although several provisions allow protection of environmental interests. These protections will be significantly enhanced with the recent passage of Chile's Environmental Protection Law. In the final instance, in any society, how much environmental protection is afforded is a matter of political choice.

The Role of Water User Associations

Assigning tradable property rights to individuals within water user associations, or even to communal groups themselves, enhances the control of these groups over water resources, better ensuring access to water than is often the case for water user groups that enjoy no such rights. In both Chile and Mexico, strong water user associations play a major role in water allocation. In Chile, user associations own and manage the physical infrastructure, monitor water allocation, approve water transfers subject to specific conditions, and provide the initial (and usually final) forum for conflict resolution. In Mexico, the turnover of irrigation districts to newly organized water user associations is fundamental to the establishment of water rights. Under Mexican law, water rights can be provided to individuals or groups, but there is a strong preference for

concessions to be made to groups, with the groups then to grant subsidiary water rights to their members.

Infrastructure Requirements for Tradable Water Rights

Sophisticated measuring devices, division boxes, and other conveyance structures are not necessary to implement a water trading system. Effective water markets are operating in Chile (and are beginning to operate in Mexico) with conveyance infrastructure no more advanced than that used in most irrigation systems in mostly developing countries. Water is usually measured only in the main channels, and, thereafter, simple proportional division devices are used that divide water into assigned shares in proportion to canal flow.

Relatively simple irrigation infrastructure is not an intrinsic problem for development of water markets. Rather, it is the complex interaction of the hydrological, infrastructural, legal, and political regimes that determines the feasibility of developing markets in tradable water rights. California's unique hydrological and geographical conditions, combined with the high transactions costs of verifying trades under the state's appropriative doctrine, and the complexity of balancing agricultural, urban, and environmental interests, constrain water market development more than do the relatively unsophisticated irrigation technologies in Chile and Mexico.

Privatization of Water Supply and Management

While, logically, developing tradable water rights leads to significant privatization of water supply, operations, and management, the California, Chile, and Mexico case studies indicate that a wide variety of divisions of public and private responsibilities is consistent with the establishment of tradable water rights, and that these divisions increase water trading flexibility. In California, water markets are highly regulated, and state and federal agencies and water projects play a major role in brokering and conveying water transfers. Mexico's reform undertakes a significant degree of privatization of infrastructure and decision-making, while retaining public control over other important functions. Chile has undertaken the most thorough privatization of water management and infrastructure. In addition to the devolution of irrigation infrastructure to water user associations, urban water services have been privatized. Private financing of water infrastructure and privatization of water management in Chile have improved the efficiency of urban and agricultural water use and allowed a large reduction in generalized subsidies, which has permitted the government to target subsidies to poor urban water consumers and small farmers so that they can buy shares of water rights coming from new infrastructure.

CONCLUSIONS

Based on the experience of the geographic areas studied in this report, significant efficiency gains and economic and social benefits can be expected from establishing markets in tradable water rights. Mexico, after a broad internal debate, passed a new water law in 1992 that shifted from state-managed water policy to a regulated market-oriented policy of tradable water rights. Water trading there initially will be closely supervised, but the law includes a number of provisions that will allow liberalized water trade as water users become more involved in the operation and

management of water and gain experience in water trading. California, with a highly regulated institutional framework and a legal tradition of appropriative water rights that are far from ideal, has nevertheless developed innovative policies that have expanded the use of market transfers to meet growing demand in urban, environmental, and high-valued agricultural uses. Indeed, market transfers have become an important element in California's drought management policies.

The comprehensive, market-oriented water policy adopted nearly 20 years ago in Chile has generated significant benefits for that country's consumers. Chile's tradable water rights have fostered efficient agricultural use of water, which has in turn increased agricultural productivity, generating more production per unit of water. The market valuation of water at its scarcity value has induced farmer investment in on-farm irrigation technology that has saved farmers water for use in irrigating more area or for selling to others. It has also encouraged a shift to high-valued crops that use less water per unit value of output, and has given farmers greater flexibility to shift cropping patterns according to market demand through the purchase, rent, and lease of water.

Market allocation of water has also improved the efficiency of Chile's urban water and sewage services because the country's water and sewage companies can no longer get free water from the state, through expropriation from farmers. When incremental water could be obtained for free, the companies had no incentive to improve either their means of delivery or economic efficiency. The urban companies' acquisition of secure water rights and an active market have encouraged the construction and operation of improved treatment plants that sell water for agricultural or urban use. In addition, Chile's water policy, by reducing huge construction and operations and management subsidies to the better-off farmers and urban water consumers, has freed up public resources that now are used to provide direct and efficient targeted subsidies to poor urban water users and small farmers.

The experiences in Chile, Mexico, and California provide guidance in resolving the complex issues that arise in the process of implementing a system of markets in tradable water rights. Issues that must be dealt with include the initial allocation of water rights, definition of rights as prior or proportional, the treatment of return flows, negative indirect economic effects, protection of the environment, the role of water user associations, infrastructural requirements, and the role of public and private institutions. The policy approach taken on these issues often will be based on the desired balance between the degree of regulation to protect various interests that are affected by water trades, and the level of transactions costs in water trading. However, the case studies here show that a variety of legal, institutional, and regulatory solutions to these issues is compatible with the functioning of markets in tradable water rights.

Furthermore, even comprehensive water law reform allows a phased approach to implementation, which can begin with carefully regulated markets that are progressively opened up as market experience is gained. Greater regulations at the outset will limit the size and scope of the market, and will likely reduce the efficiency gains (and equity gains, to the extent that such regulations perpetuate large general subsidies that favor relatively well-off irrigators and urban water users). The benefits produced by the Chilean reform show that losses incurred from excess regulation of the market could be very large, but this may be an appropriate trade-off for risk-averse governments that are in the early stages of undertaking fundamental reform.

Broad-based trends in the developing world are creating strong incentives for comprehensive water reform that incorporates tradable water rights and the development of markets in these rights. Existing inefficient water systems are under heavy pressure because of the increasing economic value of increasingly scarce water; the rising budgetary costs of highly subsidized capital development and operations and maintenance; and general economic liberalization, which boosts the cost of maintaining inflexible water allocation systems that cannot respond to changing incentives. Development of water allocation through markets in tradable water rights offers a viable approach to meeting the challenges facing developing countries, and should therefore receive serious consideration from policy-makers.

Chapter 1

INTRODUCTION

Water policy in developing countries faces a number of serious challenges, foremost among them being the need to increase the efficiency of water use in the agricultural, urban, and industrial sectors. Irrigated area accounts for production of more than two-thirds of the world's two main crops, rice and wheat; therefore, growth in irrigated output per unit of land and water is essential. Improved efficiency in agricultural water use should permit such growth to be maintained and, at the same time, reallocate water from agricultural to urban and industrial uses.

New sources of water are increasingly expensive to exploit. The only source of water savings of the necessary magnitude to meet growing demand is irrigated agriculture, which generally accounts for at least 80 percent of water use in developing countries. The improved efficiency in agricultural use, to contribute truly to reducing water scarcity, should be accompanied by improved efficiency in urban and industrial use. It makes no sense to attempt to improve agricultural water use efficiency, only to squander these savings through inefficient urban water systems.

A second major challenge for developing countries is to sustain the land and water resource base in the face of mounting pressure to degrade it through waterlogging, salinization, groundwater mining, and water pollution. A third challenge is to reduce the enormous financial resources governments use to build new water infrastructure and maintain water operations and management. Finally, an overarching challenge is to increase the flexibility and responsiveness of resource allocation. Developing countries in much of the world are rapidly liberalizing their economies, putting a premium on flexible response in allocation of water, land, and other resources in the midst of changing economic opportunities.

This paper explores the potential for and constraints against the development of markets in tradable water rights to help meet the aforementioned challenges. Tradable water rights are rights to use water that can be transferred all or in part, separately from the transfer of land. While tradable water rights should be permanent, or very long term, to ensure their security, the *transfer* of water rights need not be permanent: water rights can be leased for a season, a year, or many years.

This paper uses a comparative case study approach, drawing lessons for developing countries from experiences in tradable water rights in California, Chile, and Mexico. These three areas provide important insights: Chile has had nearly 20 years of experience with markets in tradable water rights, following a fundamental restructuring of its water laws; Mexico is in the early stages of implementing comprehensive legal reform establishing tradable water rights; and California has undertaken more gradual reforms to increase the flexibility of water marketing and

trading within a long-established water law tradition that is in some ways inimical to water markets.

The primary focus of this paper is on the laws, institutions, and policies that condition the success of allocating water through markets in tradable water rights. The study relies largely on interviews with participants in and observers of water policy in the study areas, analysis of secondary data, and synthesis of existing literature. A limited amount of primary data collection beyond the interviews was also undertaken.

In addition to outlining the potential benefits from and constraints to establishing tradable water rights, this paper examines the underlying incentives that induce institutional and legal reform bodies to establish tradable water rights; assesses policies for successful implementation of tradable water rights and the actual impact of water market allocation in practice; and concludes with lessons for the potential of tradable water rights as a key component of water allocation policy in developing countries.

Chapter 2

MARKETS IN TRADABLE WATER RIGHTS: BENEFITS AND CONSTRAINTS

For most commodities and inputs, allocation by means of markets has been the favored solution of economists. Economic theory shows that market allocation will be efficient, given well-defined and nonattenuated initial property rights and zero transactions costs. Well-defined and nonattenuated property rights are completely specified, exclusive, transferable, and enforceable (Coase, 1960).

Obviously, the assumption of zero transactions costs does not hold true in markets for water rights, where information, conveyance, and enforcement costs may exceed those in most input markets. However, even in a world with transactions costs, markets in tradable water rights may lead to considerable efficiency gains and other benefits. Tradable water rights empower water users by requiring their consent to any reallocation of water and compensation for any water transferred. Well-defined water rights improve the bargaining power of farmers and farmer groups relative to the public irrigation bureaucracy. With secure rights, water users can invest in water-saving technology knowing that they will benefit by selling or otherwise using the water saved. The combination of secure water and land rights can foster urgently needed private domestic and foreign investment in agriculture. A tradable water rights system also gives farmers an incentive to shift to water-conserving crops.

Marketable water rights can induce water users to consider the full opportunity cost of water, including its value in alternative uses, thus providing incentives to use water efficiently and to gain additional income through the sale of saved water. Such rights can also encourage users to take account of the costs their water use imposes on other farmers, reducing the pressure to degrade resources. A simple example is the farmer at the head of the canal who overuses water, thereby waterlogging other farmers through excess seepage and percolation. If he could trade the excess water instead, he would conserve resources.

Compared with the often-recommended volumetric pricing of irrigation water, the rights-based approach is more acceptable to farmers. Traditional water rights are already capitalized into the value of land. Farmers view the imposition of volumetric pricing as expropriation of these traditional water rights, which creates capital losses in established irrigated farms. Establishment of transferable water rights instead formalizes existing rights to water, increasing the capital value of land.

Market allocation of water and its logical corollary, the requirement for private financing of water infrastructure and water management and operation, work in favor of low-income populations through removal of massive capital and operating subsidies that usually favor better-off producers

and urban consumers. Market-based allocation frees up enormous budgetary resources that can be used for targeted subsidies to the poorest sectors of the population.

Finally, allocation of water through tradable rights provides maximum flexibility in responding to changes in crop prices and water values as demand patterns and comparative advantage change and diversification of cropping proceeds. A market-based system is more responsive to such changes than is centralized allocation of water.

Despite these potential benefits, the use of market-based water allocation mechanisms has been limited by concerns over the possible political, institutional, and technological constraints to managing such a system, and possible inequities arising from market-based allocations. Laws, institutions, and physical water systems must be reformed or developed to assign water rights equitably, to deal with the variability of water supply, to protect against damage to others or to the environment arising from water transfers, and to resolve conflicts. Despite these apparently formidable challenges, reforms have been implemented in California, Chile, and Mexico to develop markets in tradable water rights. The next section explores the reasons behind these reforms.

Chapter 3

INCENTIVES FOR MARKETS IN TRADABLE WATER RIGHTS

The forces behind reform of water allocation to create or expand markets in tradable water rights in California, Chile, and Mexico derive from three related developments: (1) the increasing economic value of water due to scarcity caused by rapid growth in demand for delivered water, depletion of new supply sources, and competition for water among agricultural, industrial, urban, and instream uses; (2) rising budgetary costs of maintaining centralized control of irrigation and urban water delivery due to increasingly expensive and highly subsidized capital development and operations and maintenance of water systems; and (3) broad economic liberalization, which increases the economic cost of maintaining inflexible and inefficient water allocation systems that cannot respond rapidly to changing incentives and comparative advantages.

The gradual reform of California water law to permit greater flexibility in water trading has been driven by the first two developments. Rapidly growing urban and environmental demand for water, the high economic and environmental costs of developing new water supplies, public rejection of infrastructure options such as the peripheral canal linking the water-plentiful north with the increasingly water-scarce south, and serious droughts in recent years have induced policy changes to facilitate water trading. In 1982, California adopted a statewide policy of encouraging voluntary water transfers between agencies throughout the state. This policy was based on the assessment that there are fewer environmental impacts associated with transfers than with construction of conventional projects, and although difficult to implement, transfers can be implemented more quickly and usually at less cost than construction of additional facilities. Since then, a number of laws have been passed to facilitate the sale, lease, exchange, or transfer of water and to ensure that water conveyance facilities are available for use in transferring water (Department of Water Resources, 1992).

Specific innovations in recent years have included the following:

- Water Code reform to 1) permit the transfer of salvaged or conserved water previously lost to beneficial use; 2) permit the purchase of water for instream flow as a beneficial use; and 3) allocate available conveyance capacity in state water delivery systems to water transfers;
- The establishment of the State Emergency Drought Water Banks in 1991, 1992, and 1994, which have demonstrated the ability to broker quickly large-scale market transfers;
- Market-like conservation measures such as the deal in which the Metropolitan Water District of Southern California (MWD) paid for the lining of canals and other physical and management improvements in the Imperial Irrigation District (IID) in exchange for most of the water conserved;

- Liberalization of rules for water trading in the huge federal Central Valley Project; and
- The completion of general environmental impact reports on water transfers that will streamline future analysis of individual transfer requests, reducing the costs of verification and approval.

Water policy reform in Chile and Mexico has been partly influenced by growing water-scarcity-induced increases in the value of water, but reform has been more directly driven by broad economic reform and budgetary cost considerations. Although economic liberalization is neither a necessary nor a sufficient condition for development of water markets, when a country begins the process of economic reform, moving toward liberalized trade and a market-based economy, the establishment of clear and secure land and water property rights and market allocation of both resources are necessary to generate the full benefits of overall economic reform. With a liberalized economy, if land and water rights are not clear and transferable, the agricultural sector has limited flexibility to cope with the changes in demand and price on international markets. General economic liberalization increases the costs of maintaining centralized water allocation policies, thereby increasing the incentives to shift to market-oriented water policies.

In the early 1970s, Chile's economy had become a highly centralized and regulated socialist one, following a decade of increasingly socialist policy changes, which included the expropriation of land and water rights. In addition to regulating the economy and fixing the most important prices, the state owned practically all of the productive system of both goods and services.

Immediately after the change of government in 1973, Chile's new government shifted toward a market-oriented social and economic policy, with complete economic liberalization and open trade. The shift to a market-oriented open trade policy placed a premium on efficient and flexible allocation of water, land, and other resources in the agricultural sector in response to changing economic incentives and opportunities. The fundamental policy reforms to facilitate efficiency and flexibility in resource allocation in agriculture were the redistribution of land and water resources to the private sector under the Agrarian Reform; the definition of clear and well-defined land and water property rights; market allocation of both of these resources; and the drastic reduction of general water subsidies to both agricultural and urban water users.

In the early 1990s, Mexico began its own process of economic liberalization, shifting from a state-centralized, highly regulated system to a market-oriented one. In accordance with this new economic and social approach, the government proceeded to reform Article 27 of the Constitution, which had communalized much of land and water rights in agriculture, and passed a new Agrarian Law. Under the new agrarian policy, farmers became independent from the state in their production and commercial decisions. Full and secure property rights to land were established, both in the communal (*ejidal*) sector and in the private sector. Limits on farm size were essentially abolished, as was the prohibition of foreign landownership in Mexico.

Economic reforms meant that after a transition period with direct subsidies to farmers, farmers would have to be able to produce at internationally competitive prices without subsidies of any kind, except for the extremely poor, noncommercial farmers. It was recognized during the

debate over economic reform that, under the new economic system, retention of existing water laws could severely limit the benefits of freeing up land markets and liberalizing the economy, and would continue to drain the government of budgetary resources because of the huge financial costs and inefficiency in construction and management of infrastructure, a costly central administration, and poor collection of operations and maintenance (O&M) costs in irrigation and tariffs in urban water use. When the new water law passed, the O&M cost of government-owned water and irrigation systems accounted for 0.5 percent of gross national product.

The prevailing water law, with centralized water allocation, was also considered an important obstacle to successful implementation of the new liberalized agricultural policy. Bureaucratically set water allocation would not match the water requirements of farmer-determined cropping systems. Therefore, along with general economic reform, Mexico began the process of implementing fundamental changes in its water policy with respect to water rights, water management, and water allocation, with passage of a new water law in December 1992, which, among other important features described below, created tradable water rights and initiated the process of turning over to farmers the operation and maintenance of irrigation systems.

The case studies discussed in this paper show that factors that increase the value of water, that boost the cost of government water management, or that increase the costs of maintaining relatively inflexible water allocation mechanisms provide strong incentives for governments to increase the efficiency of water allocation through reforms to establish tradable water rights and market mechanisms for water allocation. Other countries that are experiencing increasing water scarcity and budget drains for water development and management and/or are undertaking the process of economic liberalization will face similar strong pressures to reform water allocation processes to create tradable water rights and market-based water allocation. (For an example of a region that has adopted an informal water market system in response to water scarcity, see the summary of Tamil Nadu, India, at the end of this chapter. The summary offers a preview of the case study on Tamil Nadu that appears later in this volume.)

It is obviously impossible, based on the aforementioned case studies, to predict at what point developments become serious enough to cause any given country to move toward market-oriented reform. Shifting from administrative allocation of water rights to market allocation implies a very important, and likely irreversible, political decision. On one hand, it means shifting significant amounts of power from the government to water users; on the other hand, it can mean relieving the government of enormous expenses in investments in water infrastructure and O&M costs that are also shifted to the final users.

The degree to which incentives to establish market-oriented water allocation are translated into actual reform is also conditioned by the existing legal and political structures and processes governing the use of water resources. The gradual approach to reform undertaken in California has been largely the result of long-standing water law, developed under different historical and economic conditions, which in many ways constrains water trading; and the interaction of powerful and often competing interest groups with high stakes in water. (The role of existing water law in slowing the growth of water trading in California will be discussed in detail below.) The interplay of interest groups has been equally important in determining the pace of

liberalization of water trading. Urban interests have long favored maximum flexibility in making market transfers, since growing demand for water is primarily in the urban sector, and water transfers would go mainly from agricultural to urban uses.

Despite considerable dissent from farmers who see the potential benefits from water trading, agricultural and rural interests have mainly opposed rapid liberalization of water trading, fearing devastating economic losses following massive transfers of water to cities. The response of rice farmers in California's Sacramento Valley to the State Water Bank is indicative of the rural/agricultural position. Rice farmers were subject to pressure from the local community and rice farmer cooperatives not to participate in the water bank. The rice growing regions opposed water sales for several reasons. Cooperatively owned rice processing organizations feared the loss of volume, while some growers wanted a higher water price. In addition to these economic reasons, regional political leaders wanted to assert the independence of the area of origin of much of the state's water (Gardner and Warner, 1994).

Environmental interests are ambivalent on the issue of increasing the flexibility of water transfers. While water trading is seen as a partial solution to meeting increasing urban demands without building damaging new water projects, many water transfers have raised serious concerns that the temperature and flow fluctuations caused by water transfers and releases will harm fish and wildlife, particularly salmon eggs and fry. The political dynamics arising from the interplay of these competing interest groups, together with the existing legal structure (and an extraordinarily difficult hydrological and physical environment), have dictated an incremental approach to increased water trading in California.

The political conditions for establishing markets in tradable water rights in Chile and Mexico are more representative of other developing countries, and are also far more conducive to comprehensive reform, than in California's case. In Chile and Mexico, the main stakeholders in water, the farmers, did not have a strong interest in the status quo; to the contrary, the existing system of water law and management gave farmers only precarious rights to water and very little say in its distribution and management. As will be shown in more detail below, comprehensive legal reform to establish tradable water rights was seen as a major benefit by farmers, and has received their strong political support. Support for comprehensive reform has also been strong in the broader government ministries dealing with agricultural, financial, and economic planning, which have had to cope with the adverse economic and fiscal consequences of existing water policies. The main proponents of slower or more limited reform of water rights have instead been the bureaucracies that have directly controlled water management.

In Mexico, although there was broad agreement within the government on the need for well-defined, secure tradable water rights, there were differences in preferences over the appropriate degree of regulation of water markets and over the speed of turnover of irrigation systems to users. The Ministry of Agriculture was in favor of a rapid turnover of the administration of water and water infrastructure, as well as financial responsibility, to newly created independent water user associations (WUAs), while the National Water Commission (the Comision Nacional del Agua, or CNA, which builds and manages water infrastructure) favored a period of co-administration between the water authority and the users, especially with respect to dams and

river basins. The law that was passed in December 1992 reflected a compromise between these positions.

In Chile, the only serious attempt to modify the new Water Code was introduced in legislation developed at the Ministry of Public Works. The legislation, sent to Parliament in December 1992, generated a heated public discussion among policymakers and water users. The most important proposals included the following:

- Forfeiture of water rights if not used for five years from the time of effective use established in the grant;
- The requirement that prospective grantees should demonstrate need for the water;
- Provision of more authority to the central government in conflicts related to water pollution and third-party effects;
- Creation of Administrative Associations of River Basins, including both private and public entities; and
- Assignment of rights to specific use (agricultural, industrial, or household) in the most arid regions of the country; a change in use would then require government approval.

All of these provisions would reduce the security of existing water rights, and increase the administrative discretion of the government in water allocation. Water user associations and farmer associations therefore strongly opposed the legislation. To date, the bill has been frozen out of the legislative agenda by Parliament, and the government has not reintroduced it.

It is clear that the different degrees of willingness of governments to transfer economic power to their people, different government perceptions of the role of the state in managing key resources, and the political interests and strengths of the main stakeholders in water are important factors in determining whether and to what extent tradable water rights and market allocation are established. However, the politics of water in Chile and Mexico, which appear to be representative of many developing countries, have proven to be conducive to comprehensive reform.

With trends in much of the developing world pointing toward growing water scarcity, rapidly increasing fiscal costs of maintaining highly subsidized centralized water management, and increasing general economic liberalization, all of which create pressures for water allocation reform, it is important to understand how markets in tradable water rights can be established and managed. The following chapter examines policies that have been successful in implementing tradable water rights.

INFORMAL WATER MARKETS IN TAMIL NADU, INDIA

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

Tamil Nadu's increasing water scarcity has caused the development of informal water markets, both within agriculture and between the agricultural and nonagricultural sectors.

Informal water trading in agriculture is often initiated by the selling of a small plot of land adjacent to a river to people who can dig a well and pump the water either from a shallow well or directly from the river through underground pipelines to fields 5 to 15 km away from the well. This practice is illegal, however, because wells within 200 m of the river are considered to be recharged directly from the river. Thus, by pumping from these wells, pump owners divert water to which they have no rights.

In most cases, farmers who pump water from riverside wells use diesel pumpsets to do so. However, some farmer/pumpers use electricity by transferring their existing electric connections to these new wells. This practice further compounds the illegality of river pumping: selling water from pumps run using electrical power is prohibited, because electricity is provided free for direct agricultural purposes only.
Informal intersectoral water markets are also operating in and around the major river basins in Tamil Nadu. Well owners sell water to truckers, who in turn transport the water to urban centers. Two locations, Coimbatore City and Tiruppur Town, have particularly active water markets.

In informal markets, well owners pump water using diesel or electric motors (the latter, again, being illegal) and sell it to middlemen for \$0.08 to \$0.10/m^3. (The middlemen—bullock-cart owners and lorry tanker operators—are the main distributors of water to households and other customers.) The cost of water to the end consumer averages approximately \$0.75/m^3, more than 10 times the subsidized rate paid by households connected to the public distribution system. (Relatively well-to-do households served by the public water system pay only \$0.06/m^3.)

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

Chapter 4

POLICIES FOR SUCCESSFUL IMPLEMENTATION OF TRADABLE WATER RIGHTS

4.1 General Guidelines

In general, reform of water allocation mechanisms to implement markets in tradable water rights can be part of comprehensive reform aimed at improving the efficiency of the entire water distribution system, as in Chile and Mexico, or it can be incremental, as in California, which has gradually increased the flexibility of water trading within the context of a legal code that is in many ways antithetical to the trading of water rights.

Outside of the often highly effective, indigenously managed irrigation systems found in small numbers throughout the world, water rights in developing countries are typically poorly defined and precarious. Comprehensive water law reform is therefore the most effective means of moving toward markets in tradable water rights within developing countries. To form the basis for allocation of water through tradable rights, the new law should do the following:

- Be simple and comprehensive, clearly defining the characteristics of water rights and the conditions and regulations governing the trade of water rights;
- Establish and implement water rights registers;
- Delineate the roles of the government, institutions, and individuals involved in water allocation and the ways of solving conflicts between them; and
- Provide protection against negative third-party and environmental effects that can arise from water trades.

Tradable water rights can be highly beneficial even if public ownership and management of the water supply and delivery systems is maintained. However, a logical (and in the longer run, probably compelling) extension of comprehensive reform, which may significantly increase the benefits of tradable water rights, is the privatization of some or all of the physical infrastructure. If this step is taken, the water law should also set the ground rules for turning over existing irrigation system infrastructure to water users for the approval and financing of new infrastructure construction, and for the privatization and regulation of urban water and sewage services. These reforms were handled comprehensively in Chile and to a significant extent in Mexico.

When creating markets in tradable water rights, whether wholesale or incremental, a number of complex implementation issues arise. The next several sections explore the lessons that can be learned from the case studies on appropriate policies for implementing effective markets in tradable property rights. Important issues that arise include the following:

- the method for initial allocation of water rights,

- the definition of rights as prior or proportional,
- the consumptive use and the treatment of return flows in water trading,
- negative indirect economic effects,
- protection of the environment,
- the role of water user associations,
- infrastructure requirements, and
- the role of public and private institutions.

A key theme reappears throughout this discussion: the importance of maintaining fairness in the implementation of water rights and the protection of the interests of all participants in the market allocation of water, while at the same time maintaining low enough transactions costs to make water markets operate efficiently.

4.2 Transactions Costs

Transactions costs arise whether water allocation is determined through administrative discretion or through water markets, and include (1) the cost of identifying profitable opportunities for transferring water, (2) the cost of negotiating or administratively deciding on the water transfer, (3) the infrastructure cost of conveying the water and monitoring the transfers, and (4) the infrastructure and institutional cost of monitoring, mitigating, or eliminating possible third-party effects and other externalities.

Under administrative allocation, a public or quasi-public water authority (for example, a river basin commission or a national or regional water authority) would identify water demands or alternative uses and simply reallocate existing water allocations or rights to higher-valued uses. Since the losers will undoubtedly protest, the authority will have to negotiate with the users and find some way of compensating the losers. Administrative allocation also may be subject to political pressures, and is often subject to high costs of inefficiency and private rent-seeking by those managing the system, who do not have the same incentive to minimize the total cost of water transfer as a buyer would.

Markets in tradable water rights, on the other hand, use the price response of users to reallocate water. Users have an incentive to increase their water use efficiency, and low-valued uses will give up water to higher-valued uses in a decentralized decision-making process involving the individual users. With tradable rights, because buyers bear the costs of conveyance and mitigation, they will attempt to make those trades that minimize the purchase price, as well as conveyance and mitigation costs. Water markets thus hold some important possible advantages in minimizing transactions costs, but the ways in which markets are organized and regulated have a major impact on transaction costs. Excessive regulation that creates high transaction costs can greatly reduce the benefits of water trading, while inadequate regulation can impose unacceptable costs on third parties or the environment. The ways in which water law, institutions, and

technology can balance the protection of interested parties in the water market allocation process with the transaction costs of this process are explored in several sections below.

4.3 Fairness in Initial Allocation of Water Rights

The first condition for success in developing tradable water rights is agreement on the "rules of the game," beginning with the perception of fairness in the initial assignment of water rights. The fairness objective seems to have been met in Chile and Mexico, by basing initial allocation largely on historical water use, combined (in Chile) with redistribution of concentrated rights holdings. The assignment of rights is formalized through registration of the rights in public registries in both countries. In Mexico, the fundamental basis for initial allocation of water rights is the existing informal or formal water right already held; previous water use can be established by certification from an irrigation district or *ejido* administrator, or by testimony of neighbors as to the individual's land and water rights under previous law. Although granting of concessions is at an early stage, discussions with farmers and officials do not indicate much concern that the initial allocation process will be inequitable. Titling of land rights in the same areas as water rights is well under way. (The prior or simultaneous completion of land titling facilitates the allocation of water rights.)

In Chile, the establishment of tradable water rights beginning in 1975 was linked to the reprivatization of land that had been collectivized in 1966. Land and the proportional right to water historically used on this land was returned 40 percent to former landowners and 60 percent to former workers on the land. After the turmoil caused by expropriation of land and water in the 1960s, the establishment of tradable water rights and redistribution of a large portion of these water rights to former landless laborers was seen as a substantial improvement in equity. In California, the equity of initial assignment of rights has not been a major issue in the context of increasing the flexibility of water transfers; available water rights have long since been fully appropriated. However, the fairness of reallocating rights through market or other mechanisms arises in a number of contexts described below.

4.4 Prior versus Proportional Water Rights

A key distinction between water rights in California on one hand and Chile and Mexico on the other is that the former defines rights on a priority basis, while the latter two effectively define water rights as proportional to stream flow or canal flow. In Mexico, water rights are technically specified in volumetric terms rather than in proportion to stream flow, and the irrigation districts and water user associations (WUAs) are charged with developing procedures to allocate surplus and deficit water within their boundaries. Indications are that surpluses and deficits will simply be allocated proportionally across all existing rights, so that, for example, if stream flow is 20 percent below normal, each rights holder will receive 20 percent less water. This procedure effectively converts the volumetric right to a proportion-of-stream-flow right. In Chile, water rights are proportional rights (shares) over a variable flow or quantity; deeds stipulate that an owner has the right to a certain number of shares at a certain location. These rights are

expressed in volume by unit of time (liters per second or cubic meters per year or month) and are proportional if supply is insufficient.

In California, both riparian rights and appropriative rights to water exist, but tradable water comes exclusively from water held under appropriative rights doctrine. The appropriative rights doctrine limits the flexibility of reallocating water to the most productive purposes in response to drought-induced shortages. The "first in time, first in right" principle in the appropriative rights system ensures that, when shortages occur, senior rights holders, who established their rights before junior appropriators, receive first priority to available water, whether or not they are using the water for high-valued purposes. Because these priorities are not based on economic returns, but on chronological time of establishment of water rights, considerable inefficiencies can occur due to deprivation of higher-value uses of water.

Water shortages in federal water projects in California are in theory handled differently from those occurring in areas covered by privately acquired appropriative rights. In federal projects, water users within a reclamation district share the effects of drought. Thus, even the most senior irrigator in a water district may have to reduce water usage by the same percentage as every other user in the district. However, often the burden is deliberately shared unequally. In California's San Joaquin Valley, for example, most water districts allocate surface water on the basis of acreage served, and during shortages, many give preference to lands growing permanent crops (Reisner and Bates, 1990). Thus, under either state or federal water rights, top-down rationing of water is often invoked during droughts. The inability to get water where it is most needed during shortages is a major limitation of the prior rights system.

The choice as to which type of rights works best to facilitate water markets must balance the advantages and disadvantages of each of the two approaches (Howe, Schurmeier, and Shaw, 1986). The priority rights system allows different degrees of water supply reliability to be purchased, but the heterogeneous nature of the rights makes it difficult to organize the market. With proportional rights, some inefficiencies may be introduced because users must hold more shares to reach any given level of assurance of water supply due to the variable supply of water, but the homogeneity of proportional rights makes it much easier to create markets. The proportional rights system is also more flexible and equitable in allocating water deficits than a prior rights approach. The equal sharing of shortages gives the system an important advantage. Overall, the advantages of the proportional rights approach in facilitating market creation and in equitable allocation of deficits outweigh the possible market inefficiencies from the need to hold extra shares (Frederick, 1986).

The proportional rights system has worked well in water trading in Chile, despite the variability in actual water produced by a given share right. Water users there readily adjust their purchase or lease decisions depending on the probable yield of a water right at any particular time. A typical case of a Chilean short-term cash rental would be a farmer who uses three shares of 15 liters per second (l/sec) to irrigate 30 hectares (ha) of high-yield wheat from October to December. He crops his wheat in late December and rents the water from January until April, to a 30-ha sugar-beet producer who also uses his own three shares for irrigation. The wheat farmer is willing to rent his water because each share will actually be delivering only about 7 to

8 l/sec during the low-flow summer period. With the rental, the sugar-beet farmer attains the 45 l/sec he needs. Were the water market unavailable, the wheat farmer would apply his water to a lower-income purpose, such as irrigating the wheat-cropped land for grazing. On the other hand, the sugar-beet farmer would have to cultivate only the 15 ha he can irrigate with his summer availability of water. With the rental options, both farmers win.

4.5 Consumptive Use and Return Flows

A second key distinction between water rights in California and in Chile and Mexico lies in the definition of the tradable portion of the water right. In California, the transferable portion of the appropriative water right is limited to consumptive use, with protection of third-party rights to return flows. This system protects prior rights to return flows, but, depending on the implementing regulations, significantly increases the transaction costs of water trading because of the difficulty in measuring consumptive use and return flows.

California's system for determining the tradable portion of appropriative water rights in terms of consumptive use imposes a strong burden of proof on the prospective water seller for determining how much water is tradable. Six sources of tradable water are available: fallowing (not irrigating crops), shifting to less water-using crops, substituting groundwater for surface irrigation water, direct pumping of groundwater, conserved water, and water from reservoir storage. In regulating each of these types of transfer, the Department of Water Resources (DWR) distinguishes between new water, which is water previously unavailable to the system; real water, which is water available for transfer that is not derived at the expense of other water rights holders; and paper water, which is water proposed for sale that does not create an actual increase in system supply. Strict requirements are placed on each category for identifying the new or real water available for transfer. The level of proof required can be illustrated in the following example of fallowing.

Water saved by fallowing a crop for an entire irrigation season can be transferred to another use. Although this concept appears straightforward, determining tradable water requires verification of farmer intentions, adequacy of water supply, and computation of consumptive use. To determine farmer cropping intentions, the DWR uses long-term crop and water records, and personal knowledge of extension agents and other experts. Determining the adequacy of water supply requires information about the rights and contracts pertaining to the fallowed farm, together with an estimation of the actual availability of irrigation water during the period of transfer. For short-term transfers this is relatively easy, but for long-term transfers, considerable uncertainty arises because future availability can vary due to droughts, operational restrictions, or legal and policy changes affecting future contracts.

The final step in determining tradable water is computing consumptive use. In California, the concept of consumptive use has evolved over time, and some uncertainty about its interpretation prevails. However, the generally accepted definition now is actual crop evapotranspiration plus percolation of water that is lost to further use. Under the 1992 Central Valley Project Improvement Act, water available for trade includes "water that would have been consumptively

used" and water "irretrievably lost to beneficial use." Thus, water that would otherwise percolate to the degraded groundwater in parts of the San Joaquin Valley would be tradable, but water draining to wetlands or used by vegetation that provides significant wildlife habitat would not be (Department of Water Resources, November 1993).

Chile and Mexico have in essence followed an alternative model developed in the Northern Colorado Water Conservancy District (NCWCD), where rights are proportional to stream flow and rights to return flow are retained by the district. Return flows are made available to water users at no charge, but no rights to these flows are established. Changes in patterns of return flows due to trades therefore cannot be contested. By denying third-party rights to return flows, the NCWCD has greatly reduced the transactions costs involved in trades, resulting in a very active water market (Howe, Schurmeier, and Shaw, 1986; Cummings and Nercissiantz, 1992).

Chile and Mexico have followed the NCWCD model by defining tradable rights as full diversion rights that are proportional to stream or canal flow. Rights to return flow do not exist, although the laws in both countries do protect third parties from potential damages arising from trades (see Section 4.6).

In Chile, return flows to neighboring areas may be used by the recipients of the return flow without the need to establish a right of use. However, use of this water is contingent upon the flow of the main waterways and usage rates of the rights holder. The rights holder has no obligation to supply return flows, and such flows are thus not permanent. In Mexico, the initial concession of water rights is based on the normal previous consumption of water by the individual or group. The law, however, makes clear that this "consumption" is not the "consumptive use" right with obligation to maintain a specific amount of return flow that is common in the western United States, but rather is the full diversion right.

The question of which system is more appropriate for developing countries raises complex issues. Potential water transfers that go undone because of restrictive regulations can be very costly in terms of lost opportunities to gain water supplies. The transactions costs of enforcing the consumptive rights approach can be very high, reducing the number of trades possible, but it clearly protects third parties against adverse impacts resulting from water trades. The decision on which approach to use is ultimately an empirical one. If benefits lost from failure to undertake water trades due to the high transactions costs of enforcing return flows exceed the net cost of adverse impacts resulting from lost return flows, the full diversion right approach is preferable.

To the extent that real losses do occur from loss of return flows, innovative methods could be used to compensate those who are hurt by them. Possible reforms that could move in this direction would be to provide financial compensation for losses out of the proceeds of the trade, or reserve a portion of water rights to water user associations, water districts, or other water suppliers to be allocated to compensate for actual damages resulting from reduced return flows if simpler procedures fail in some cases.

Under developing country conditions, the Chile and Mexico approach of tradable shares with no rights to return flows is preferable as a general principle because enforcing consumptive rights

following the California model would be extraordinarily costly and would likely prevent market development. Nevertheless, within many countries, hydrological conditions in some river basins, where return flows are very large and traditional rights to these flows exist, will make additional protection of return flows necessary.

In Chile, additional protection of return flows has been afforded in two important river basins: the Aconcagua River, in an area with a large proportion of high-valued crops; and the Elqui River, a small but significant river because it is located in the desert zone. These two rivers irrigate very narrow valleys, and return flows are large. The reduction or elimination of return flows due to sales or efficiency gains could drastically affect the total flow of a section of either river. The Elqui River Water Users Association has dealt with this problem by limiting trades within upstream areas to farmer-to-farmer transactions (to retain all return flows within the basin), unless unanimous approval of members is obtained, with agriculture-urban transactions authorized only downstream.

Where return flows are highly significant, other methods could also be tested to protect the flows while keeping transactions costs low. New Mexico, for example, uses simpler and less costly procedures than California. The State Engineer's Office determines transferable water quantities using standard formulas together with historical and secondary data. Reliance on standard transferable quantities for specific regions, soils, and climates reduces the transactions costs applicants incur to hire hydrologic and engineering experts, saves staff time among water agencies, and creates more certainty in the transfer process (Colby, 1988).

An even simpler procedure would be to create a uniform presumption regarding consumptive use and return flows, which eliminates the need to determine consumptive use on a case-by-case basis. In Wyoming, the statute authorizing temporary water transfers creates the presumption that 50 percent of diverted water is allocated to return flows, with the remainder considered to be tradable. Although attempts to rebut the presumption could be made, they would likely be infrequent if the presumption is a reasonable approximation of the amount of return flows. If, as is likely, a uniform statewide presumption is infeasible due to different agroclimatic conditions, regional presumptions could be established (Gould, 1989).

An approach worth assessing for river basins where return flows are significant would be a combination of the Elqui and New Mexico methods. A determination first could be made of areas where return flow restrictions would be unnecessary because return flows are lost to beneficial use. In these areas, such as the downstream area of the Elqui, any trades could be made of the fully diverted share. In all other sections of the river basin, intersectoral water trades (which would affect beneficial use of return flows) would be subject to a presumptive return flow allowance. In evaluating any of these alternatives to protect return flows where doing so is empirically necessary, the key is to keep transactions costs low while limiting return flow presumptions to the maximum that are actually produced, so as to preserve incentives for conservation and increase the gains from efficient market transfers of water.

4.6 Protection against Negative Indirect Economic Effects

Water transfers can hurt business activities, local government fiscal capacity, and the quality of public services in areas from which water is being transferred because reductions in irrigated area or production cause associated reductions in agriculturally linked economic activities in the area of origin and in the property tax base. In addition, permanent transfer of water rights may limit future economic development in the area of origin. If future economic conditions make expanded irrigated agriculture, new industrial activities, or residential development economically attractive, water transfers may make water unavailable locally to pursue these opportunities.

Although area-of-origin effects are of understandable concern to area residents, analysis suggests that the direct and indirect economic impacts of water transfers on the area of origin generally are small from a regional or state perspective. For example, indirect economic effects from water transfers using the 1991 California State Emergency Drought Water Bank were small. Farmers who sold water to the bank reduced their farm operating costs by $17.7 million, or 11 percent, and crop sales by $77.1 million, or 20 percent. These reductions adversely affected the suppliers of farm inputs and the handlers and processors of farm outputs, but the impacts were not large when compared with the agricultural economy in the selling region. One study estimated that operating costs, crop sales, and agribusiness revenues dropped 2 to 3 percent in selling counties because of the bank (Dixon, Moore, and Schechter, 1993).

Despite these relatively small impacts, in California, both state and federal law contain protections against general economic impacts, and more have been proposed. During the years when major water projects were being developed in the state, a variety of area-of-origin legislation was enacted to protect northern California supplies from being depleted as a result of the projects. For example, County of Origin Statutes provide for the reservation of water supplies for counties in which the water originates when, in the judgment of the State Water Resources Control Board, water transfers will deprive the counties of water necessary for their present and future development. State law also prohibits the use of public agency facilities to transfer water unless a finding is made of no unreasonable impact on the overall economy of the county from which the water is diverted. Further restrictions on aggregate amounts of water that can be transferred are embodied in recently enacted provisions that limit the amount of total water supply suppliers can transfer as a result of fallowing. The new limit is 20 percent of the water that the supplier would have applied or stored.

Explicit protection for specific categories of indirect adverse impacts are not included in the Chilean and Mexican water laws. However, both laws provide for strong protection of third-party rights arising from trades. In addition to approval authority by the local WUA, third parties that could be damaged by a trade are further protected through prohibition of damaging transfers or the setting of compensation; by appeals to appeals to the CNA (the National Water Commission) in Mexico, and the National Water Authority in Chile; and by final appeals to courts in each case.

Furthermore, in Mexico, the greater the change in the type of consumptive use of water through a proposed trade (which increases the probability of indirect impacts), the greater the scrutiny the trade receives in the approval process. Additionally, all water rights transfers must be recorded

in the Public Registry of Water Rights maintained by the CNA. In general, the process can be seen as a regulatory hierarchy, with WUAs having authority over trades among individuals, the regulations of the irrigation district (ID) having primacy over the WUAs, and the CNA having authority over operations of the IDs. Transfers among farmers in the same general locale have been commonplace for decades, with implicit or explicit CNA approval, so it is unlikely that the CNA will exercise a heavy hand over these types of transfers. However, the CNA intends to play a strong role in approving and brokering intersectoral trades, paying particular attention to possible adverse indirect impacts.

Evidence from Chile suggests that not only are negative impacts small, but agricultural regions have benefited substantially from water trading. An important outcome of Chile's water policy is the ability of urban water suppliers to purchase agricultural water without having to buy land or expropriate water. Rarely have negative effects occurred in the agricultural zones surrounding water-demanding urban areas, because farmers mostly sell small portions of their rights and maintain agricultural production with highly efficient on-farm irrigation technology for orchard or vegetable crops grown in these areas.

Agriculture-urban trades consist mostly of purchases of rights from farmers by urban water and sewage companies. A typical Chilean case would involve one of the eight water companies that serve Santiago buying water rights to the Mapocho River from several farmers in order to provide water to a new housing development or a new industry. The farmers will usually sell a small portion of their rights, which they can dispose of because they have improved their irrigation efficiency. The farmers obtain an important amount of fresh capital in exchange for their water rights. A farmer who increases irrigation efficiency by 30 percent on a 40-ha grape farm can dispose of water rights shares equivalent to 24 l/sec, selling for $7,000 to $10,000, without reducing agricultural production.

The 5 percent per annum growth in Chilean agriculture since reform of land and water rights also calls into question any presumption of negative area-of-origin effects on the agricultural sector, which is the source of virtually all water sales. With the increasing value of water, the area planted to fruits and vegetables, which require more water per hectare but far less water per value of output than most field crops, increased by 206,000 ha from 1975 to 1982, replacing traditional crops and irrigated pastures. In addition, two studies have attempted to measure the increase in aggregate water use efficiency in Chile's agriculture from 1975 to 1992. The first study found a 26 percent increase in efficiency (Munita, 1994), and the second a 22 percent increase (Frías, 1992). Considering the lowest estimate, and taking into account that Chile's total irrigated area, with permanent rights, amounts to 1.2 million ha, this is equivalent to freeing up enough water to irrigate an additional 264,000 ha of crops of average water-use intensity. On the other hand, in a conservative estimation, an investment of about $400 million in new infrastructure would be required to supply the incremental water saved through efficiency gains generated by policy reforms.

The experiences of California and Chile thus suggest that negative indirect economic effects from water trading are small or nonexistent. In Chile, tradability of water has contributed to diversification and rapid growth of the agricultural sector. Broad-based area-of-origin protection

against intraregional or intrabasin trade on vague grounds of "unreasonable impact" can suppress otherwise effective water markets, and afford excessive discretionary power to regulatory agencies. Given the generally small impacts of the indirect costs of trade, it would be better to make explicit what is unreasonable, and to place the burden of proof on the area of origin to demonstrate negative impacts.

4.7 Protection of the Environment

The evidence from the Chile, Mexico, and California case studies shows that allocation of water by markets is perfectly compatible with environmental protection. Implementation of environmental protection in a market system is no more difficult than with administrative allocation. In fact, in California, many environmental groups have joined with urban interests in cautious support of water marketing as the way to meet growing water demands without building new infrastructure, which is seen as more damaging to the environment than water transfers.

Among the three case study areas, California's water policy includes by far the most protection for the environment, followed by Mexico and then Chile. In California, state law prohibits water transfers that would have an unreasonable impact on fish, wildlife, or other instream uses. A wide range of environmental and water quality laws affect the feasibility of water transfers. Probably the most significant constraints are those imposed by the federal and state Endangered Species Acts (ESAs). Under the ESAs, an endangered species is one that is in danger of extinction in all or a significant part of its range, and a threatened species is one that is likely to become endangered in the near future. The ESAs prohibit the "take" of endangered species and threatened species for which protective regulations have been adopted. Take has been broadly defined to include actions (including water transfers) that could harm or harass listed species or that cause a significant loss of their habitat. This interpretation imposes severe limitations on the timing and volume of water transfers that could affect natural flow rates through the Sacramento-San Joaquin Delta. A large portion of potential future market transfers would need to be pumped through the delta (see also below), so these limitations may seriously constrain growth in market transfers.

Mexico's new water law is the first to establish strong explicit protection of the environment. The law stipulates a regulatory, rather than a market or tax/subsidy, approach. The quality of discharge for nonagricultural uses must be specified in the granting of the water right, and the CNA can invoke restrictions over water use in the event of damage to ecosystems, overexploitation of aquifers, and other environmental impacts. The law establishes a minimum stream flow for rivers, but makes no explicit reservation of flows for environmental purposes. The transfer of water rights for instream flow is not prohibited.

Invocation of restricted or prohibited areas gives the CNA particularly strong powers to regulate water transfers that could affect the environment. The law allows the CNA to regulate the extraction and use of water and establish restricted areas or reserves for the following reasons: to prevent overexploitation of aquifers, to protect or restore an ecosystem, to preserve sources

of potable water or protect them against pollution, to preserve and control water quality, and to restrict use during unusual water shortages or drought. Under these provisions, the CNA has full control over extraction, discharge, and transfer of water in affected areas. Some 70 percent of total irrigated area served by groundwater is currently under some form of prohibition or restriction in Mexico.

In Chile, strong environmental protection is lacking in the Water Code, although several provisions allow protection of environmental interests. All major infrastructure construction (dams of more than 50,000 m^3 or aqueducts carrying more than 2 m^3 per second) requires the authorization of the General Directorate of Water (Direccíon General de Aguas, or DGA) in order to prevent harmful third-party effects or environmental damage. The DGA is also empowered to undertake vigilance over water in natural channels for public use and will prevent the building, modification, or destruction of waterworks along natural channels unless prior authorization has been obtained. The president of the Republic, at the request or upon the report of the DGA, may declare drought zones during extraordinary dry periods for maximum and nondeferrable six-month periods. The DGA will determine, by resolution, the drought periods that are to be considered extraordinary.

Once a drought zone has been declared, if no agreement is reached between the users regarding the distribution of water, the DGA is empowered to distribute for public use water available in natural waterways and in channels that impound water from them. With the aim of minimizing the general drought-induced environmental and other damage, the DGA may suspend the authority of the users' organizations. Any rights holders who might receive a lesser portion of water than they are due (in accordance with existing availability) will be entitled to state compensation for the lost portion. These protections will be significantly enhanced with the recent passage of Chile's Environmental Protection Law.

The range and type of environmental protection thus vary widely across the three case study areas. As with the case for protection of return flows, a balance must be struck between the benefits from environmental protection and the costs of rejecting profitable water trades. Some analysts of California's water system have argued that regulations and mandated water allocations for fish and wildlife have resulted in excessive protection of the environment versus other water uses, and that a market-based approach to environmental protection would be preferable (Gardner and Warner, 1994). A possible reform that would increase market flexibility and better measure preferences across all types of final demands would be to reduce mandated water allocations for environmental purposes and require that environmental interests compete for scarce water in the market.

The primary economic argument supporting mandated environmental allocations is that the benefits of water allocations to fish and wildlife are dispersed across a large number of people, so it is very difficult to form environmental coalitions to purchase water rights. However, private groups have in fact begun to purchase instream water rights in California and elsewhere. Allocation of some portion of public funds (the amount of which would be subject to public determination) for purchase of instream water would also facilitate a market allocation approach to environmental uses of water. The latter policy has already been implemented on a small scale

in California. The state's Department of Fish and Game purchased 41,000 acre-feet of water from the 1991 Drought Water Bank and 16,000 acre-feet from the 1992 bank.

It must be noted that reducing mandated water allocations for environmental reasons would meet with strong opposition from environmentalists. Environmental groups have won substantial gains in mandating water for environmental purposes, and would likely oppose a policy that "gives back" some of these gains. In the final instance, in any society, how much environmental protection is provided is a matter of political choice.

4.8 The Role of Water User Associations

It has been argued that establishing tradable property rights in water is somehow antithetical to traditional community values, and inimical to communal management of water (Young, 1986). However, assignment of tradable property rights to individuals within WUAs, or even to communal groups themselves, should in fact enhance the control of these groups over water resources, better ensuring access to water than is often the case for water user groups that enjoy no such rights. In practice, turnover of irrigation systems in many countries has simply legitimized the transfer of the responsibilities for operations and management to farmers, thereby reducing the costs to financially strapped public bureaucracies. However, the turnover of costs and responsibilities has not been accompanied by change in the fundamental incentives governing water use. If well-defined transferable water rights are granted to the group, or to the individuals within the group, water user groups will have the incentive to economize on water use, and will have the legal standing to negotiate with the relevant water delivery agency for timely and efficient service.

In both Chile and Mexico, strong WUAs play a major role in water allocation. In Chile, user associations own and manage the physical infrastructure, monitor water allocation, approve water transfers subject to specific conditions, and provide the initial (and usually final) forum for conflict resolution. In Mexico, the turnover of irrigation districts to newly organized WUAs is fundamental to the establishment of water rights. Under law, water rights can be provided to individuals or groups, but there appears to be a strong preference for concessions to be made to groups, with the groups then to grant subsidiary water rights to their individual members through internal processes to be authorized by the CNA.

An important question arises as to whether water rights or full veto power over all water trades should be granted to water user groups. On one hand, assignment of tradable property rights in water to communal groups may be more cost-effective than assigning rights to individuals in instances when internalizing bargaining within the group reduces the informational, contractual, and enforcement costs relative to bargaining between individuals. Preventing the domination of groups by powerful individuals would require establishment of easily understood decision-making mechanisms within the community.

Conversely, assigning tradable water rights to a group, while preferable to most existing allocation systems, inevitably weakens the security of the rights of the individual, who is making the fundamental farming and other resource allocation decisions. Experience in California

indicates that granting too much authority to WUAs also can stifle water market development. Recent reforms of laws governing water transfers in the huge Central Valley Project (CVP) operated by the federal Bureau of Reclamation were designed to reduce the power of irrigation districts to veto trades and to increase the flexibility of water marketing, by providing that all individuals and districts receiving CVP water may transfer it to any other entity for any project or purpose recognized as a beneficial use under state law. The affected district has approval power only over transfers involving more than 20 percent of the CVP water under long-term contract with the district. This clause, allowing farmers to sell up to 20 percent of their water without approval of their local irrigation or water district or agency, has, for the first time, vested the property right to the first 20 percent of contract water directly in the individual user (Howitt, 1994).

These conditions contrast sharply with the incentives facing potential water sellers in Bureau of Reclamation districts before passage of the CVPIA. Water transfers then required permission from existing irrigation and water districts in a water project, and such transfers could not be detrimental to the project or to any senior appropriator. In effect, as long as any users in the district could use the water at its nominal cost, individuals could not sell water at market prices. With these legislative restrictions on gains from trade, water districts and groups of members often obstructed water trades (Howitt, 1994). Thus, strong WUAs are a key to the successful development of markets in tradable water rights, but excessive power vested in them is detrimental to market development.

In Chile, strong WUAs have the authority to veto water transfers in artificial watercourses if they cause hydraulic third-party effects, or if the buyer fails to finance the necessary infrastructure changes to ensure no effect on water rights delivery to third parties. Chile's WUAs also can deprive of water those who fail to pay the water fees for operation and management or investment repayment. Nevertheless, there has been virtually no conflict between Chile's WUAs and individual water users within the WUAs because the WUAs' authority is limited to specific cause, and, perhaps more importantly, because water rights are individually titled. Allowing individuals to hold title to the rights ensures a natural balance of power between individuals and WUAs.

4.9 Infrastructure Requirements for Tradable Water Rights

Sophisticated measuring devices, division boxes, and other conveyance structures are not necessary to implement a water trading system. Effective water markets are operating in Chile (and are beginning to operate in Mexico) with conveyance infrastructure no more advanced than that used in most irrigation systems in mostly developing countries. Water is usually measured only in the main channels, and, thereafter, simple proportional division devices are used that divide water into assigned shares in proportion to canal flow.

The question of technology is more a matter of degree than an either/or situation: Better technology will improve water market efficiency, and increase market benefits by reducing the transactions costs of trading, but significant gains from trade can be realized without highly sophisticated technology. Moreover, synergy exists between markets and technological

improvements in conveyance: Technological innovations in water delivery and metering can reduce transactions cost and encourage market-oriented reform in allocative mechanisms, while markets in turn can induce technological change by increasing the returns to investments (Young, 1986).

Ironically, California, with the most sophisticated technology by far in the case study areas, faces the most difficult hydrological and physical constraints to water trading, due to its unique geography. If water transfers are to be made on a large scale in California, a substantial portion of them will be transported by either the California State Water Project (SWP) or the federal Central Valley Project (CVP), and will be pumped by these projects through the Sacramento-San Joaquin Delta, the 1,153-square-mile region located where California's two biggest rivers converge and flow into San Francisco Bay. (Forty-two percent of the state's annual runoff flows through the delta.)

The SWP and CVP water facilities in the south delta pump water to supply farms and cities in central and southern California, providing water to about two-thirds of the state's population. These projects and local facilities also provide about 60 percent of the water used in the San Francisco Bay area. Delta waters support 28 native and 28 nonnative fish populations, in addition to the salmon and steelhead populations that migrate through the delta on their journey to the Pacific Ocean. Significant water trading is likely to occur in California only if a fair balance can be found among urban, agricultural, and environmental uses that resolves the delta's very complex and controversial water issues.

In order to minimize impacts on the winter-run Chinook salmon, delta smelt, and striped bass in the delta, and to avoid disruption of service to existing contractors, pumping of water by the SWP and CVP through the delta to meet transfer agreements has been limited mainly to August through October. Such strict delta protection requirements could severely constrain the potential for an increased volume of water transfers through the delta.

In the short term, even existing SWP and CVP contractors relying on the delta for all or a portion of their supplies face great uncertainty in terms of water supply reliability because of the uncertain outcome of ongoing bay-delta proceedings. For example, in 1993, an above-normal runoff year, environmental restrictions limited CVP deliveries to Westlands Irrigation District to only 50 percent of contracted supply. Until solutions to the delta's complex problems are identified and put into place, existing contractors who rely on transport through the delta will experience more frequent and severe water supply shortages, and the potential for more active trading of water, which would increase flows through the delta, will be highly problematical.

Relatively simple irrigation infrastructure is not an intrinsic problem for development of water markets. Rather, it is the complex interaction of the hydrological, infrastructural, legal, and political regimes that determines the feasibility of developing markets in tradable water rights. California's unique geographical conditions, combined with the high transactions costs of verifying trades under the appropriative doctrine, and the complexity of balancing agricultural, urban, and environmental interests, constrain water market development more than do the relatively unsophisticated irrigation technologies in Chile and Mexico.

4.10 Privatization of Water Supply and Management

An issue that cuts across many of the other issues described above is the delineation of roles between the private and public sectors in the management of a water market allocation system. While, logically, developing tradable water rights leads to significant privatization of water supply, operations, and management, the California, Chile, and Mexico case studies indicate that a wide variety of divisions of public and private responsibilities is consistent with the establishment of tradable water rights, and that these divisions increase water trading flexibility.

In California, water markets are, and likely will remain, highly regulated, and water market implementation will require considerable central participation from the DWR and other state and federal agencies and projects. This is because of (1) the strong burden of proof placed on potential traders to verify consumptive use and lack of direct and indirect damage to third-party and environmental interests under California's appropriative doctrine; (2) the necessity to balance the demands of powerful interest groups with competing demands for agricultural, urban, and environmental purposes, a challenge that is accentuated by the state's geography; (3) the unique hydrological and geographical conditions governing water transfers in California, especially considering the fact that a large share of future water transfers will need to be transported through the Sacramento-San Joaquin Delta; and (4) the related need for careful timing of water transfers, which will be made in most cases through storage and delivery infrastructure that is already heavily committed to existing contractors. The DWR (and the federal CVP) will therefore be expected to play a major role in facilitating water transfers, including identifying transfer opportunities, determining the amount of water available for transfer under individual transfer proposals, certifying that trades do not cause third-party damages, and scheduling the actual transport of traded water in the SWP and other projects while meeting environmental requirements and contractual commitments.

Mexico's reform undertakes a significant degree of privatization of infrastructure and decision-making, while retaining public control over other important functions. As was mentioned above, in Mexico, the turnover of irrigation districts to water users was fundamental to the water law reform that created tradable water rights. Privatization of urban water and sewage companies is also proceeding quickly, with the government finalizing an international bid to choose one or several private water companies to operate, through a long-term concession, Mexico City's water and sewage facilities, which will serve a population of 22 million.

A key objective of district turnover is to improve the funding of and eliminate subsidies to the operations and maintenance (O&M) of irrigation systems. After turnover, WUAs are required to fund and implement O&M for canals and other infrastructure under their control, with the level of fees set by the implementing regulations approved by the CNA. The reform has already achieved considerable success in improving cost recovery, with the CNA reporting that farmer payments as a proportion of total O&M have increased from 18 percent in 1988 to nearly 80 percent in 1993. These gains have been achieved through budget restrictions on O&M outlays and the informal transfer of irrigation district administration to water users as the formal turnover proceeds.

The CNA will retain control over dams and main (as well as larger secondary) channels and diversion structures both above the irrigation district level and within districts. The CNA will collect a fee from WUAs to pay for conveyance of water to the district and O&M on infrastructure within the district that is retained under CNA control. Mexico's water law also allows the construction of new water infrastructure only with water users' approval and their participation in funding capital costs, but regulations to implement these provisions have not been activated.

Chile has undertaken the most thorough privatization of water management and infrastructure. In addition to the devolution of irrigation infrastructure to WUAs, urban water services have been privatized. Before reform, the state-owned urban water and sewage city services were highly subsidized and quite inefficient, both physically and economically. Beginning in the early 1980s, they were transformed into urban water and sewage companies. Shares are owned in different proportions by the public, municipalities, the regional governments, and the national government, and are traded on the stock market. Because utility concessions are a natural monopoly, the maximum fees for the privatized urban water and sewage services are fixed by the Ministry of Commerce, taking into account the market price of raw water, amortization of infrastructure, preservation, maintenance, management, distribution, collection, and a certain percentage for investments in infrastructure improvement. Each utility fixes its rate, which must be below the maximum set by the government.

Privatizing urban water services has had dramatic efficiency and equity impacts in Chile. Reform has contributed to the expansion of coverage of potable water in the country's urban areas from 63 percent in 1970 to 99 percent currently, and in agricultural areas from 27 percent to 94 percent. In addition, the removal of broad-based water subsidies has allowed the government to increase the level of subsidies it targets directly to the rates that low-income sectors of the population pay for urban water. These subsidies amount to a specified monthly free quantity of water (up to 20 m^3 per month) in predetermined sectors of the cities accounting for the poorest 20 percent of the population. These subsidies are paid directly to the local water company.

Finally, a major innovation in Chile is the creation of water rights prior to construction of an irrigation system, and the requirement of consultation and approval for construction plans, together with participation in the capital cost by prospective rights holders, which establishes strong incentives for cost-effective investments in irrigation. Publicly funded irrigation construction requires active participation by potential users, commitment of at least one-third of prospective users for project development, and commitment by one-half of prospective users to acquire infrastructure prior to the start of construction. The infrastructure built under this process, and that previously constructed and state owned, must be transferred to the users, represented by their organizations.

Private financing of water infrastructure and water system management and operation in Chile has worked in favor of the poorest sectors of the population. The large reduction in subsidies generated by Chile's policy again allows the government to target the poor, by subsidizing small farmers so that they can buy shares of water rights coming from new infrastructure. Private financing of infrastructure also has corrected inappropriate incentives that in the past often led

WATER ALLOCATION IN JORDAN: POTENTIAL FOR REFORM

Jordan has one of the lowest levels of per capita water consumption in the world, at only 82 liters per capita per day (l/c/d). In contrast, domestic use in Europe and the United States averages 250 to 350 l/c/d. Despite the country's severe water shortages, water policies in Jordan encourage overuse of water and then impose strict rationing to allocate the resulting scarcities.

In Jordan's urban sector, a tiered pricing scheme has been inadequate to spur the government water authority to deliver and distribute water efficiently. (In Amman, the water distribution efficiency is only 65 percent.) The pricing scheme is based on water subscribers' quarterly consumption: tariffs increase as usage goes up. The highest tariff (for consumption exceeding 101 m^3 per household) is equivalent to $1.27/$m^3$ of water. At average household use levels, the tariff is about $0.75/$m^3$. This price represents a considerable subsidy relative to market prices in residential areas not served by domestic water networks. The latter areas are served through tankers operated by the water authority and by the private sector. The cost of domestic water delivered by these tankers can be as high as $1.50/$m^3$.

Overuse of irrigation water is also encouraged in Jordan via massive subsidies. Irrigation water developed by the public sector is priced at only one-tenth of the actual cost of water produced by the private sector, because capital and operations and maintenance costs are almost fully subsidized. The price charged to irrigators for water developed by the public sector in the Jordan Valley and southern Ghors is only $0.01/$m^3$, while the average cost of private groundwater is $0.10/$m^3$. Some farmers use trucked water to irrigate greenhouse crops such as cucumber, strawberries, flowers, or house plants, and to supplement fruit tree irrigation. The delivered price ranges from $0.30/$m^3$ to $0.45/$m^3$.

The practice of pricing water based on its different uses rather than on its scarcity value has led to widespread rationing in Jordan since 1988. In this situation, comprehensive water policy reform with tradable water rights would likely generate substantial benefits. With such reform, water would be priced at its opportunity cost, fostering investments in improved irrigation technology and likely boosting the agricultural value of production, as water would be allocated to the farming activities with the highest returns.

With appropriate water pricing, and the subsequent increase in agricultural water use efficiency, the agricultural sector would be able to release large amounts of water that could be sold to Amman. A doubling of the current 39 million m^3 per annum pumped from the Jordan Valley to Amman would require only 6 percent of the water currently used in agriculture. With construction of a new pumping plant, this water could be delivered at a cost of $0.82/$m^3$ without storage at the plant, or $1.10/$m^3$. These costs are well within the tariff structure described above. Privatization of urban water services together with development of markets in water rights would also provide incentives to reduce the heavy water losses incurred by urban delivery systems.

However, despite the possible benefits of adopting a tradable water rights system, policymakers in Jordan have expressed strong reservations about market-based decisions on intersectoral transfers, because of the economic and political importance of water in Jordan (Annex E). Nonetheless, many policymakers also indicated an interest in research and pilot testing to assess under what conditions and with what type of government oversight such intersectoral water transfers could lead to improved water use efficiency. Because of these concerns, the most appropriate reform strategy might be a phased approach, with considerable supervision of water transfers. Market mechanisms could be introduced on at least a pilot basis using a higher water tariff, which would provide incentives to economize on water use, together with brokered water trading.

to the construction of unprofitable infrastructure and large capital and operating subsidies financed in large part through taxes. This meant transferring resources from the poorest sectors of the population (who usually did not have subsidized water and spent a large percentage of their incomes on sales taxes) to the better off, who received subsidized water. Under the new policy, taxes are saved through the private financing of infrastructure, self-financed and regulated urban water companies, and WUAs that finance infrastructure and O&M costs.

One country that could benefit from adopting similar privatization reforms is Jordan, which is the subject of a case study later in this volume. The following analysis offers a brief preamble to that study and suggests how policy reform could improve water use efficiency in the country.

Chapter 5

CONCLUSIONS

Water policy in developing countries faces several serious challenges: to increase water efficiency in all uses; to preserve and sustain the natural resources involved in water management; to reduce sharply the enormous amounts of financial resources invested in and expended on state-managed water policies; and to increase the flexibility and responsiveness of resource allocation. Based on the experience of the geographic areas studied in this report, significant efficiency gains and economic and social benefits can be expected from establishing tradable water rights markets. The potential benefits of policy reform to establish tradable water rights markets are the empowerment of water users, provision of investment incentives, improvement in water use efficiency, reduced incentives to degrade the environment, acceptability to farmers, improved equity in the provision and financing of water services, and increased flexibility in resource allocation.

The experiences in Chile, Mexico, and California show that markets in tradable water rights can be a viable alternative to cope effectively with the challenges described above. Chile's long-term experience with market allocation of water shows important strides the country has made toward achieving a large share of the potential benefits of maintaining tradable water rights markets. Mexico, after a broad internal debate, passed a new water law in 1992 that shifted from state-managed water policy to a regulated market-oriented policy of tradable water rights. Water trading there initially will be closely supervised, but the law includes a number of provisions that will allow liberalized water trade as water users become more involved in the operations and management (O&M) of water and gain experience in water trading. California, with a highly regulated institutional framework and a legal tradition of appropriative water rights that are far from ideal, has nevertheless developed innovative policies that have expanded the use of market transfers to meet growing demand in urban, environmental, and high-valued agricultural uses. Indeed, market transfers have become an important element in California's drought management policies.

Tradable water rights in Chile have fostered efficient agricultural use of water, which has in turn increased agricultural productivity, generating more production per unit of water. The market valuation of water at its scarcity value has induced farmer investment in on-farm irrigation technology that has saved farmers water to use in irrigating more area or to sell to others. It has also encouraged a shift to high-valued crops that use less water per unit value of output, and has given farmers greater flexibility to shift cropping patterns according to market demand through the purchase, rent, and lease of water.

Market allocation of water has also improved the efficiency of Chile's urban water and sewage services because the country's water and sewage companies can no longer get free water from the state, through expropriation from farmers. When incremental water could be obtained for

free, the companies had no incentive to improve either their means of delivery (pipes, metering, and so on) or economic efficiency. The urban companies', acquisition of secure water rights and an active market have encouraged the construction and operation of improved treatment plants that sell water for agricultural or urban use. In addition, Chile's water policy, by reducing huge construction and O&M subsidies to the better-off farmers and urban water consumers, has freed up public resources that now are used to provide direct and efficient targeted subsidies for poor urban water users and small farmers.

Given the precarious and poorly defined water rights policies prevalent in most developing countries, comprehensive water law reform is the most effective means of moving toward markets in tradable water rights. To form the basis for allocating water through tradable rights, the law should be simple and comprehensive; should clearly define the characteristics of water rights and the conditions and regulations governing the trade of water rights; establish and implement water rights registers; delineate the roles of the government, institutions, and individuals involved in water allocation and the ways of solving conflicts between them; and provide cost-effective protection against negative third-party and environmental effects that can arise from water trades.

The experiences in Chile, Mexico, and California provide guidance in resolving the complex issues that arise in the process of implementing a system of markets in tradable water rights. Issues that must be dealt with include the initial allocation of water rights, definition of rights as prior or proportional, the treatment of return flows, negative indirect economic effects, protection of the environment, the role of water user associations, infrastructural requirements, and the role of public and private institutions. Some of these questions appear to have relatively simple solutions. For example, basing the initial allocation of water rights largely on historical water use, combined (in Chile) with redistributing concentrated water rights holdings, offers substantial gains in security to farmers and other water users. Highly sophisticated infrastructure is not required to implement water markets; effective water markets are operating in Chile with conveyance and distribution infrastructure no more advanced than that found in most developing countries.

Other implementation questions are more complex, and the approach chosen often will rest upon the balance desired between the degree of regulation to protect various interests that are affected by water trades, and the level of transactions costs in water trading. However, as the California, Mexico, and Chile case studies show, a variety of legal, institutional, and regulatory solutions to these issues are compatible with functioning markets in tradable water rights.

California, with a legal tradition in many ways inappropriate for water marketing, strongly entrenched interest groups with high stakes in water, and difficult hydrological and physical constraints to water transfers, has adopted a highly regulated approach to water markets with relatively high transactions costs. Conversely, Chile's water law, while providing significant protection from direct adverse impacts from trade, places an emphasis on water market liberalization with low transactions costs. Mexico has taken the middle ground, with a law that maintains strong government control of water trading, but that also allows for rapid relaxation in controls as experience is acquired in the market allocation of water.

Even comprehensive water law reform allows a phased approach to implementation, which can begin with carefully regulated markets that are progressively opened up as market experience is gained. Greater regulations at the outset will limit the size and scope of the market, and will likely reduce the efficiency gains (and equity gains, to the extent that such regulations perpetuate large general subsidies that favor relatively well-off irrigators and urban water users). The benefits produced by the Chilean reform show that losses incurred from excess regulation of the market could be very large, but this may be an appropriate trade-off for risk-averse governments that are in the early stages of undertaking fundamental reform.

Broad-based trends in the developing world are creating strong incentives for comprehensive water reform that incorporates tradable water rights and the development of markets in these rights. Additionally, the establishment of secure and well-defined tradable rights will in most cases be perceived as producing an increase in wealth and equity. Existing inefficient water systems are under heavy pressure because of the increasing economic value of increasingly scarce water; the rising budgetary costs of highly subsidized capital development and O&M; and general economic liberalization, which boosts the cost of maintaining inflexible water allocation systems that cannot respond to changing incentives. Development of water allocation through markets in tradable water rights offers a viable approach to meeting the challenges facing developing countries, and should therefore receive serious consideration from policymakers.

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Annex A

CHILEAN WATER POLICY: THE ROLE OF WATER RIGHTS, INSTITUTIONS, AND MARKETS

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CHILEAN WATER POLICY: THE ROLE OF WATER RIGHTS, INSTITUTIONS, AND MARKETS

The goals of water policy in Chile are similar to those of other countries throughout the world, but the policy instruments used are different from those chosen elsewhere. Among the goals of water policy are increasing the availability of the resource (mostly through increases in physical and economic efficiency), exploiting new sources only when absolutely necessary, and minimizing any ecological damage from new infrastructure or from different uses of water. The policy goals also include improving water quality and avoiding or compensating for third-party effects. While the goals of water policy are similar to those in many other countries, Chile has developed innovative legal and institutional means to reach these goals, beginning with the basic definition of water rights. This paper discusses the political and economic environment that facilitated the establishment of the new Chilean water policy; it also describes tradable water rights in Chile and the legal and institutional basis for enforcing them, including the role of government authorities and the state's role in the development of infrastructure. The paper then describes the experience in water trading in Chile, discusses the achievements of Chile's market-oriented water policy in the 18 years it has existed, and presents lessons for other countries from the Chilean experience.

POLITICAL AND ECONOMIC ENVIRONMENT UNDERLYING THE NEW CHILEAN WATER POLICY

In the early 1970s, Chile, with a previous history of democracy and capitalism, had become a highly centralized and regulated socialist economy, following a decade of increasingly socialist policy changes. In addition to regulating the economy and fixing the most important prices, the state owned practically all of the systems for producing both goods and services, leaving no room for private enterprise.

Immediately after the change of government in 1973, the new government shifted gradually towards an orthodox market-oriented social and economic policy and towards complete liberalization and open trade; a low tariff (now 11 percent) for all imports was achieved by the early 1980s. Policies were based on private property, market allocation of goods, private businesses supplying goods and services, open trade, and a small but strong state sector. The government took a normative, regulatory, and redistributory role. It thus abandoned its role as the producer of goods and services, undertaking such production only when market failure or external forces prevented the private sector from fulfilling this function. With the market becoming increasingly important in the pricing and allocation of resources, government was freed to concentrate on redistributing its resources to help eradicate extreme poverty and to improve the quality of life of those in need. The new economic policy permitted a drastic cut in overall government expenses, with the remaining resources focused on fighting extreme poverty through increasing investment in nutrition, sanitation, health and education.

The radical application of socialist policies (which meant expropriation of land and water rights), followed within a relatively short period of time by the shift to new social and economic concepts, were key factors in producing the reform of Chilean water policy from 1974 until the present. The shift to market-oriented policies created an urgent need for the government to make the structural changes in the agricultural sector that would allow a rapid increase in production, mainly of those goods in which the country had natural advantages.

The new open trade policy placed a premium on efficient and flexible allocation of water, land, and other resources, in response to changing economic incentives and opportunities. The fundamental policy reforms to allocate agricultural resources with efficiency and flexibility were (a) the redistribution of land and water resources to the private sector under the Agrarian Reform; (b) the definition of clear and well-defined land and water property rights; and (c) market allocation of both of these resources.

Water policy reform ended both state-owned water rights and centralized water management and allocation. In accordance with the general economic guidelines, it was necessary to create an efficient market policy of water allocation and pricing that also shifted the costs of overall water management by state agencies to water users--both urban and agricultural--thus ending the huge budget subsidies of the past. Excessive budget expenditures were caused by the construction of unprofitable water infrastructure; inefficient centralized management of irrigation systems; inefficient state-owned urban water services; and poor collection of water tariffs, both from farmers and urban users. Instead of subsidizing all the inefficiencies of a publicly managed system through state financing of the deficits, policy shifted to using subsidies only for those who are "left out" of the market, thus making all other water users responsible for the real cost of the water they used. This set of policy reforms will be described in detail below.

LEGAL AND INSTITUTIONAL FRAMEWORK FOR WATER POLICY

The Water Code, introduced in 1981, integrates previously piecemeal legislation. There are three sections: the first covers definitions and concepts concerning ownership, development, and exploitation of water; the second elaborates administrative and judicial procedures and regulations; and the third establishes the functions and procedures of the General Directorate of Water (DGA) and establishes rules for the construction of certain water works.

In general, Chilean water law grants secure water rights that are both tradable and transferable. The prevalent form of these rights is proportional rights (shares) over a variable flow or quantity; deeds stipulate that an owner has the right to a number of shares at a certain location. These rights are expressed in volume by unit of time (liters per second or cubic meters per year or month) and are proportional to stream flow if supply is insufficient. Changes in allocation of water within and between sectors are made through markets in tradable water rights, and the law provides effective protection from detrimental third-party effects. Water users are organized in strong and compulsory users' organizations, with capabilities for solving most conflicts between members. The law provides for judiciary recourse for conflicts not solved by users' organizations or government water authorities. Before turning to a detailed outline of basic water

rights, it would be useful to identify some of the main government and other institutions involved in water management.

Institutions Involved in Water Management

The General Directorate of Water (Dirección General de Aguas, or DGA), under the Ministry of Public Works, is responsible for water development planning. The Directorate supervises the National Hydrometric Service and is responsible for vigilance over natural inland waterways. It is also in charge of entitling original rights (either originating from prescription or requests for rights to available water), keeping the National Official Water Record (Catastro Público de Aguas), approving all major hydraulic works, authorizing private irrigation infrastructure, and looking over hydrologic (not economic) third-party effects.

The National Irrigation Commission (Comisión Nacional de Riego, or CNR) is in charge of national irrigation planning and the evaluation and assignment of priority to state-financed projects for irrigation infrastructure. In conjunction with the Directorate of Irrigation (below), CNR supervises the bidding for the construction of infrastructure.

Directorate of Irrigation (Dirección de Riego, or DR) is primarily in charge of the preparation and supervision of state-financed irrigation projects, once they have been approved by the CNR. The construction itself is let for bid to private construction companies.

The Ministry of Commerce (Ministerio de Economía) fixes public monopolies' rate charges, taking into account the underlying costs. Water rates are applied to urban water and sewage companies regardless of their ownership.

Users' Associations are a very important factor in the enforcement of water rights and in self-regulation of water users, including collecting fees for the construction, maintenance, and administration of infrastructure.

Water Rights

Basic characteristics

In Chilean law,[1] water is considered a public good, but individuals can obtain private rights over water by receiving a grant from the state for new water sources, by prescription,[2] or by purchasing water rights. The Constitution of Chile (passed in 1980 and modified in 1988)

[1] Aside from the Constitution, the legislation most relevant to water is the Civil Code and the Water Code (Law 1.122-1981), the National Irrigation Commission Law (Law 1.172 of 1975 reformulated in 1981) and the law regulating state-financed irrigation or multipurpose infrastructure (Law 1.123-1981).

[2] The establishment of a claim or title on the basis of historical use.

provides that *"The rights of private individuals, or enterprises, over water, recognized or established by law, grant their holders the property over them."*[3]

The Water Code establishes the basic characteristics of water rights. The right to use water is an actual or real right that confers ownership to its holder. The owner is entitled to use water, obtain benefits from it, and dispose of it, and water rights can be alienated from land and mortgaged.

Types of water rights

According to the Water Code, rights of use are either consumptive or non-consumptive. Their exercise can be permanent or contingent, continuous or discontinuous, or rights may alternate among several persons. *Consumptive rights* entitle the holder to completely consume the water for any activity without any obligation to replenish it. *Non-consumptive rights* (e.g. for hydropower generation) allow the holder to use water but compel the owner to restore the water at a stipulated quality or in a manner (or both) set forth in the deed or private contract evidencing ownership. Water extraction must always be accomplished in a way that does not adversely affect the rights of third parties over the same water in terms of its quantity, quality, and opportunity for use. Non-consumptive rights do not imply any limitation on the consumptive rights which may exist over the same water.

Permanent water rights allow the owner to use unexhausted sources of supply every year without restriction. As stated previously, rights of use are expressed in volumes per unit of time. In the case of permanent rights, water can be used in corresponding volumetric shares, except when the source of supply is insufficient to satisfy them fully. In this case the available volume will be distributed proportionally. This applies both to surface and underground waters. *Contingent rights* empower the holder to use water only after the main waterway has a surplus volume, that is, after the needs all users with permanent rights have been met. Lake or dammed water is not subject to contingent rights. *Continuous rights* allow water to be used uninterruptedly 24 hours a day, every day in the year; *discontinuous rights* allow water to be used only during certain periods. *Alternate rights* are those wherein use is distributed among two or more persons in successive turns.

Tail water

Tail water running naturally into neighboring premises may be used by the recipients without the need to establish a right of use. The production of this water is contingent upon the flow of the main waterway and the distribution or use it is given in the source premises; there is no obligation to supply tail water, and the supply is not permanent. Rights, liens, or easements on spillage and tail water can be established in favor of third parties only by way of a title deed.

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[3] Constitución Política de la República de Chile, Chapter III, Article 24, final paragraph: *"Los derechos de los particulares sobre las aguas, reconocidos o constituidos en conformidad a la ley, otorgarán a sus titulares la propiedad sobre ellos."*

Underground water

Chile's Water Code also has a chapter dedicated to *underground water*. Once the existence of underground water has been confirmed, the interested party may apply for the respective right of use. In general, the right to use underground water is covered by the same legal regulations applicable to the use of surface water; the Water Code, however has some ad-hoc regulations for this type of water. First, the resolution granting the right of use to underground water will establish an area of protection in which the installation of similar works (for example, pumps) will be banned. Additionally, if the exploitation of underground water by certain users causes detriment to others who are legally entitled to the water, the DGA, at the request of one or more of the affected parties, may establish temporary and proportional reduction of the rights of use. By publishing a resolution in the official journal (*Diario Oficial*) this agency may also establish proscribed areas, barring any new exploitation therein in order to protect the aquifer. Where there is a serious risk of depletion of a specific aquifer, the DGA may also establish restricted areas in hydrogeologic sectors for common use. This will be done at the request of any user of the respective sector on the basis of the historical exploitation, if the user produces evidence that demonstrates the necessity of restricting access to the aquifer. This restriction will be imposed proportionately.

Means of Acquiring Water Rights

The trade, transfer, or loss of the right to use water is performed according to the provisions of the Civil Code, unless otherwise regulated by the Water Code. Obtaining and documenting water rights that were previously owned by the state is a feature of the Water Code. The rights to use water (new or surplus) are originally granted by act of authority, by prescription by the DGA, or by the judiciary, on the basis of prescription. The other means of acquiring rights is by outright purchase. Thus, there are three ways of obtaining rights: (a) by application on the basis of prescription;(b) by application or bidding for new or surplus water or (c) by outright purchase in the market. Where there is water that is available but not claimed by prescription, the DGA establishes rights by public bidding; public bidding may also be applied when two or more people request the same available water. Also, surplus water provided by new infrastructure (rights beyond allocation of at least 50 percent of "new water" to those who committed to finance the infrastructure) must be let for bid (see also the section on infrastructure below). The ownership of rights in each of these three cases is established by inscription of the right in the respective water registry of the property registration authority (Registro de Propiedad de Aguas del Conservador de Bienes Raíces). Grants of water use or deeds of purchase specify the type of right and the number of shares.

Of the methods of obtaining water rights mentioned above, state or judiciary grant by prescription has been the most important, as a consequence of the state's prior expropriation of water rights in 1966. Beginning in 1966, a high proportion of state-owned water was assigned through precarious (weakly defined) concessions, mostly to the same use, but not to the same owner as previously. The next step was that private users were progressively expropriated. By the early 1970s the state owned all the electrical companies, almost all the urban water services, and over

90 percent of the irrigated land. After the change in government in 1973, privatization began and the agrarian reform was consolidated by distributing the state-owned farms (expropriated between 1966 and 1973) to 60,000 peasants and a few thousand former owners. In 1975, when Chile shifted from a highly regulated system where water rights were state-owned to a private, market-oriented one, the government, through administrative orders and transitory laws, froze the actual use of water at 1975 levels. Because of this sequence of events, most new water users had fairly good bases to obtain water rights that were established in 1979 (by Law 2.603 of the Ministry of Agriculture) through prescription.[4]

After state, or judiciary, grants by prescription, the second most common way of obtaining water rights has been market transactions. Only a very small proportion of water rights have originated in grants over available water, either for unowned surplus water or for water from new infrastructure. There is little available water left in areas that need irrigation, and that water which is available comes mostly from rivers or streams with steep banks or from deep underground aquifers. From 1975 until 1992 Chile built no new water supply-creating infrastructure, limiting that source of new water rights.

Mortgages, Collaterals and Liens

Because of the secure nature of water rights, water can also be mortgaged or used as collateral for loans. Mortgages on water rights must be executed by public deed and registered at the Water Mortgage and Lien Registry (Registro de Hipotecas y Gravámenes de Aguas) of the respective property registration authority (Conservador de Bienes Raíces). Rights are always encumbered with liens in order to guarantee the payment of fees owed for the use or acquisition of irrigation works, or the administration, distribution, maintenance, and water distribution expenses of the users' association. These liens have priority over any others. Acquirers of any title to rights will be jointly liable, together with their predecessors, for any rates outstanding at the time of acquisition. Users' organizations may deprive holders of the use of water in the event of nonpayment of the aforementioned fees and rates, as well as if members extract water in excess of their allotment. This is a key provision in the law, providing strong enforcement capability to the user associations to prevent illegal use of water.

Easements

Water-related easements are governed by the provisions of the Civil Code, unless otherwise amended by the Water Code. Chilean law establishes the following types of easements: natural runoff, aqueduct, overflow and residual water, cattle watering, towpath, research, and voluntary easements. Two of the most relevant for farmers are aqueduct and cattle watering easements.

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[4] Between 1973 and 1979, water was regulated mostly by the Ministries of Agriculture, Finance, and Commerce, which had all the power granted by the 1966 agrarian reform law (Law 16.640), the 1969 Water Code, and the 1975 Law 1.172 that created the CNR.

Aqueduct easement authorizes water to be conveyed through someone else's property at the expense of the interested party. This includes the right to build the necessary channels and waterworks as well as outlets to allow the water to empty into natural courses. The owner of the property through which these channels, waterworks, or outlets run will be entitled to receive by way of compensation the value of all land that is occupied and any improvements that are affected by the construction of the aqueduct. Occupied land will include a space on either side of an aqueduct not less than 50 percent of the width of the channel, with a minimum width of one meter along the entire length of its course. (The minimum width can be increased if so agreed by the parties or if so directed by a judge.) The property owner may modify the direction of the aqueduct.

The property owner will also be entitled to receive compensation for any damage caused by the building of the aqueduct or by the seepage, spillage, and overflow that can be attributed to construction defects or bad management. Should any disagreement arise regarding the amount of compensation due, a judge will decide on the basis of expert reports. Building may start once the sum provisionally established as security for the final compensation due has been paid.

Any town, village, hamlet, or property lacking the necessary water for its animals will be entitled to impose a cattle-watering easement. This easement consists of the right to take cattle along customary paths and tracks to drink on private property at established locations and on established days for a certain number of hours. Nonetheless, the owner of the property may sell the rights of use.

REGULATION OF WATER RIGHTS AND TRANSACTIONS

Priority Uses

One of the most discussed issues in water policy is priority in the use of the resource. There is no priority in Chilean law. When no other means are available to satisfy the domestic water needs of a locality, rights of use may be expropriated for reasons of public welfare, and prior payment of compensation must be made. The expropriated party must be left with enough water for domestic use.

Third Party Effects

To assure rights of third parties, any transfer of the rights of use (not the trade itself) of natural watercourses requires authorization from the DGA. This authorization will only insure the absence of damage in those third-party effects covered by the Water Code, which are effects on water rights or on hydraulic infrastructure. The respective application will be announced in the *Diario Oficial*. Those persons or organizations with hydraulic infrastructure that would be affected by a transfer of water rights to natural watercourses may file relevant motions before the respective user organization and the DGA. In order to obtain authorization to transfer natural watercourse rights, the interested party will assume responsibility and cost of constructing any

works that may be necessary to avoid affecting the water rights or the infrastructure belonging to third parties.

Transfers of the rights of use, in artificial water courses, require the same formalities of those in natural water courses, with the only difference that the respective users' association (UA) authorizes the transaction, instead of the DGA.

The merits of constructing any new water-related infrastructure to facilitate a water rights transfer will be determined in the first instance by the DGA and, upon appeal, by the judiciary. Any disagreement arising about compensation due because of detrimental effects of building water infrastructure will be settled by a judge. Operation and maintenance of new waterworks will continue to be incumbent upon the entities that operated and maintained the original system (users' organizations). If the necessary modifications involve an increase in operation and maintenance costs, the interested party will pay the resulting higher cost.

Loss of Water Rights

Ownership of rights of use may lapse in circumstances established by ordinary law and in the manner prescribed thereby. These are fundamentally expropriation, loss of sources of origin, sale, or barter, acquisitive prescription by third parties, and enforcement of mortgages or liens.

Government Intervention

If the directors or managers of any users' organization commit serious offenses regarding the distribution of water or if they misuse their authority, any of the affected parties may request the intercession of the DGA. If the reported errors, offenses, or misuses should continue, the DGA may request the courts to order that the DGA control the distribution of water for periods not exceeding 90 days. All of the authority of the directors or managers would be exercised by persons appointed by the DGA. This has not happened yet.

The DGA is also empowered to undertake vigilance over water in natural channels for public use and will prevent the building, modification, or destruction of waterworks along natural channels unless prior authorization has been obtained.

The president of the Republic, at the request or upon the report of the DGA, may declare drought zones during extraordinary dry periods for maximum and non-deferrable six-month periods. The DGA will determine, by resolution, the drought periods that are to be considered extraordinary.

Once a drought zone has been declared, if no agreement is reached between the users regarding the distribution of water, the DGA is empowered to distribute for public use water available in natural waterways and in channels that impound water from them. With the aim of minimizing the general drought-induced damage, the DGA may suspend the authority of the users' organizations. Any holder of rights who might receive a lesser portion of water than is his due (in accordance with existing availability) will be entitled to state compensation for the lost portion.

Water accumulated in private dams is not subject to any drought zone declaration. In natural currents or artificial channels where no users' organizations have been established, the DGA may, at the request of one of the parties, take charge of water distribution in declared drought zones.

INVESTMENT IN WATER INFRASTRUCTURE

Government Involvement

All major infrastructure construction (dams of more than 50,000 cubic meters capacity or aqueducts carrying more than 2 cubic meters per second) need authorization of the DGA in order to prevent harmful third-party effects or environmental damage. Obtaining state funding for irrigation or multipurpose infrastructure construction requires a positive economic evaluation and the active participation of potential users in the respective project.[5] In order for an applicant to be eligible for the government's financial assistance, the total cost of the projected infrastructure, or the portion of it that is allocated to irrigation (in the case of multipurpose infrastructure) cannot exceed the incremental value of the of the total irrigated area, considering market values for comparable irrigated and non-irrigated land in the same *region*.[6]

Potential Users Role and Infrastructure Ownership

Aside from the requirements mentioned above and the associated evaluation, 33 percent of potential beneficiaries must approve the proposed water project in writing. If the project is an improvement to an existing system, beneficiaries must contract for at least 33 percent of the additional water availability. In order to actually program the construction of works, it is required that the project be accepted by the beneficiaries and that at least 50 percent of beneficiaries commit to finance the project. The infrastructure constructed under this process, as well as previously constructed state-owned facilities, must be transferred to the users, represented by their organizations. The market value of th[illegible]rastructure, determined as already described, must be paid by the users; any excess will b[illegible]ed by the state because the state is responsible for the project and has a previous deed w[illegible]tial users.

Acting in the public interest, the president of the Republic may order the study of state-funded water infrastructure projects and the construction of respective works, even if they do not meet the preceding requisites. The state may also subsidize small farmers so that they can buy shares of water rights coming from new infrastructure. Notwithstanding the provisions of the law regarding the compulsory transfer of state-built or state-funded water infrastructure to the users, the president of the Republic, for reasons of public welfare, may direct the state to preserve waterworks within its jurisdiction and to take over their administration or exploitation. The beneficiaries of such works are compelled to pay annual dues for the use thereof and for

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[5] Law 1.172-1975, modified by law 1.123-1981, specially regulates state-financed irrigation or multipurpose infrastructure.

[6] Chile is geographically and administratively divided into 13 regions ("*regiones*").

exploitation expenses. This has happened with state-owned infrastructure constructed before the market value regulations were in effect and which had actual construction costs higher than its economic value.

For example, the cost of the Digua Dam in Región VII, financed by the state and the Inter-American Development Bank (IADB), far exceeded the economic value of the project. Construction was abandoned in 1970 and recommenced in 1974; the Inter-American Development Bank (IADB) made resumption of construction a requirement of considering any new loans to Chile. The final cost was three times the original estimated cost. The economic return to irrigation in that specific area of the VII Región is very low; many farmers can't even pay the rates for use and exploitation. Today only 40 percent of the Digua Dam's capacity is actually used. This dramatic case, similar to most state irrigation infrastructure projects in Chile (and all over the world) strongly influenced the adoption of the evaluation system and the state responsibility for irrigation infrastructure costs previously described.

USERS' ORGANIZATIONS

Any entity holding rights to water must join a users' organization or organizations. There are several types of water users' associations established by the Water Code. These organizations are fundamental to management of Chile's water. The general function of these associations is to distribute the water according to rights and to collect the fees for administration, distribution, maintenance, and amortization of constructed or acquired infrastructure. Users' organizations are empowered to deprive of water those who neglect paying user fees or who extract excess water, and they are responsible for solving conflicts among members according to the law.

Users' associations are responsible for drawing water from main or secondary waterways, as well as for building, exploiting, administering, preserving, and improving water infrastructure necessary to their members. The responsibility for management includes state-constructed dams (which are transferred to water users' associations as representatives of users) as well as small privately-built aqueducts.

The Water Code stipulates that if two or more persons hold the right to use water from the same source (for example, river, dam, channel, or underground water), this creates a de facto association between them, which they may regulate as such by establishing a water community (*comunidad de aguas)*, a channel user's association *(asociación de canalistas*), or any other legal association they may agree on.

The formalities of organization are simpler for *comunidades de aguas* than for *asociaciones de canalistas*. The former are usually in charge of secondary infrastructure used by neighboring farmers; the latter are in charge of large infrastructure, from principal channels to dams. Frequently a farmer belongs to both types of organizations. For example, a *comunidad de aguas* might govern a secondary channel coming from a principal channel governed by an *asociación de canalistas*. In the case of natural sources of water, such as rivers, users must organize as a control committee (*junta de vigilancia*). Both types of organizations mentioned previously may be members of a *junta de vigilancia*, which may also include individuals, public entities, urban

public utility companies, hydroelectric enterprises, or any other user that has rights over water coming from a natural source.

URBAN PUBLIC UTILITY COMPANIES

Urban water and sewage city services were formerly state-owned entities, highly subsidized and quite inefficient, both physically and economically. Nevertheless, although service was poor, it was cheap because of subsidies, and potential market solutions were a highly sensitive political issue. Policy changes for urban water service were initiated in the early 1980s. Previously state-owned urban services have been transformed into urban water and sewage companies. Shares are owned in different proportions by the public, municipalities, the regional governments, and the national government, and are traded in the stock markets. The government has embarked on a program of selling its shares to the public on a bid system, and full privatization is expected before December 1995.

These urban companies have concessions to supply water and sewage services to a specific city or specific sectors of larger cities. The companies own the water rights to which the former municipal service entities were entitled, and many of them have bought additional rights in the private market. They are obliged to supply services to new users. The water company fulfills these obligations either through the market purchase of raw water rights by the new user, with subsequent transfer of the rights to the company, or by the company's buying rights directly from farmers or other water companies. Utility companies apply for state grants over surplus water only in southern Chile, which enjoys a high level of well-distributed rainfall.

TARIFFS FOR URBAN WATER

Since utility concessions are a natural monopoly, the maximum fees for urban water and sewage services are fixed by the Ministry of Commerce, taking into account the market price of raw water, amortization of infrastructure, preservation, maintenance, management, distribution, collection, and a certain percentage for investments in infrastructure improvement. Each utility fixes its rate, which must be below the maximum set by the government. The government subsidizes the rates paid for urban water by low-income sectors of the population. This subsidy amounts to a specified monthly free quantity of water (up to 20 m^3 per month) in predetermined sectors of the cities. The subsidy is paid directly to the water company.[7] The number of low income families that receive the potable water subsidy has been increased to 450,000, which includes the 20 percent poorest sector of the population.

[7] Law 18.788 of 1989.

WATER TRANSACTIONS AND WATER PRICES

Active water markets have developed both within agriculture and between agriculture and other sectors. Typical transactions within the same use would be sales and purchases of water rights between two urban water companies serving different sectors of the same city, or serving neighboring cities, or transactions among farmers. (See also Appendix 2 for examples of transactions).

Transactions between Farmers

Perhaps the most frequent transactions in water markets are rental of water, or water swaps between neighbor farmers with different water requirements during different periods. Renting or swapping water offers greater flexibility for irrigation and increases efficiency.

These farmer-to-farmer water rentals or swaps take place only between farmers irrigating from the same, or very near, channels, because of excessive transaction costs of long-distance trades. Deeds for these transactions are not required to be registered in the respective Water Register. Actual prices of short term rentals and swaps are difficult to determine, because of their informal nature. Many transactions do not involve money exchange. However, recent prices for cash rentals have been in the range of $90-120 l/sec for effective in-plot delivery of water for about three-months during low flow periods.

A typical case of a short-term cash rental would be a farmer who uses 3 shares of 15 l/sec to irrigate 30 hectares (ha) of high yield wheat from October to December. He crops his wheat in late December and rents the water from January until April, to a 30 ha sugarbeet producer, who also uses his own 3 shares for irrigation. This last farmer will be willing to rent water because each share will actually be delivering only about 7-8 l/sec during the low flow summer period (see Appendix 1). With the rental of water, the sugarbeet farmer completes the 45 l/sec he needs. If the water market were not available, the wheat farmer would apply his water to a lower income purpose, such as irrigating the wheat-cropped land for grazing. On the other hand, the sugarbeet farmer would have to cultivate only the 15 ha he can irrigate with his summer availability of water. With the rental options, both farmers win. The first farmer gets a better economic return for his water, and the second can cultivate an additional 15 ha of sugarbeet, just by renting water in the scarce season.

Permanent transactions of water between farmers also occur, motivated by the necessary shifts in cropping patterns in response to changes in prices in an open trade market economy, as is the Chilean case, according to the domestic and international demand. Permanent transactions typically occur between owners of land that is not suitable for the most water-demanding, high-valued crops, such as orchards or vegetables, who sell part of their water shares to owners that can cultivate these high-valued crops. The water seller, with little investment, can introduce simple irrigation techniques, such as small dams to store water over night or lined channels, to increase efficiency according to his crop options (mostly high yield irrigated grains or irrigated pastures for dairy production) and get incremental capital from the transaction to introduce other profitable innovations in his cropping.

Other water sellers are highly intensive crop farmers who introduce more sophisticated techniques, such as drip irrigation, and sell water to finance the investment. The buyer may be another intensive farmer or one who owns land with good soil but inadequate water rights. Most permanent transactions between farmers are also made by users of the same main channel, or the same natural watercourse, because of transaction costs. Nevertheless some important sales that imply long transportation of water and significant modifications of infrastructure, have taken place. These cases could typically involve water purchased by a large, newly established export-fruit plantation in previously unirrigated areas where the economic return to the water is sufficient to pay the transaction costs.

Transactions between Farmers and Urban Water and Sewage Companies

One of the greatest innovations of Chile's water policy is allowing cities to buy water without having to buy land or expropriate water. As a matter of fact, growing cities now buy rights from many farmers, in some cases buying a small portion of each farmer's total rights. There have rarely been negative effects in the agricultural zones surrounding water-demanding urban areas, because farmers sell mostly small portions of their rights and maintain agricultural production with highly efficient irrigation technology for the orchard or vegetable crops grown in those areas.

These agriculture-urban water rights transactions are the most frequent among those between different sectors (although agriculture-mining or mining-urban trades have also taken place). Agriculture-urban trades consist mostly of purchases of rights from farmers by the urban water and sewage companies. A typical case would involve one of the eight water companies serving Santiago buying water rights of the Mapocho river from several farmers in order to provide water to a new housing development or new industry. The farmers would usually sell a small portion of their rights, which they can dispose of because they have improved their irrigation efficiency. The farmers obtain an important amount of fresh capital in exchange for their water rights. A farmer who increases irrigation efficiency by 30 percent on a 40 ha grape farm can dispose of water rights shares equivalent to 24 l/sec, selling for $7,000-$10,000[8] altogether, without reducing agricultural production. The scope and nature of water transactions in Chile are described in more detail in the following sections.

Price of Water Rights in Transactions between Farmers[9]

The price of water rights in permanent transactions between farmers varies according to the different agroclimatic zones which are described in Appendix 1 and varies further inside each zone, depending on the economic return of the crops that can be cultivated and the transaction costs.

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[8] Unless stated otherwise, all dollar figures are current U.S. dollars.

[9] These prices were obtained from the Water Registers, UAs, and real state traders.

In the northern desert zone (NDZ) the average price is very similar to those of agricultural-urban transactions (see below)--$2,500/l/sec that, in this zone, typically irrigates 0.3 equivalent ha. The high price results both from water scarcity and from the common practice of agriculture in the vicinity of cities. In the semi-desert zone (SDZ) the average price of $2,000/l/sec (enough water to irrigate 0.45 ha in this zone) is also similar to those for agricultural-urban transactions, for the same reasons mentioned above. However, the variability in prices is much higher because of different micro-climates and soil potentials. Prices can vary from $400/l/sec for water for vegetables to over $4,000/l/sec for vineyards for "Pisco" production using drip irrigation.

In the central zone (CZ), where rainfall amounts range from 300 mm in the northern part to 1,500 mm at the boundary with the Southern Zone, the median price is around $500/l/sec (an amount that would irrigate from 0.5 to 0.6 equivalent ha). Prices also have a great variability according to soil potential and micro-climates, and range from $300 to $1,000/l/sec. In the southern zone (SZ) transactions are very unusual because, although irrigation is increasing for high value crops that cannot afford even occasional rainfall shortages, there still is available water that can easily be diverted from rivers after the respective grant has been attained.

Prices of Water Rights in Agricultural-Urban Transactions[10]

Agricultural to urban transactions are made by farmers whose farms surround the cities and urban utility companies, and the prices are very similar to those of water rights on deeds between farmers of the same area. There is good information among farmers on market prices for water. Water users and farmers' associations maintain records of recent prices; therefore farmers are not at a disadvantage, compared to the urban buyers, in their access to information.

The average price of water transactions from agriculture to urban utility companies of Santiago (the capital and largest city with more than 5.0 M people) is $950/l/sec (1 l/sec in this zone allows irrigation of 0.5 ha). The range goes from $800, for distant water contaminated by silt and minerals, to $1,500/l/sec for high quality water. This last price, the highest known in Santiago, is paid by a private utility company that has a concession on a sector of the city -- Empresa de Agua Potable Lo Castillo S.A. They have, at that price, an open offer to buy shares of the upper part of the Mapocho River (enough to irrigate 0.5 ha). The reasons for this higher value is that the water for these rights is diverted from a very small flow of high quality mountain-spring water, that previously irrigated crops in a small valley with rich soils, with an extraordinary micro climate and at a distance of only ten miles from Santiago. Agricultural property in this area is divided into small, very expensive plots, with high water requirements because of the little rainfall of the area (300-400 mm/year). Treatment costs are low because the water is so pure that it needs little processing. Because the treatment plants of the company are in the vicinity, transportation costs are also very low.

[10] These prices were obtained from the public utility companies directly, answering newspaper advertising requesting water rights, UAs and real estate traders.

In the NDZ, the price of water rights for urban use goes from $2,000 to $3,800/l/sec, depending on the transaction costs (mainly conveyance costs). The high price differential as a function of conveyance costs (as in the Santiago case noted above) shows that, although buyers are responsible for conveyance costs, these costs are actually passed back to sellers in the form of lower buying prices. In the SDZ, prices range from $1,800/l/sec to $2,500, with the same considerations; and in the CZ the prices are nearly the same as Santiago's, diminishing in the southern sector because of increases in rainfall. In the SZ there are no transactions of this kind because there is surplus water available.

Prices of Potable Water

As noted above, since utility concessions are a natural monopoly, the maximum fees for urban water and sewage services are fixed by the Ministry of Commerce. The tariff on potable water, in the water scarce zones, has two components: the average of the monthly amount that the user expends during normal months is charged at a certain price; and the amount used in the dry season in excess of that average is charged at a much higher rate. This fosters water conservation by the users and allows water companies to buy more expensive water to meet the public needs. Unlike previously, when state-owned public water services had a national price for all cities, the tariffs of each water and sewage company now depend on its costs. The price of raw water and the cost of transportation are responsible for most of the difference in water tariffs, especially in the northern desert region.

Table 1. Potable water tariffs per m^3 in six cities with indication of the zone they belong.[11]

City	Zone	Normal ($)	Excess ($)
Arica	NDZ	0.39	1.02
Iquique	NDZ	0.66	1.59
Antofagasta	NDZ	0.86	1.33
Serena	SDZ	0.36	0.58
Santiago	CZ	0.18	0.54
Valdivia	SZ	0.16	None

[11] These prices were obtained directly with the public utility companies and checked by user's bills.

Frequency, Type of Transactions, and Volumes Involved

We examined water transactions during the period April 7, 1993, to April 6, 1994, in three Water Registers of the Property Registration Authority[12] (registro de agua del Conservador de Bienes Raices) belonging to the counties (departamentos) of Santiago, Chillán and Bulnes. Only transactions of water not linked to land, or other uses, were taken into account. Thus, water transfers registered because land was also sold were not examined in this study. These registers cover areas where there is growing urban demand for water (Santiago) and where there is highly diversified agriculture with rapidly shifting cropping patterns (Chillán and Bulnes). All three registers are in areas of medium rainfall, concentrated mostly in winter, with a very dry summer period of three months. The results presented here, while not necessarily representative of all regions of the country, are indicative of quite active water markets in regions which are characterized by growing competition between urban and rural water demand or by dynamic agricultural sectors.

The Water Register of Santiago County covers 12,000 ha of land irrigated through rights from sections of the Maipo and Mapocho rivers. This register had 587 permanent transactions inscribed in the one-year period. Thirteen percent of the trades were between farmers, representing 94 percent of transferred water; 85 percent were agriculture-urban, representing about 3 percent of transferred water; and 2 percent were agriculture-mining, representing 1 percent of the transferred water. The total amount of water involved was 720 l/sec. To get an approximation of the proportion of total water rights held which were sold during this year, we can compute that 1 l/sec irrigates about 0.5 equivalent ha in this zone, so the water necessary to irrigate 360 ha was transacted. Thus, water rights adequate to irrigate about 3 percent of the total land area covered by the Santiago register were transacted in one year, indicating a very active water market.

It is interesting to note that agriculture-urban sales are numerous, but of very small size compared to sales within agriculture. Urban purchases usually acquire a small proportion of water from each of many farmers in the vicinity. As noted above, urban utility companies inherited the water rights of the formerly state-or municipality-owned services, and have had, from the early 1980s, a long period of time to purchase water in the open market. The water they are buying now is mostly for new urban development.

The Water Register of Chillán County covers 15,000 irrigated ha. During the period examined, 72 transactions were transcribed, all of them between farmers, involving 270 l/sec. Since in this zone 1 l/sec irrigates 0.67 equivalent has, this represents 1.2 percent of the water necessary to irrigate land held within the register boundaries. The Water Register of Bulnes County covers 20,000 ha of irrigated land. During the one-year period, 91 transactions were recorded, all between farmers, involving a total of 190 l/sec, or about 0.6 percent of the available water rights. Exact prices could not be obtained through the analysis of water registers, because prices are not

[12] Chile is divided in regions, provinces and counties (departamentos). Each county has a Property Registration Authority that, besides other property registers,
has its Water Register.

always specified and transactions are not always paid in money, but with land, products, machinery, etc.

Obviously one year of transactions is not a representative sample of nearly 20 years of market operations and cannot give us a tendency; however, it can demonstrate that markets are permanently operating. In the Santiago area, it is likely that more agriculture-urban transactions occurred during the first years of operation of the new, share-owned, water companies. EMOS, the largest one urban utility, bought more water during that period than now.

In the coming years in Santiago, however, agriculture-urban transactions will probably increase, both in number and in quantity, because new water companies are expanding to supply water and sewage services to the rapidly increasing new urban developments for upper middle class people and the new industrial sectors developing in new areas. On the other hand, transactions between farmers in the area should stabilize, as the cropping pattern is not likely to change; it has already shifted largely to export fruit and wine production.

In Chillán and Bulnes areas there were more transactions between farmers in the early 1980s, when cropping patterns began to change with increased trade liberalization, which removed government subsidies and lowered import tariffs, dramatically shifting the profitability of crops. In the near future the number of transactions should increase again because of two main reasons. First, water supply will not keep up with demand growth, because the Laja-Diguillín project, that will increase water supply in Chillán and Bulnes, has been delayed and will not deliver water until 1998 or 1999, rather than 1995, as had been planned. Second, increasing imports of grain, edible oil, and meat imports from Argentina and the expected signing of a new trade agreement with the United States will continue to force down prices of many traditional crops and will encourage a new, and more complete, shift to crops like raspberries, asparagus, and blueberries, which produce a high value of output relative to the cost of water inputs.

In general, water trade between farmers, both in number and volume, in an open economy such as Chile's, will be largely determined by changes in the price and demand for agricultural output in the international markets. The number of agriculture-urban water trades, and the volume involved in them, will be mostly determined by the growth in urban and suburban population and by industrial growth.

The most important indicator of how water markets are operating in Chile is the fact that they are efficiently re-allocating water rapidly and smoothly, according to the changes in demand between sectors or by different users in the same sector. This makes possible adequate water supply in growing cities and shifting cropping patterns in agriculture according to the evolution of markets.

RECENT DEVELOPMENTS

New Infrastructure

After an eighteen-year hiatus in construction of major irrigation infrastructure in Chile, one new project has now been constructed and is operating, and several others are planned or under construction. The large period without construction was a consequence of the strict project evaluation criteria in effect and of the obligatory purchase of new irrigation infrastructure by potential users. The requirement that new infrastructure be fully paid, rather than subsidized, made it more profitable in most cases to increase the efficiency of existing water, rather than to invest in new infrastructure.

The first four projects CNR approved in 1990 were: Pencahue Channel in the VII Región, that started operation last year, Tronco Linares Channel in the VII Región, Laja Diguillín Channel and Dam complex in the VIII Región, and Convento Viejo Dam in the V Región. The first two are channel constructions, and based on project evaluations, are quite cost-effective, as is the Laja Diguillín complex; the Convento Viejo dam has a higher cost per irrigated acre than established standards, but it will irrigate a priority area. Other projects recently approved by the CNR include the Santa Juana Dam in the IV Región, the Puclaro Dam in the III Región, two dams in the Aconcagua river in the V Región, and the Victoria-Traiguén channel in the IX Región.

All the preceding infrastructure will be operating by year 2001, irrigating about 240,000 ha, with a total investment of $240 million. The largest of the projects under construction is the Diguillín Canal, which forms an aqueduct between two rivers. The new rights to use water have already been allocated among owners of 60,000 hectares. The extra water transfer will irrigate 40,000 ha which had previously insufficient irrigation, and the remainder will be newly irrigated land. Most of the improved or newly irrigated land will be devoted to export crops such as asparagus, raspberries, blueberries, pears, and apples, and to sugarbeets for domestic consumption. The cost of the shares necessary to irrigate one hectare will be about $800, payable in 25 years starting in 1993. Using Law 1.123, the government will subsidize small farmers on a sliding scale down to about $72 an hectare for those who have 20 acres or fewer.[13]

Privatization

The process of privatization of water-related industries is continuing. Almost all formerly state-owned electrical generation and distribution companies have been sold, including the Empresa Nacional de Electricidad (ENDESA), the largest of these companies and owner of most of the hydroelectric generators in the country (about 66 percent of Chile's electricity comes from hydroelectric power (Chile 1992)). The Empresa Eléctrica del Norte (EDELNOR) is being let for bids; another remaining company, Colbún-Machicura, has a negative economic value.

[13] This was established in a contract-letter between potential users of Laja Diguillín canal and the DGR, signed in January 1993.

In July 1994, the government transferred the Recoleta Dam in the Limarí basin to the users' association. This dam was the first state-constructed dam in Chile, built between 1929 and 1934, with a storage capacity of 100 million m3, irrigating 15,000 has. The "Asociación de Canalistas" (UA), that has administered the dam for a long time, has already paid the 60 percent of the investment, while the rest was subsidized by the government. The ceremonial transfer was used to reaffirm government policy to always require majority private financing and ownership of new infrastructure, thus limiting the subsidies available for construction.

Also in 1994, an important precedent was set to establish the requirement that private utilities adequately manage the environmental impacts of water supply and treatment. All of the shares of ESSAL, the water company serving Valdivia (population 180,000), were purchased in an international bid by a Chilean electrical company. As an integral part of the bid, the company is required within a short time to fully treat all of Valdivia's sewage, which contains a high industrial component. Implementation of this agreement will completely decontaminate one of the most beautiful rivers of the south, the River Calle-Calle, that previously has received poorly treated or untreated sewage.

Also a new private water company, Biwater Supply Chile, created in a joint venture between British and Chilean investors, won the bid to serve "La Deheza", one of Santiago's new important urban developments (425 has).

Conflicts

Two controversies over interpretation of consumptive and non-consumptive water rights have also occurred in recent years. The electricity companies that own hydroelectric infrastructure are entitled to non-consumptive rights to use water. Despite the legal restrictions on non-consumptive rights (the ones used in hydroelectric dams) protecting consumptive rights by establishing that the use of the former cannot imply any limitation to the use of the latter, there have been conflicts between the Colbun Machicura electrical complex and the farmers that hold consumptive rights over the same water. The electrical company was using water in the low-flow seasons to fill its hydroelectric dams, thus compromising the consumptive rights of farmers. The Supreme Court has ruled in favor of the farmers, in accordance with the Water Code, restricting dam filling to the surplus flow season, when it will not jeopardize consumptive water rights.

Another conflict, more artificial than real, arose when power companies were accused of buying consumptive water rights in southern Chile in large quantities for their future development programs. The companies had actually bought less water than they were accused of buying, and the water they did buy was in an area with abundant water.

There has been intense controversy over the construction of the hydroelectric dam on the upper reaches of the Bio-Bio river. This dam will flood an extensive area covered by native forest containing several species that are close to extinction. In addition, some of the last members of a native tribe, the Pehuenches, live in the area. Also, some of the most impressive rapids for kayaking in the world are located in the area to be flooded. After receiving assurances that there will be enough water to ensure a continuous flow of the river, even during the dry season, and

that pollution would be sufficiently controlled, the president of the Republic approved the project. There is substantial doubt as to whether alternative dam sites that could have provided the same benefits without the high social and environmental costs were adequately considered. A new environmental protection law was recently produced and should be in effect before the end of 1994.[14] This law will provide a formal framework for consideration of environmental consequences of projects, which will reduce the discretionary faculties of the government.

Attempts to Modify the Water Code

The only serious attempt to modify the actual Water Code was introduced in legislation developed at the Ministry of Public Works. The legislation, sent to parliament in December 1992, generated a substantial public discussion among policy makers and water users.[15] The most important proposals included: (a) forfeiture of water rights if not used within 5 years of the time established in the grant to begin effective use; (b) requirement that solicitors of new grants should demonstrate need for the water (justification of use) and indicate the time in which effective use will begin, that could not be more than 5 years; (c) provision of more authority to the DGA in conflicts related to water pollution and third party effects; (d) creation of Administrative Associations of River Basins (Administradoras de Cuencas Hidrográficas), including both private and public entities; and (e) assignment of rights to specific use (agricultural, industrial, or household) in the most arid regions of the country. A change in use would then require DGA approval.

All of these provisions can be interpreted as reducing the security of existing water rights and increasing the administrative discretion of the government in water allocation. Because of this, water users and farmers' associations have strongly opposed the legislation. The bill has been frozen out of the legislative agenda by parliament, and the government has not reintroduced it. The legislation is unlikely to be passed in its present form.

ACHIEVEMENTS

A full determination of the impact of the Chilean water policy would require a long term research project, but several positive effects can be identified, based on existing information. The water policies applied in Chile, mostly because of sure, permanent and tradable water rights, with transferability of water uncoupled from land, have fostered efficient agricultural use of water. Improved water use efficiency has increased agricultural productivity, generating more production per unit of water. The market valuation of water at its scarcity value has induced farmer investment in on-farm irrigation technology, which has saved water to irrigate more area or to sell to other uses.

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[14] The new environmental law ("Ley Marco del Medio Ambiente") has recently been approved. It requires the Reglamento to become effective.

[15] Legislation Project 283-325; December 2, 1992.

Agricultural Use of Water

The freedom to buy and sell or "rent" water also gives flexibility, allowing farmers to shift cropping patterns based on profitability, and permitting the most effective use of water rights by different land owners, through short term agreements or rentals, in different periods of the year. In areas where water is the limiting factor of production, market-oriented water policies have also increased the agricultural frontier, in its traditional definition. More land can be irrigated with the same amount of water, as a consequence of the above-mentioned increase in efficiency.

Aggregate cropping data support these conclusions. The area planted to fruits and vegetables, that require more water per hectare (but less water per value of output) than most field crops, with high demand in the most water-scarce months mentioned before, increased during the period 1975-1982 by 206,000 hectares, replacing traditional crops and irrigated pastures that needed less water. In addition, two studies have attempted to measure the increase in aggregate water-use efficiency in agriculture from 1975 to 1992. The first study found a 26 percent increase in efficiency (Munita 1994) and the second one a 22 percent increase (Frías 1992). If we consider the lowest estimate, and taking into account that Chile's total irrigated area, with permanent rights, amounts to 1,200,000 hectares, this is equivalent to freeing up enough water to irrigate an additional 264,000 hectares of crops of average water-use intensity. On the other hand, in a conservative estimation, an investment of about $400 million in new infrastructure would be required to generate the incremental water saved through efficiency gains generated by policy reforms.

Substantial agricultural development occurred after the 1973 shift to market-oriented social and economic policies. Water policy was only one of several economic reforms that contributed, but the pattern of agricultural changes shows the importance of tradable water rights in facilitating flexible response to changing comparative advantage in agriculture. Tradable water rights also fostered investments in agriculture, allowing farmers to invest and obtain financing not only for irrigation improvement, but also for slow maturing projects, like some fruit crops.

From the mid-1960s until 1973, Chile's agricultural GNP grew at around 2 percent per year, less than the population growth of the country (Valdés 1973; Varas 1975). In this period, the agricultural trade balance was almost always negative; by 1973 the agricultural trade deficit had reached $544 million (imports were $607 million and exports just $63 million) (Mujica 1991). In addition, rural life at this time was very poor; incomes were low and social services deficient.

The surface covered by fruit farms (grapes, apples, pears, nectarines, kiwis, etc. and small fruit such as raspberries, strawberries, blueberries, cranberries) has gone from 54,000 ha in 1973 to 235,000 ha in 1993 (INE 1994). Chile, like Australia, New Zealand, and Argentina, produces in counter-season with the Northern Hemisphere, thus having an important advantage in fruit marketing by providing fresh fruit in the northern winter. Chile has become the largest fruit exporter in the world. Additionally, 35,000 ha of wine-producing vineyards have been planted in the same period, more than doubling the 25,000 ha of vineyards existing in 1973.

The agricultural GNP grew an annual average of 5.1 percent between 1974 and 1990, including recession years 1981 and 1982 (2.1 and 3.6 respectively). In 1993, there was an agricultural

trade surplus of $2.2 billion (exports of $2.8 billion and imports of $0.6 billion) that compares with the deficit of $544 million in 1973 (ODEPA 1993, Banco Central).

The rural population is about 15 percent of Chile's total population, and agriculture accounts for some 24 percent of the country's jobs. Half of the new jobs created by the agricultural conversion from traditional to export-oriented crops are occupied by women (mostly in labor-intensive fruit harvesting and processing) (Valdés 1988).

As mentioned previously, the dramatic increase in agricultural production and employment has been accomplished without the need for new hydraulic infrastructure. It has been achieved mostly by shifting land from cultivation of grain, corn, oilseeds, and cattle raising to fruit production, which creates far more production and income per unit of water.

Urban Water Use

One of the most important benefits of Chile's water policy is the requirement that cities buy water without having to buy land or expropriate water. Efficiency in urban water and sewage services has been greatly increased, with no significant impact on prices, except in a few cities that were previously highly subsidized (Ale 1990). Operational efficiency of urban water companies has been fostered because they can no longer get free water from the state through expropriation from farmers. When incremental water could be obtained for free, there was no need to improve either physical efficiency (pipes, metering, etc.), or economic efficiency. The coverage of potable water has risen to 99 percent in urban areas and 94 percent in rural areas from 63 percent and 27 percent respectively in 1970. Rural areas include towns of less than 5,000 people (Wisecarver 1992).

Besides the increase in coverage, there have been substantial improvements in the maintenance and operation of the infrastructure (old state companies had regularly over 20 percent of water lost because of pipe leakages). The supply is now very reliable, even in water-scarce zones. In the past, during the dry seasons, many cities, including Santiago, often had water only during certain hours of the day. The pricing system has corrected incentives for both users and for the supplying company. Having a secure right over the use of water and an active market is fostering the construction and operation of treatment plants that sell water for agricultural or urban use, like those being constructed in Santiago and Arica.

Conflict Resolution

Water policy reform has also improved the efficiency and reduced the costs of conflict resolution. The certainty of water rights and the legal and managerial attributes of users' organizations have greatly diminished the number of conflicts arriving in courts. In the past, all conflicts that are today resolved by users' organizations were sent to criminal courts. The resolution of such conflicts could take several years, often benefiting the offender.

Redistribution of wealth

Perhaps the most important results of Chilean water policy are social benefits achieved through redistribution of wealth and reduction of poverty. In the past, the construction of subsidized and often unprofitable hydraulic infrastructure and the distorted water prices and deficits caused by inefficiencies in state-owned water services, were all financed through taxes. This meant transferring resources from the poorest sectors of the population (that had no water) to the wealthiest (that had water). Everyone in Chile pays a consumer tax over all purchases at an 18 percent rate, accounting for 60 percent of all tax revenues. This tax represents a substantial portion of the income of poor people, who spend a high percentage of income on basic consumption goods. The new water policy, by reducing subsidies to better-off farmers and urban water consumers, has freed-up tax resources that the state can use to reduce poverty. The government can use these funds to subsidize the poorest water users through direct, transparent, focused, and efficient targeted subsidies such as described above for poor urban water users and small farmers.

FUTURE ISSUES IN CHILEAN WATER POLICY

The evidence thus indicates that new water policy has made strong positive contributions to the development of both agricultural and urban areas in Chile. Nevertheless, as the country develops and as the new policy has been operating for near 20 years, some modifications of the law should be considered in the future to solve specific problems that have emerged in the operation of the system and to allow user associations to cope with the New Environmental Law.

First, regulations should clarify the fact, established in the Water Code, that non-consumptive rights do not imply or permit any limitation on the consumptive rights which may exist over the same water. The experience acquired in conflicts between hydroelectric companies and farmers, and the arguments that were introduced before the issue was resolved by he Supreme Court, should be considered in the clarification of these rights in any future modification of the law. More precise definition of when non-consumptive rights can be used without limiting consumptive rights should reduce the potential for conflict over this issue.

Second, selective reforms could be introduced to better deal with the issue of third-party effects resulting from reduced return flow due to water trades. As described above, in Chilean law, the return flows to neighboring areas may be used by the recipients without the need to establish a right of use, but there is no obligation to preserve return flows. By defining away third-party rights to return flows, the Water Code maintains relatively low transaction costs to trades. This approach has been acceptable to water users, because of the initial equitable allocation of proportional water rights, and because of the hydrological characteristics of Chile; in most river basins return flows do not have productive uses, but are lost to drainage, so third-party effects are small.

However, there are two important exceptions to this: the Aconcagua, an important river in an area with a large proportion of high value crops, and the Elqui river, which is very small but significant river because it is located in the DZ. These two rivers irrigate very narrow valleys,

and return flows are large. The reduction or elimination of return flows, because of sales or efficiency gains, may drastically affect the total flow of a sector of the river.

The Elqui River UA has dealt with this problem by limiting trades within upstream areas to farmer-to-farmer transactions, unless unanimous approval of members is obtained, with agriculture-urban transactions authorized only in the utmost downstream area irrigated by the river. Where return flows are important, two approaches could be incorporated into the Water Code. The first is to reserve a certain number of water rights to the users' associations to distribute according to actual third party effects of trades; if third party effects do not occur, the reserved rights could be distributed proportionally within the association. The second is the solution developed by the Elqui River UA: empower the UAs to determine areas in which transactions could be made only between farmers belonging to that area; areas where agricultural-urban transactions could take place without third party effects.

Third, to be able to cope with the New Environmental Law (Ley Marco del Medio Ambiente) dispositions, UAs should be given the power to join in Basin Users Associations because they own the water infrastructure (dams, main channels, secondary channels), operate and maintain them, represent all water users (agricultural, urban, mining, aquaculture, etc.) and are empowered by law to sanction them, even depriving them of water in cases of serious transgressions. The establishment of basin level associations would facilitate an integrated response to environmental regulations.

CONCLUSIONS

The definition of secure, tradable, transferable water rights not attached to land was essential for constructing the new water policy in Chile and accounts for most of its achievements. Chile had in many ways a unique opportunity, which not all countries have, to dramatically shift its water policies. The fact that all water rights were expropriated in 1966 and transferred to the state made it possible to define clearly the characteristics of the new water rights in 1975.

Although the Chilean experience in water policy is in some ways unique, important lessons can also be drawn from this experience, thus contributing to efficient use of water in other countries. Some of the tools that can help are secure, tradable water rights, market allocation of water, market pricing, user participation in new irrigation investment, and direct targeted subsidies. These fundamental issues should be seriously considered in other countries before continuing with construction of huge projects with high economic and social costs and severe environmental consequences.

What factors have accounted for the economic and social achievements of the Chilean market-oriented water policy based on tradable water rights? At least seven lessons can be derived from the discussion above. First, the initial assignment of water rights must be perceived as equitable. In Chile, the establishment of tradable water rights beginning in 1976 was linked to the re-privatization of land that had been collectivized in 1966. Land and the proportional right to water were returned to former owners (40 percent) and to former workers on the lands (60 percent);

the new assignment of tradable water rights was seen by farmers and other water users as a significant improvement in equity.

Second, the system of water rights, allocation, and trading should be, to a significant extent, managed by the water users. In Chile, strong water user associations play a major role in allocation of water and in conflict resolution. Water user associations own and manage the physical infrastructure, monitor the allocation of water, approve water transfers, and provide the initial (and usually final) forum for conflict resolution. It should be noted that establishment of the system of secure tradable rights, which increases the value of water, creates strong incentives for water users to develop effective institutions for water management.

Third, the certainty of water rights is not only essential for market solutions, but is a requisite to foster investment in agriculture. The existence of secure rights was fundamental to the large private investments that diversified the agricultural economy and resulted in agricultural growth of 5.6 percent annually between 1980 and 1992.

Fourth, water rights should be defined so as to keep the transactions costs of trading low, while still protecting third parties against damage from trades. In Chile, rights, although expressed in volume per unit of time, are proportional to streamflow or canal flow, when supply is insufficient to satisfy all rights. This system is more flexible in allocating water, and particularly deficits, than a straight volumetric right. In addition, rights to return flow do not exist. Return flows to neighboring areas may be used by the recipients without the need to establish a right of use. However, use of this water is contingent upon the flow of the main waterways and usage rates of the rights holder. There is no obligation to supply return flows, and such flows are thus not permanent. If, as noted above, initial water rights are allocated equitably, proportional rights with no rights to return flow should facilitate efficient allocation without compromising equity.

However, where changes in return flows may affect drastically the total flow of a sector of the river, greater protection from possible third party damage due to reduction in return flow resulting from water transfers is required. In these cases, it would be possible to reserve a certain number of water rights for the UA to distribute according to actual third party effects, or to empower the UAs to determine areas in which transactions could be made only between farmers belonging to that area, and areas where agricultural-urban transactions could take place without third party effects. Another alternative would be to arrange for financial compensation for third-party effects, if accepted by the adversely affected party, to be paid from the proceeds of the water sale.

Fifth, economic liberalization is neither a necessary, nor a sufficient condition for development of water markets. However, when a country begins the process of economic reform, moving toward liberalized trade, and a market-based economy, as Chile did, clear and secure land and water property rights and market allocation of both resources are necessary to generate the full benefits of overall economic reform. With a liberalized economy, if land and water rights are not clear and transferable, the agricultural sector has limited flexibility to cope with the changes in demand and prices on international markets. General economic liberalization increases the costs of maintaining centralized water allocation policies, thereby increasing the incentives to shift to market-oriented water policies.

Sixth, to ensure that a market system works, it is fundamental to clearly define the regulatory and supervisory functions of water-related authorities and to shift the operational functions to water users. Government institutions which previously allocated water and investments in water within centralized administrative schemes should not be granted discretionary powers in a market-oriented water allocation policy. In Chile, the only serious attempt to modify the actual Water Code to reduce the security of water rights and weaken users associations' power, while re-centralizing substantial authority in the government water agencies, was developed at the Ministry of Public Works, by remaining officials of the old system.

Finally, market solutions have to be perceived, by the society as a whole, as working in favor of social equity. Chilean experience demonstrated, contradicting what has been traditionally thought, that market allocation of water and private financing of infrastructure work in favor of the poorest sectors of the population, through correct pricing and the liberation of resources that can be used by the State in its redistributing role. Protection should be provided for those who are "left out" by market solutions. In Chile, direct water price subsidies have been provided to the urban poor who would be hurt by the prevailing market prices, and subsidies have been extended to smaller farmers to permit them to purchase rights to water produced by newly constructed irrigation infrastructure.

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APPENDIX 1

BASIC INFORMATION ON CHILEAN IRRIGATION SECTOR

Soil Use

Chile has a total area of 75.6 million hectares; of these, 25.1 million ha (32.2 percent) are productive lands, consisting of 11.5 million ha of forest lands, 8.5 million ha of extensive grazing land, and 5.1 million ha of cultivable land suitable for crops. The use of this land was distributed as follows in the 1993/94 cropping season:

CROPS	AREA (ha)
Basic Crops (Wheat, corn, sugarbeet, etc.)	1,092,780
Orchards (Fruit, mostly for export)	235,530
Flowers and vegetables (Mostly for export)	90,210
Wine producing vine	73,370
Natural and artificial pastures	3,644,677
Total	**5,136,567**

Irrigated Sector

The total irrigated sector amounts to 1,900,000 ha, of which 1,200,000 ha have permanent irrigation, and 700,000 ha have eventual or contingent water supply. Channel irrigation, diverting water from rivers, accounts for 835,000 ha of the permanently irrigated surface and 400,000 of the eventually irrigated one. Almost all of the diversion irrigation infrastructure was built by private enterprise, beginning in the 16th century.

Underground water, also with privately constructed pumping infrastructure, permanently irrigates 65,000 ha. Water provided by dams, most of them state-constructed, are responsible for 300,000 of the permanently irrigated hectares and 300,000 of the eventually irrigated ones.

Irrigation by Geographical Sectors

According to rainfall and irrigation, Chile can be divided into 4 zones, which have very different characteristics.

The North Desert Zone includes three geographical regions (Tarapacá, or I Región; Antofagasta, or II Región; and Atacama, or III Región). The desert zone has an annual rainfall between 0 and 50 mm, with an irrigated area of 35,000 ha. Because of the excellent desert climate, the hectares are dedicated to very intensive crops. The first grapes exported each year to the northern hemisphere (October) are produced here.

The Semi-Desert Zone includes the Coquimbo, or IV Región, with annual rainfall from 0 to 200 mm. Irrigated surface amounts to 106,300 has. The climate allows the growing of crops all year round and has excellent conditions for fruit production. The largest irrigation dam in Chile (capacity of 748 million m^3) and four other dams (that have a total capacity of 290 million m3) are located here.

The Central Zone includes five regions (Valparaiso, or V Región; Metropolitan Región, where Santiago is located); O'Higgins or VI Región; Maule or VII Región, and Bío-Bío or VIII Región). This region is the heart of Chile's agriculture, with 1,600,000 irrigated ha of the 1,900,000 total irrigated area. Annual rainfall ranges from 300 mm. in the northern part to 1,500 mm in the southern limit. Three large multipurpose dams and four irrigation dams (323 million m3) are located here. The largest is the Digua dam (222 million m^3).

More than 90 percent of the irrigated land in this zone obtains water from channels diverting river flows. Rainfall is concentrated mostly in winter, when water is abundant. The dry season begins in mid-December and continues until mid- March. Some of the rivers, like Maipo and Maule, that are nourished from glaciers in the deep Andes valleys, have quite steady flows. Others that depend on snow accumulation or rainfall infiltration have highly variable flows, like the Aconcagua, Ñuble and Diguillín Rivers.

The Central Zone is the most traditional agricultural zone in Chile (a great portion of the North desert zone belonged to Peru and Bolivia before "1879 War," and the South wasn't colonized until the 19th century), and is the region where water allocation customs and traditions developed. Further institution development was influenced by the highly variable flow pattern of many rivers in the region. Thus, from colonial times, water rights have been expressed in volume by unit of time, but were proportional to the river's flow when streamflow was inadequate to service all of the water rights. Control Committees (Juntas de Vigilancia) were in charge of controlling the correct water extraction, week after week, by each water right's holder. The only period in which state authority ruled this distribution was the time when water rights were expropriated by the state (1966-1974).

Operation of the proportional flow system can be illustrated by the Diguillín River, whose water rights are expressed in shares of 15 l/sec, the quantity considered adequate to irrigate 10 has. These flows will be real for most of the year, until the beginning of December. In January, the flows provided by a share can fall to 8-9 l/sec and in February to 5 l/sec, or even less in very

dry summers. Most of the farms have overnight dams to accumulate nocturnal flow and use it in daytime; some have winter dams to stabilize summer water flow. In this zone short term water trade agreements and "rentals" are customary and have fostered efficient water use.

The Southern Zone includes Araucanía or IX Región and the Los Lagos or X Región. Rainfall fluctuates from 1,250 to 1,800 mm, and the total irrigated area amounts to 208,100 ha, mostly in the IX Región. All irrigation here is diverted from rivers and used in high value crops, like sugar beets, supplementary crops for feeding milk cattle, raspberries and in recent years cranberries.

Infrastructure Requirements and Water Distribution Among Users

Beginning as early as the 16th century, inexpensive devices for measuring and dividing flows of water have been developed in Chile. These devices are adequate to meet the hydraulic requirements for implementation of tradable water rights regimes based on proportional rights. Water is diverted from rivers through many main channels that carry the rights of several right owners (sometimes hundreds or thousands). Each main channel has a diverting device called a "bocatoma," which includes a flow measurement device where water flow can be easily calculated just by measuring the height of the water flow. Downstream, this flow is diverted to secondary channels by distribution structures called "marcos partidores" that proportionally divide the flow. Finally, when water flow has to be divided into very small flows (less than 50 l/sec), it must be distributed by shifts, because irrigating with such small flows is very inefficient. If the flow is to be delivered in a specified volume, the appropriate flow can be set by fixing the necessary time of flow delivery to reach the specified volume.

Farm Size and Water Distribution

The average area of irrigated farms in the Central Zone is approximately 80 ha but ranges from smaller farms of 2-3 ha to large farms of up to 300 ha. A typical situation in this zone would be a unit that was, prior to the Agrarian Reform, a privately owned farm of 500 ha. After the reform, the farm would have been divided into a plot of 200 ha for the previous owner (as the only compensation for the expropriation of the whole farm) and 15 plots of 20 ha each, distributed as private property, to the former farm workers. In most cases, water rights for the whole area would be administered and water fees paid through a Water Community, ("Comunidad de Aguas"). The actual distribution of water would be by "marcos partidores," between the large plot and sections of the small ones and by time shifts for the small plots within sectors. The previous owner would have water rights for 300 l/sec and the smaller farms for 30 l/sec each.

APPENDIX 2

AGRICULTURE-URBAN WATER TRANSACTIONS: ILLUSTRATIVE CASES

In the main text, we reported the results of an examination of frequency, volume, and type of transaction in three Water Registries for all water trades which were not linked to land transactions. The appendix, on the other hand, looks in detail at representative agriculture-urban sales in order to illustrate different types of transactions and who is involved in them.

For these cases, besides obtaining certified copies of the official register of the transactions, we searched the previous inscription of the rights of the seller to determine the total rights held and the proportion of the total that was being sold. The typical register contains such information as the date of sale, buyer, seller, amount sold, and number, page and year of the previous inscription of the seller's right. Price of the sale is sometimes included, but it is not obligatory to be registered.

The 1994 registers were not available for this analysis, because they were in daily use by the public, and to select the cases and to obtain all the information needed would require access to the registers for a considerable amount of time. The following sample transactions give a sense for the types of agriculture-urban transactions taking place in Chile.

1. April 18, 1991, page (P) 107, Register Number (RN) 203 of year 1991, of the Puente Alto Water Register. EMOS, represented by a lawyer, buys from a farmer and his wife water rights equivalent to 1.5 shares of the Maipo River. The total amount of water owned by the seller was 7.6 shares, for which the first inscription is found in P 793, RN 647 of 1961 Puente Alto Concession Register. The price of the sale is Chilean $6,500,000. Thus, the sale represents 19.4 percent of the total water rights of the farmer; the price, converted to 1994 Chilean dollars (deflated by the price index) and then to 1994 U.S. dollars represents US$20,120 on US$670.7 per l/sec.

2. August 21, 1989, P 182, Register Number (RN) 309 of year 1989, of the Puente Alto Water Register. EMOS, represented by a lawyer, receives a transfer of water rights equivalent to 0.114 water shares of the Maipo River from a development company to provide potable water to 58 houses. This company bought the water to be transferred to EMOS— according to the law—from a family of 10 people who jointly owned a farm. The total shares of the seller were 3.76 shares; the previous registration is P 124, RN 130 of 1982 Puente Alto Water Register. The sale represented 30 percent of the total water rights of the family. No price was mentioned in the register.

3. January 12, 1983, P 1, RN 1 of year 1983, of the Santiago Water Register. EMOS, receives a transfer of water rights equivalent to 0.0552 shares of the Maipo River from a developer who

bought these rights— to be transferred to EMOS according to the law—from a farmer. The total shares of the seller were 0.1422, previously registered in P 350 N 336 of the 1982 Santiago Water Register. The sale represented 38.2 percent of the farmer's shares. No price was mentioned in the register.

4. March 24, 1993, P 67, RN 63 of year 1993, of the Santiago Water Register, "Empresa de Agua Potable Villa Los Domínicos," bought from an agricultural enterprise, which is co-owner of a farm, water rights equivalent to shares of 170.6 l/sec of the Mapocho River, fifth section. The total shares of the farm were 8871.2 l/sec, which were before registered from P 39 up to P 388, RN 39 up to 416 of 1981 and 1982 Santiago Water Register. The sale represents 19.23 percent of the farm's share. No price was mentioned in the register.

5. April 1, 1993, P 50, RN 81 of year 1993, of the Santiago Water Register, "Empresa de Agua Potable Villa Los Domínicos," bought from a farm family water rights equivalent to 0.4 shares of the Mapocho River. The total amount of water owned by the sellers was 1.05 shares, which were first inscribed in P 246, RN 238 of 1982, Santiago Water Register. The price of the sale is Chilean $2,200,445. The sale represents 38 percent of the total water of the farmer, and the price, converted to 1994 Chilean dollars and then to 1994 U.S. dollars, represents US$6,025, or US$753 per l/sec.

6. January 18 1993, P 33, RN 52 of year 1993, of the Santiago Water Register. "Empresa de Agua Potable Lo Castillo," bought from a small farmer whose land has been converted to non-farm purposes because of urban expansion, water rights equivalent to 0.226 shares of the Arrayán River (Tributary of the Mapocho River). The total amount of water owned by the seller, was 0.30 shares granted by the DGA in 1988. The price of the sale is Chilean $500,000. The sale represents 75.3 percent of the total water of the farmer, and the price in 1994 U.S. dollars represents US$1,369, or US$303 per l/sec.

7. February 23, 1993, P 33, RN 52 of year 1993, of the Santiago Water Register. "Empresa de Agua Potable Lo Castillo," bought from a farmer water rights equivalent to 1.0 shares of the Mapocho River. The total amount of water owned by the seller was 3.0 shares, granted by the DGA in 1979. The price of the sale is Chilean $6,000,000. The sale represents 33 percent of the total water of the farmer, and the price, in 1994 U.S. dollars represents US$16,429, or US$821 per l/sec.

8. May 16, 1993, P 91, RN 145 of year 1993, of the Santiago Water Register. "Empresa de Agua Potable Villa Los Domínicos," buys from a farmer water rights equivalent to 0.0618 of the Maipo River. The total amount of water owned by the seller, a small farmer, was 0.40 shares, first inscribed in P 342, RN 385 of 1981. The price of the sale is Chilean $351,023. The sale represents 15.4 percent of the total water rights of the farmer, and the price, converted to 1994 U.S. dollars represents US$961, or US$777 per l/sec.

Annex B

ESTABLISHING TRADABLE WATER RIGHTS: IMPLEMENTATION OF THE MEXICAN WATER LAW

Mark W. Rosegrant
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ESTABLISHING TRADABLE WATER RIGHTS: IMPLEMENTATION OF THE MEXICAN WATER LAW

INTRODUCTION

Mexico is in the process of implementing fundamental changes in its water policy with respect to water rights, water management, and allocation of water, following passage of a new Water Law. This paper describes the political and economic background and developments that led to the new Water Law, summarizes the emerging characteristics of the system of tradable water rights in Mexico and the process by which these rights are being implemented, and concludes with some lessons for other countries from the Mexican case.

BACKGROUND OF THE NEW MEXICAN WATER POLICY

In order to understand the forces behind the passage of the new Mexican Water Law, it is necessary to comprehend, the historical structure of property rights for land and water in this country and the broad economic developments that have led to reconsideration of this structure of rights. Through the late 1980s, water policies and water-related laws were consistent both with Mexico's relatively centralized economy, where the government had a significant role in allocating resources and producing goods and services, and with the concept of the role of agriculture, developed as a result of Mexican Revolution, that tried to give to this sector more a social welfare role than a productive role (Téllez, 1994).

Special Status of Agriculture

According to this special role of the agricultural sector, Article 27 of the Mexican Constitution (which ruled agriculture, including land and water property rights) established a very different legal status for this sector than for the other productive sectors of the economy. As a result of this distinction, the Civil Code applied to all other activities and citizens, except to agriculture and farmers.

Land Tenure

Land was clearly divided into two types: the social property, consisting of the "ejidos," and the private property, made up of land owned by small farmers. The "ejido" in Mexico, means large farms whose land is owned in common by all the entitled farmers, called "ejidatarios." The concept was taken from the Spanish "ejidos", that were the common land for grazing cattle that surrounded the villages. The titles and rights of the "ejidatarios" came either from those originally allocated during the Revolution over "ejidos" created on the farms of the defeated, or

from those that were later adjudicated when new "ejidos" were created after expropriation of private land under the Agrarian Reform that went on from 1914 until 1991.

All rural properties of more than 100 irrigated hectares (ha), or the equivalent in production potential on other types of land, were considered large, and so subject to expropriation, to increase the size of the reformed, or "ejidal" sector. No share-based enterprises could own, rent, or administrate any kind of rural property. Individuals could own land in units below the farm size limit, only if they were born in Mexico.

The "ejidos" have three types of land: that used for housing and urban needs, the common land, and the individual plots. The common land includes livestock and forest. Land that can be cultivated is divided into plots that are worked either individually or collectively, according to the majority decision of the "ejidatarios" of each "ejido". When worked individually, plots are assigned to the "ejidatario" under certain fundamental conditions: (1) He has the right to cultivate the plot in the terms decided by the majority, but he has no ownership over it; he cannot rent it or make any kind of deal with third parties for exploiting the land, nor even hire labor, except those belonging to the his direct family. Despite these regulations, the rental of plots became a common practice because small plot size, lack of capital, and lack of access to credit often made farming of small individual plots uneconomical.

In 1991, when the Article 27 of the Constitution was reformed and the New Agrarian Law produced, the ejidos represented 103 million hectares (M ha), about 60 percent of the 172 M ha of total potentially usable land (agriculture 24 M ha, cattle raising 105 M ha, and forestry 43 M ha); however, but only 3.4 M ha of ejidal lands were irrigated. The other 2.6 M ha of irrigated land were in the private sector (SARH, 1991).

Results of the Ejidal Agricultural System

By the late 1980s it was clear that the ejidal system was failing both to achieve adequate and sustainable growth in agriculture and forest production and — its main objective, derived from the Mexican Revolution—to improve farmers' welfare and quality of life. In forestry the ejidal system ended with more than 70 percent of Mexican natural forests deforested--mostly through illegal exploitation--with practically no new forestation undertaken. New forestation was authorized to be done only by the Government or the "ejidos". Private enterprise could not plant new forests (Gazmuri & Zamudio, 1992).

Despite the relatively high productivity of private agriculture (legal and illegal) that produces most export agricultural products (principally fruits, vegetables and meat), between 1991 and 1992 agricultural exports decreased by 14.8 percent and imports increased by 36.1 percent. The income level of 57 percent of the rural labor force was below the minimum wage, and 26 percent of the rural labor force was unemployed (INEGI, 1992).

Irrigation and Water Rights in the Ejidal System

Of the 6.0 M ha of irrigated land, 4.6 M ha are irrigated by state irrigation systems and 1.4 M ha by privately constructed and operated irrigation systems. The state-irrigated lands are divided into 3.4 M ha, in 79 state-created and managed Irrigation Districts (IDs)--almost all "Ejidos" are obliged to be in IDs--and 1.2 M ha in private irrigation Units (IUs), which are voluntary associations of farmers that receive water either from state-owned or state financed infrastructure or from private infrastructure. They were originally formed as the voluntary irrigated Agricultural Units (AUs) to receive technical assistance from the Ministry of Agriculture (SARH).

Private irrigation includes 0.5 M ha in IUs and 0.9 M ha of private farms irrigated individually. Through the late 1980s, cropped area and agricultural production were centrally planned by SARH. SARH provided the seeds, fertilizers, pesticides, etc., deemed necessary under the plan, and, through a state-owned enterprise (CONASUPO), bought the output at fixed prices. Based on the cropping plan, the CNA (or its precursor, the Ministry of Water Resources) would provide water through highly precarious water rights called "concessions," that, although according to the law could extend from 1 to 50 years, actually had effect for only a single growing season. In practice very few concessions for irrigation were granted, and water was directly distributed by the CNA to the IDs and the IUs, depending on state-owned and state-managed infrastructure. The only farmers that could irrigate without the intervention of the CNA were those private farmers who worked individually or who had voluntary integrated in IUs that used privately constructed and privately managed infrastructure.

Previous Water Legislation

In the Mexican Constitution, before reform of Article 27, the treatment of water rights was linked directly to the treatment of agricultural property rights. Under this system, water rights (or water allocations) could not be sold, rented, or used on other lands, or for uses other than those specified in the grant. The maximum area that could be legally irrigated by a farmer, with state owned water, was 20 ha. However, analogously to rental of ejido lands, there was an active market in short-term water rentals or swaps within agriculture, facilitated by the CNA operators of the irrigation devices. Many farmers cultivated and irrigated 100 ha or more, mostly illegally rented to "ejidatarios," through these mechanisms. However, despite these informal market solutions, there was great uncertainty in receiving water each season because of the discretionary power of both the SARH and the Comision Naciónal de Agua (CNA). Water concessions could be diminished or revoked for cause, such as past history of crop yields, employment needs, government decisions to encourage a different crop, a judgment of inefficient use, public need, or force majeure.

Inefficiency of Water Use in the Ejidal System

This system of water allocation resulted in low physical and economic efficiencies; the losses through the irrigation infrastructure, both outside and inside the plot, were as high as 50 to 70 percent; also, in spite of the user's legal obligations to pay for the water, the IDs were highly subsidized. In 1988 only 18 percent of ID operational costs were financed by water users (CNA, 1991). In many of the IDs, the conveyance inefficiency left the downstream plots absolutely without irrigation. These plots were often then rented at very low prices and irrigated with water rented by the new tenant from CNA authorities in the ID.

The coverage of water and sewage services was only 70 percent in urban areas and 49 percent in rural ones. In urban water, physical losses through leakage are very high, fluctuating, depending on the city, from 40 percent to 60 percent. In Mexico City, despite having the best measuring and collecting system, only 30 percent of the water delivered to houses and industries is measured, and only 18 percent of water tariffs are collected (McKinsey, 1992). By the year 1992 the total subsidy from the government to CNA and to state or municipal water companies, just to cover their O&M deficits, without considering amortization of infrastructure, was equal to 0.5 percent of the national GNP (López Presa, 1992).

Toward a New Water Policy

In the early 1990s Mexico began to rapidly liberalize its economy, shifting from a state-centralized, highly regulated system, to a market-oriented one. Social and economic policy reforms were based on private property, market allocation of goods, private businesses supplying goods and services, and liberalization of trade, combined with a strong state sector emphasizing social policy to alleviate the poverty of those left out of the economic growth process.

In accordance with this new economic and social approach, the government proceeded to reform Article 27 of the Constitution and passed a new Agrarian Law. Under the new agrarian policy, farmers become independent from the state in their productive and commercial decisions. Full and secure property rights to land were established, both in the social (ejidal) sector and in the private sector. Limits to the size of farms were essentially abolished, as was the prohibition on foreign land ownership in Mexico. Titles to the individual plots of ejidatarios are currently well along in the process of being registered, and ejidatarios are now permitted to rent or sell their plots. The common lands of the ejidos can be integrated under stock companies jointly owned by the ejidatarios, and through this mechanism, the common land can also be sold. After the legal reforms the differences between "ejidatarios" and small farmers disappeared; today, in official government documents, they are all "farmers."

On the other hand, the economic reforms meant that after a transition period with direct subsidies to farmers, farmers would have to be able to produce at internationally competitive prices without subsidies of any kind, except for the extremely poor, non-commercial farmers. This implies that on the irrigated land that contributes 50 percent of agricultural production, farmers will have to become responsible for the efficiency of water use, as water is one of their most important inputs.

It was clearly recognized by policy makers that, under the new economic system, retention of the existing water laws could severely limit the benefits of freeing up land markets and liberalizing the economy. With respect to macroeconomic policy, the existing water laws would remain an important source of Federal Government budget problems because of financial inefficiency in construction and management of infrastructure, a costly central administration, and poor collection of O&M costs in irrigation and of tariffs in urban water use. The prevailing water law was also an important obstacle with respect to the newly liberalized agricultural policy. With individual farmers making the cropping decisions, it would be difficult and inefficient to maintain topdown water allocation that would not match the water requirements of farmer-determined cropping systems.

Allocation of water through tradable rights would instead provide the flexibility in responding to changes in crop prices and water values, as demand patterns and comparative advantage of crops changed and diversification of cropping proceeded. By turning over to the agricultural users the financing of new infrastructure and full O&M costs and by establishing adequate pricing of raw water, with no possible expropriation of irrigation water for urban use, the new law would force improvements in physical and financial efficiency of the State or Municipally owned water and sewage companies. Following economic liberalization, a market-based water allocation system would be more responsive, and less expensive, than centralized allocation of water.

THE NEW WATER LAW

Among the key features of the law are establishment of concessions to water users of transferable volumetric de facto proportional water rights, assignment of initial rights based mainly on historical use, and establishment of strong regulation over the transfer of water rights under the supervision of the CNA.

The objectives of the new water law were clearly stated during the debate leading up to its passage: to increase the availability of water resources through efficient use (both physical and economic) of the existing water resources; to exploit new (and increasingly expensive) water sources only when absolutely necessary; to minimize environmental damage from new infrastructure or from inappropriate uses of water; to improve water quality and avoid, as far as possible, third party effects; and to shift to users the real costs of water management and of infrastructure financing.

To meet these objectives, both the CNA and the SARH, were in agreement about the need for well-defined, secure tradable water rights (Téllez, 1994). However, during discussions, there were differences in preferences on the appropriate degree of regulation of water markets and on the speed of turnover of irrigation systems to users. The SARH was in favor of a rapid turnover of the administration of water and water infrastructure, as well as financial responsibility, to newly created independent water users' associations (WUAs) (Gazmuri, 1992). The CNA favored a period of co-administration between the water authority and the users, especially in respect to dams and river basins (CNA, 1992). As will be shown in detail below, the law that was passed in December 1992 reflected a compromise of these positions.

Definition and Allocation of Water Rights

According to the new Article 27 of the Constitution all water (sea, river, lagoons, underground, etc.) belongs to the Nation, and this property right is perpetual and non-transferable. Private individuals or associations may use water through concessions. The only water that can actually be owned by private individuals are streams that run exclusively within the boundaries of a private property and underground water pumped by the owner of the land overlying that water. However, in both cases the Constitution authorizes the government to regulate the use of this privately held water. This provision is the origin of the regulated, restricted, or reserved zones under the new law that permit CNA to regulate virtually all underground water (see more detailed description below).

The new law and regulations, which now define water rights and allocation policy, are the "Ley de Aguas Nacionales" (National Water Law), passed in December 1992, and the "Reglamento de la Ley de Aguas Nacionales" (National Water Law Regulations), published in January 1994. Under the new law, water rights are given by means of "concessions" to individuals, or legally defined groups of individuals, and by "assignations" or "grants" to federal, state, and municipal departments or agencies. There is no discernible difference between and responsibilities of "concession holders" and those of "grantees," but a right given by concession cannot be transferred to a grantee without CNA authorization.

Concessions and grants are given for periods that range from 5 to 50 years, with terms in excess of 30 years apparently to be the norm, to ensure security of the water right. However, other sections of the law appear to weaken somewhat the security of the water right, by making it dependent on administrative criteria and decision. Some of these conditions are the possibility of forfeiture, to be declared by the CNA if water has not being exploited for three years; redemption for reasons of public interest; and forfeiture for not complying with "efficient use" of water. These articles appear to be aimed at prevention of "speculation" (buying and holding water rights for future use), but arbitrary enforcement could constrain development of markets in water rights.

Initial Rights Determination

The fundamental basis for initial allocation of water rights is the existing informal or formal water concession already held. Thus, according to the Reglamento, the concession of water goes to "those that legally demonstrate the use of water before law." The law explicitly recognizes concessions, allocations, and permits issued under the Federal Water Act of January 11, 1972, as well as "precarious" rights currently held. Precarious rights are the least secure rights because they are supported by no written documentation, instead relying on such evidence as verbal testimony of neighbors that water was used in some place in some quantity.

The prospective rights holder must establish evidence of previous rights in the application for a concession, which includes name and address of applicant; basin, region, and locality to which the applicant refers; the site from which national water is to be extracted; the volume of consumption required; the initial use to which the water will be put; the point of discharge; the

necessary investment to extract and use the water; and the period for which the concession is sought. Previous water use can be established by certification from an Irrigation District or ejido administrator as to the individual's land and water rights under previous law. Although granting of concessions is at an early stage, discussions with farmers and officials do not indicate much concern that the initial allocation process will be inequitable. Titling of land rights in the same areas as water rights is well under way. The prior completion of land titling, together with the close linkage of initial water concessions to land, will facilitate allocation of water rights.

Other mechanisms may also be used to grant water rights. The water law reserves the right for CNA to award certain waters on the basis of bidding, when competing interests are anticipated. Alternatively, the CNA may award the concession to the first applicant, or if various applicants come forward simultaneously the CNA may select the one who offers the best terms and conditions.

Individual and Group Water Grants

As noted above, water rights can be provided to individuals or groups, but there appears to be a strong preference on the part of the CNA to make concessions to groups, with the groups then to grant subsidiary water rights to their members through processes to be authorized by CNA. Three distinct types of groups are distinguished in the granting of water rights in agriculture, irrigation districts, irrigation units, and ejidos; however, the procedures for establishing concessions are nearly the same, and after the process is complete, the organizational structure, water rights, and operating rules for these three groups are likely to be virtually indistinguishable. Ejidos with access to irrigation are virtually coterminous with irrigation districts. The few irrigated ejidos outside of IDs will form water user associations and will devolve water rights to individuals in proportion to the assignment of individual property rights to land, as noted in the Reglamento ("members of the ejido are entitled to water to irrigate their respective parcels").

Under the law, farm producers in Irrigation Units "may freely associate" and "so convened" will be able to set up Irrigation Districts; the procedure that follows is then conceptually the same as for concessions to irrigation districts.

New Water Users Associations and Transfer of Irrigation Districts

Before being granted water concessions, IDs will be turned over to be "managed, operated, conserved, and maintained" by their users, organized into water user associations. To be legally constituted and provided with a water concession, the WUA must develop internal regulations that govern group decision-making processes, including the terms and conditions under which the rights to the water concession are to be assigned to individuals; the terms under which rights are transferable; specification of other individual rights and responsibilities of members; and specification of procedures for undertaking and paying for investments and operations and maintenance of the irrigation system. These rules of operation to govern the water users associations must be approved by the CNA.

WUAs are, in turn, organized at the Irrigation District level through the Hydraulic Committee, composed of representatives of each WUA in the district and presided over by the Chief Engineer appointed by the CNA. This committee, as will be described in more detail below, regulates district-level water transfers.

Specification of Quantity and Quality of Water Rights

The initial concession of water is based on the normal previous volume of consumption of water by the individual or group. However, it should be noted that this "consumption" is not the "consumptive use" rights with obligations to maintain a specific amount of return flow, which are common in California and other western states in the U.S.A. The concession is instead for the full diversion of the water. Water rights are technically specified in volumetric terms, rather than in proportion to streamflow; however, the irrigation districts and WUA are charged with developing procedures to allocate surplus and deficit water within their boundaries. Indications are that surpluses and deficits will simply be allocated proportionally across all existing rights, so that, for example, if streamflow is 20 percent below normal, each rights holder will receive 20 percent less water. This procedure effectively converts the volumetric right to a proportion of streamflow right.

The general terms of the law indicate that the quality of discharge is to be specified in the concession. However, quality restrictions in the specific terms of the law and the Reglamento are placed only on non-agricultural use. Based on interviews with government officials, this was an explicit decision based on the perception that discharge quality, in agriculture, is not a significant problem, and that the costs of enforcement of discharge quality in agriculture would be excessive.

Registration of Water Rights

The water law establishes a Public Registry of Water Rights to be maintained by the CNA. All water concessions and grants will be recorded in the register, as well as their extensions, suspension, termination, and transfer of any or all of the concession. The certificates of inclusion in the Registry are the means of proving the existence, entitlement and status of the rights; inclusion is a prerequisite for the transfer of rights conferred by the concessions or grants. The registry also includes the permanent national register, by zone or region, of the extraction and releases of groundwater, in order to monitor, and if necessary, regulate the use of aquifers.

Regulation of Markets in Water Rights

There are no regulations on the length of transfers of water rights, nor are there direct restrictions that a rights holder can trade only a given proportion of his water right. Entire water rights can be transferred for any length of time up to the remaining length of the water concession. However, there are significant regulations governing transfers between various uses and sectors.

Seven types of water trades can be distinguished, with a different regulatory process governing each one. All transfers of water rights must be recorded in the Public Registry of Water Rights maintained by the CNA. In general, the process can be seen as a regulatory hierarchy, with water user associations having authority over trades among individuals, the regulations of the irrigation district having primacy over the water user associations, and the CNA having authority over operations of the IDs.

Types of Water Transfers

The following types of trades can be identified:

(1) Trades in which the precise consumptive use specified in the existing concession is not altered, i.e., transfer of a right to use irrigation water on the same land-linked transfer of land and water, can be made without prior approval, with simple registration of the transfer in the Public Registry of Water Rights.

(2) Trades between irrigators within a water user association (WUA) or between irrigators within the same irrigation district (ID) are governed by the "regulations of the WUAs or the district." Under the law, the irrigation district's hydraulic committee (composed of representatives of each WUA in the district and presided over by the Chief Engineer, nominated by the CNA) will propose internal regulations that govern the transfer of water rights held in its concession. These regulations must not contradict the original specification of the concession and must be submitted for authorization by CNA. With publication of the Reglamento implementing the new water law in January 1994, the process of formal turnover of districts to farmers, definition of water concessions, formation of WUAs and hydraulic committees, and development of the regulations governing the water concessions is just beginning.

(3) Trades between two associations of any kind (WUAs or IDs) require, in addition to CNA approval, the approval of a majority of the general assembly of the irrigation districts involved.

(4) Transfers between individual (private) irrigators, who have received private concessions outside Irrigation District structure, are also subject to CNA approval.

(5) Trades between sectors (i.e. between irrigation and industrial uses) are subject to approval of the CNA, as well as to a majority vote of the general assembly of the district.

(6) The transfer of groundwater rights, in restricted or regulated areas that cover most of the groundwater area, shall be done jointly with transfer of ownership of the pertinent land. The groundwater right can be transferred separately only if the ruling of the restricted or regulated area establishes so, and if authorized by the CNA after fulfilling its requirements.

(7) Transfers inside approved river basins which have legally constituted Basin Councils can be made under the rules established by the council, without further approval of the CNA. A potentially very important provision in the water law, that would significantly increase the ease of water transfers, creates the option of establishing councils on a river basin, aquifer, or other regional basis. These councils should develop agreements between the CNA; federal, state, and municipal departments and agencies; and water user groups within the basin, region, or aquifer to formulate broad plans for water administration and development, and conservation. Once the CNA establishes a Basin Council--composed of seven government officials and six water users representative of and presided over by a delegate of the SARH--and approves the overall plan and operating regulations, water would be freely transferable among different users and uses within the basin, region, or aquifer, without further CNA review. The only formality for effecting transfers would be registration in the Public Registry of Water Rights. The CNA has the right to work out, with the Basin Councils, as representatives of the users, possible temporary limitations to the rights in emergency, scarcity or excessive exploitation. A Water Basin Council has recently been constituted for the Lerma-Chapala River Basin, an area with multiple uses and increasing competition for water between agricultural, household, and industrial restricted areas.

Along with other oversight functions, the Federal Executive Branch, through the CNA, may regulate the extraction and use of water, establish restricted areas and water reserve areas in the following cases of public interest: to prevent excessive exploitation of aquifers, to protect or restore an ecosystem, to preserve sources of potable water or protect them against pollution, to preserve and control water quality in case of unusual water shortages or drought. With this regulation, established in Article 38 of the law, the CNA can impose limitations that can virtually freeze water transactions. Under these provisions, the CNA has full control over extraction, discharge, and transfer of water in affected areas. Some 70 percent of total irrigated area served by groundwater is currently under some form of prohibition or restriction.

Regulation of Water Trades During the Transition Period

Overall, these regulations give the CNA broad discretionary power over the concessional right to use water, over virtually all water transfers, and particularly over all transfers with significant efficiency implications. It is likely, however, that the degree to which CNA exercises its authority over trades will increase as the difference in location of use or type of consumptive use of the traded water increases. Transfers among farmers in the same general locale have been commonplace for decades, with implicit or explicit CNA approval, so it is unlikely that CNA will exercise a heavy hand over these types of transfers.

Furthermore, both the government, because of budget restrictions, and the farmers, in order to diminish O&M costs, are putting great pressure to speed up the process of IDs transfers to the WUAs. As more IDs are transferred to WUAs, the number of water transfers within agriculture will likely increase significantly because the WUAs are empowered, by the law, to fix, with the approval of CNA, general regulations for transactions between farmers in their respective IDs.

Once these general rules are approved by the CNA, the CNA will not have to approve each transaction within agriculture.

During the transition phase, indications are that CNA intends to play a strong role in approving and brokering intersectoral trades. However, a number of developments are likely to promote increased intersectoral trading. An easing of regulations on trades for all types of water transactions, including agriculture-urban trades, will occur as Basin Councils are established. It is expected that at least one or two more Basin Councils in addition to the Lerma-Chapala, will be established by early 1995.

In addition, the government policy of privatizing water and sewage services should also encourage agriculture-urban transactions in order to cope with the increasing water needs. The privatization process appears to be moving quickly, with the government finalizing an international bid to operate, through a long term concession, the Mexico City water and sewage facilities, which will serve a population of 22 million people, to one or several private water companies.

Protection of Third Parties

Since CNA and/or the Irrigation Districts approve all trades other than exact transfer of original consumptive use and transfers governed by basin level agreements, they, by definition, monitor and have approval over any trade potentially involving third party effects. Protection of third parties through prohibition of transfers causing damage to third parties or setting of compensation also receives separate emphasis in the water law as a responsibility of CNA.

Protection of the Environment

The water law establishes strong explicit protection of the environment for the first time in Mexican water law, using a regulatory, rather than a market or tax/subsidy approach. As noted above, the quality of discharge for non-agricultural uses must be specified in the granting of the water right, and the CNA can invoke restrictions over water use in the event of damage to ecosystems, over exploitation of aquifers, and other environmental impacts. A minimum streamflow is established for rivers, but explicit reservation of flows for environmental purposes is not made. The transfer of water rights for in-stream flow, however, is not prohibited.

Conflict Resolution

The processes for resolution of disagreements and conflicts over water rights and transfers are delegated in the first instance to the WUA and IDs, which are directed in the law to incorporate such procedures in their internal regulations. Conflicts which cannot be resolved at these levels can be appealed to the CNA. The law does not provide explicitly for recourse to courts for conflict resolution, but it also does not deny it; therefore, following common law, appeals can

always be taken to the judiciary, if conflicts are not solved by the CNA. Recourse to the courts to solve water conflicts was not available prior to reform Article 27 of the Constitution.

Transactions Costs

A basic condition for operation of the new water law is the turnover of irrigation districts to the users, which the law directs to be completed within three years. The turnover process anticipates that most IDs will require substantial rehabilitation and modernization prior to turnover, if they are to achieve the level of the water management implied by the law. However, the number of investments required is still a matter of debate, as is the modality for undertaking such investments. Water user associations are in many instances requesting to receive the systems as is and then to bid out any necessary upgrading, while the CNA prefers to undertake this upgrading itself, with funding from the water user associations and from international lenders, particularly the World Bank.

It appears that many WUAs also believe that the necessary investments in infrastructure to implement the new water law, including tradability of water rights, is relatively modest and that existing simple conveyance structures and measuring devices will in many cases be adequate. Under the current system, water is usually directly measured only at the main channels entering the irrigation district, using the method of section-width and height, multiplied by the velocity of the water; which gives the flow (m^3/second). The flow multiplied by time provides the volume of water. At lower levels in the system, the flow is divided into proportions (60-40 or 80-20, etc.) for secondary channels or tertiary canals, so the flow of each one of them can be determined. The de facto definition of water rights as proportional to flow facilitates the use of relatively simple division structures rather than installing measuring devices at most points in the conveyance system. At the plot level the proportional rights are delivered trough shifts of a predetermined number of hours.

Administration and Conveyance Fees

Although irrigation districts are being turned over to water user associations, CNA will retain control over dams and main (and larger secondary) channels and diversion structures. A key objective of district turnover is to improve the funding of and eliminate subsidies to operation and maintenance of irrigation systems. Considerable success has already been achieved, with CNA reporting that farmer payments as a proportion of total O&M have increased from 18 percent in 1988 to nearly 80 percent in 1993. These gains have been achieved both by budget restrictions on O&M outlays, and because of informal transfer of irrigation district administration to water users, as the formal turnover proceeds.

After turnover, WUAs are required to fund and implement O&M for the canals and other infrastructure under their control, with the level of fees set by the implementing regulations approved by CNA. In addition, CNA will collect a fee on WUAs to pay for conveyance of water to the district and O&M on infrastructure within the ID which is retained under CNA control.

These fees are set at levels ranging from 5 percent of WUA irrigation fees, if CNA operates only the main dam serving the district, to 10 percent if both dam(s) and channels are operated by CNA, and to 20 percent if pumps are used and under CNA control.

Two earlier laws, already mentioned above, which are broadly consistent with the new water law, could also contribute to putting irrigation financing on a self-sustaining basis, if they were seriously implemented. The "Ley de Derechos en Materia de Aguas" ("Federal Law of Water Fees") specifies the fees to be paid for use of national waters and for the operation and maintenance of infrastructure outside the irrigation districts. The "Ley de Contribución de Mejoras Por Obras Públicas de Infraestructura Hidraulica" ("Hydraulic Infrastructure Repayment Law") establishes the charges the beneficiaries are committed to pay for cost recovery on capital investments. These two fees, for O&M incurred outside of the district and for recovery of capital investment, are collected by the IDs administration (user's or CNA) and transferred to the treasury.

WATER TRANSACTIONS

It is too early in the water law reform process to evaluate its impact on development of water markets. However, traditional short-term trades among farmers will continue to be negotiated between buyer and seller (with participation of CNA when their conveyance facilities are involved). These transfers are often swaps of water between time periods within the cropping year, involving no exchange of money. A few purchases of short term water within agriculture have also been completed. Water purchased for production of high yielding dry season corn in Sinaloa recently cost US$400-450 for the amount of water required to irrigate one hectare (about 20,000 m^3 at the turnout).

Intersectoral trades under the new law have been brokered by CNA. These transfers have not been direct market purchases of water; three recent examples show the type of transfer that is being made thus far. The city of Hermosillo acquired a flow of 2 m^3/sec from nearby pump irrigators, paying the irrigators for the entire electricity cost of pumping of nearly 8 m^3 on average, thus covering the cost of pumping for both the city and for irrigation purposes. The city of Monterrey, which is beginning to face serious water shortages, purchased one crop season of water rights from farmers in the Bajo Bravo and Bajo San Juan Irrigation Districts by paying the equivalent of estimated crop income from the land. With an approximate net income of crop per ha of US$750-1000 and an amount of water released per ha of 12,000-16,000 m^3, this implies a price of about US$ 0.05-0.08/m^3. In Guanajuato, a new factory required a permanent flow of 1.0 m3/sec, which would have required the purchase of 25 water concessions in the local area. To acquire the full, long-term concessions, the land would have to be purchased as well, since this would have required permanent fallowing of the land. Instead, the CNA put together a package that had the factory owner pay the costs of having 100 farmers invest in pressurized drip irrigation, saving 40 percent of previous water use, which was then delivered via aqueduct to the factory. Long-term (50 years) right to the water was acquired by the factory. Total cost to the factory was about US$1,000,000.

CONCLUSIONS

The new water law contains considerable tension between relatively unfettered transferability of water and highly regulated trading. However, the law that was produced is sufficiently flexible that it should be able to evolve, if market solutions prove to be efficient, to a more liberal interpretation in which the role of the government would be reduced to establishment of rules and regulations, investigating and measuring the resource base, granting new water rights (to available water or water generated from new infrastructure), keeping the water rights register, fixing tariffs in natural monopolies (urban water), and subsidizing marginal farmers and the poorer urban users. With respect to major state-constructed or state-financed irrigation infrastructure, farmers would participate in the project decisions, with the need for their approval before construction, and would have to take a strong commitment to pay back the investment. Nevertheless, given the political and social sensitivity of water allocation, it may be appropriate to have relatively close oversight of water trades in the early stages of development of water markets, with a relaxation of this oversight as experience is gained.

This process of liberalization may be fairly rapid, since both government and farmers are requesting a quick transfer of Irrigation Districts, and municipal, regional and state authorities are requesting the establishment of Basin Councils, with the enormous implications for water trade liberalization that were explained above. Also the Government decision of privatizing urban water services will help in the approval of agriculture-urban trades.

At least four major forces are likely to keep pushing for further liberalization. First, continued macroeconomic reform will require further market development at the micro level in both agricultural and non-agricultural sectors. Second, with municipalities no longer permitted to expropriate water to meet rapidly growing needs, they will push for increasingly open water markets to transfer water to urban use.

Third, the farmers themselves will continue to lobby for strong and easily transferable rights. With the removal of subsidies to farmers, it would be particularly inappropriate to maintain an implicit tax through market restrictions that reduce the value of water.

Fourth, all the economic authorities that have a leading role in political decisions were convinced during the discussion of the new water law that further steps toward deregulation were needed, and a strong compromise on appropriate policy directions in the water sector was taken. This last consideration is important in the actual political circumstances of Mexico. To have the necessary resources to provide targeted subsidies to those who are left out of the growth process, which is a primary goal of the recently elected government, budget restrictions in both state investments on hydraulic infrastructure and in current expenditures are urgently needed. This means transferring to the users the financing of infrastructure and of all O&M costs. It also means, through adequate pricing of raw water—with no possible expropriation of irrigation water for urban use—forcing improvements in physical and financial efficiency of state or municipally-owned water and sewage companies, and charging efficiency water prices to urban users and improving collection of water fees. The broad policy consensus forces government to rely on

private enterprise in developing commercial agriculture, which implies the need for stronger water rights and flexible water markets.

Lessons from the Mexican Case

Since the new water law became effective only in January 1994 with the publication of the regulations to implement the law, it is too soon to derive generalizable conclusions about the functioning of water markets in Mexico. The main lessons of the Mexican case instead relate to the underlying reasons that made the changes in the water law necessary. The first reason behind the reform of water law was the urgent need to improve efficiency in the entire water system. Both agricultural and urban water were used quite inefficiently, with large losses of water and with an absolutely discretional allocation of the resource imposing further hidden costs. Appropriate market pricing of water and the transfer to the users (both agricultural or urban) of the costs of investment and O&M were thought to be the right tools, both to improve physical and financial efficiency, and to allocate water to its best use.

Second, implementation of the new macroeonomic policy required a large reduction in broad-based subsidies, in order to finance the new emphasis of the Government on targeting those persons left out of the growth process. A primary target for budget cutting was the enormous subsidies to water management and operations (0.5 percent of GNP) that benefited mainly the wealthier sector of the population, including farmers who irrigated with state water both in the ejidal system and the private one, and urban water users who paid very little or not at all.

Reduction of these subsidies necessitated the transfer of at least some capital investment costs and most or all of O&M costs to the users; construction of new water infrastructure only with the approval and participation in funding of capital costs by water users; and introducing incentives for urban water companies to become efficient, through adequate market pricing of raw water, ending agricultural water expropriation, and appropriate tariff fixation that considers all involved costs, including growing investments.

Last, the agrarian policy reforms that lead to individual farmers making the cropping decisions could not be effectively implemented with topdown water allocation that would not match water requirements of farmer-determined cropping systems. Allocation of water through tradable rights would provide the flexibility in responding to changes in crop prices and water values, as demand patterns and comparative advantage of crops changed and as diversification of cropping proceeded. Following economic liberalization, a market-based water allocation system would be more responsive, and less costly, than centralized allocation of water. Well-defined tradable water rights and secure land property were essential prerequisites to foster the investments, national or foreign, that the newly liberalized agricultural sector needed.

It is likely that other countries which are undertaking the process of economic liberalization will face similar strong incentives to reform water allocation processes to allow market-based allocation. General macroeconomic reform and economic liberalization significantly increase the costs of retaining inefficient water management policies.

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Annex C

WATER TRANSFERS IN CALIFORNIA: POTENTIALS AND CONSTRAINTS

Mark W. Rosegrant

ACRONYMS

CEQA	California Environmental Quality Act
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
EIR	environmental impact report
ESA	Endangered Species Act
IID	Imperial Irrigation District
MAF	million acre feet
MWD	Metropolitan Water District of Southern California
SWP	California State Water Project
SWRCB	State Water Resources Control Board
USFWS	U.S. Fish and Wildlife Service

WATER TRANSFERS IN CALIFORNIA: POTENTIALS AND CONSTRAINTS

INTRODUCTION

A number of factors have combined to stimulate interest in improving the flexibility of water market transfers in California. Rapidly growing urban and environmental demand for water, the high economic and environmental costs of developing new water supplies, public rejection of infrastructure options such as the peripheral canal linking the relatively water-rich north with the increasingly water-scarce south, and serious droughts in recent years have brought the issue of water market transfers, as a component of comprehensive demand management, to the forefront of the water policy dialogue in California. In 1982, California adopted a statewide policy of encouraging voluntary water transfers between agencies throughout the state. This policy was based on the assessment that there are fewer environmental impacts associated with transfers than with construction of conventional projects, and that although transfers are difficult to implement, they can be accomplished more quickly and usually at less cost than additional facilities can be constructed. Since 1982, a number of laws have been passed to facilitate the sale, lease, exchange, or transfer of water and to ensure that water conveyance facilities are available in transferring water (Department of Water Resources [DWR] 1992).

Demand for water has grown rapidly in California. Between 1960 and 1990, urban water use rose from 2 million acre-feet (MAF) to 6 MAF, and legally mandated natural runoff for environmental purposes increased from 1 MAF to 24 MAF, or 28 percent of total water supply. Water use in irrigated agriculture also increased, from 20 MAF to 24 MAF (Figure 1). This rapid growth is expected to continue. California's population is projected to increase to 49 million people by 2020 (from about 30 million in 1990). According to the California Water Plan Update (DWR, 1993a), even with extensive water conservation, urban annual net water demand is projected to increase by about 3.8 MAF to 10.5 MAF by 2020. Almost half of the population increase is expected to occur in the water-scarce southern coastal region, raising that region's annual water demand by 1.5 MAF.

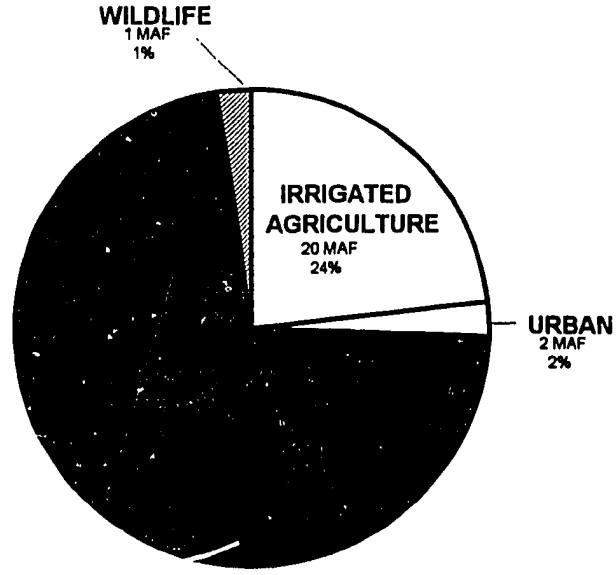
Severe droughts in recent years have revealed the need for greater flexibility in water trading. The 1987-92 drought required increased water conservation in much of California. In many instances, mandatory water rationing for urban users sharply diminished surface water supplies for many agricultural users and strained environmental resources. The prolonged drought prompted urban water agencies to develop drought emergency plans to address water supply shortages of up to 50 percent of normal supply and led to the development of the California State Emergency Drought Water Bank, which brokered large-scale water trading in 1991 and 1992.

However, despite increasing demands on water supplies and laws explicitly encouraging water trading, California water law and policy is characterized by conflict between the desire to facilitate water transfers and the desire to protect a wide range of constituencies against possible adverse effects of water trades. The controversy over water markets is typified by the environmental movement's ambivalence toward water transfers. While water trading is seen as

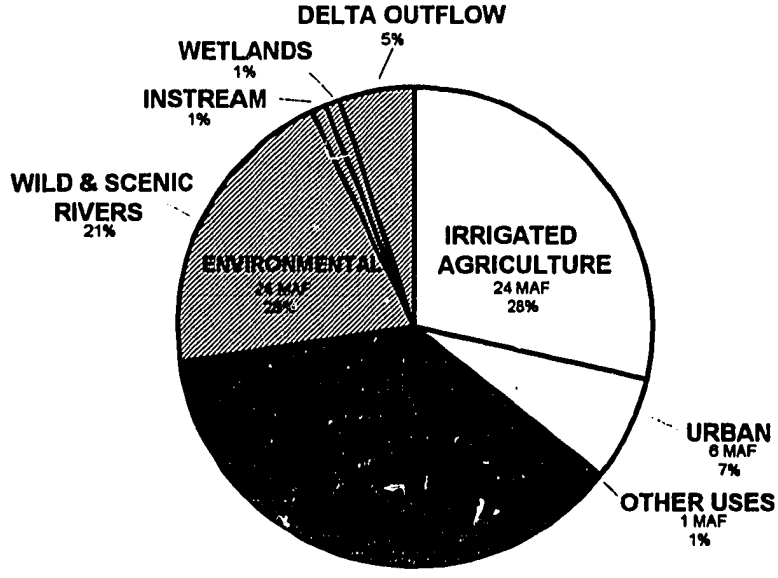
FIGURE 1. DISPOSITION OF AVERAGE ANNUAL WATER SUPPLY

1960 AND 1990

85 Million Acre-Feet (Includes Ground Water)



1960



1990

Outflow to Ocean

Dedicated Natural Runoff
Environmental Needs

Source: Draft California Water Plan Update, 1993.

a partial solution to the problem of meeting increasing urban demands without building new water projects, there are serious concerns that temperature and flow fluctuations caused by the water releases will harm fish and wildlife, particularly salmon eggs and fry. These concerns are heightened by the fact that many transfers must be pumped through the Sacramento-San Joaquin Delta, an area where environmental and water quality problems are already complex, because most of California's precipitation falls on the northern part of the state and the greatest demand for water is in central and southern California.

This paper will examine how the complex trade-offs between flexibility and regulation of water transfers are resolved in practice in California. It will discuss briefly trends in water transfers; describe the historical development of water rights in California and the implications of this legacy for tradability of water; examine the regulatory structure governing water transfers and specific protections and constraints that condition water transfers; identify recent legal and policy innovations that have developed in response to these potentials and constraints; and discuss implications for the future of water transfers.

TRENDS IN WATER TRANSFERS

Based on available evidence, the annual volume of water market transfers has grown, albeit slowly. Table 1 shows the annual water transfers using the facilities of the State Water Project and those transfers reviewed and approved by the State Water Resources Control Board (SWRCB). These figures do not represent a comprehensive accounting of water transfers in California, since many transfers do not require reporting. As will be described in more detail, water transfers do not need approval from the SWRCB if the water rights involve a pre-1914 appropriative right, if the transfer is exempted from SWRCB approval (for example "water leases") or if post-transfer use is consistent with original use. Moreover, many water transfers within or between irrigation districts do not need approval, and the districts do not report these transfers to the state.

Nevertheless, the trends shown in Table 1 appear to be broadly indicative of the general pattern of water trading during the past several years. There has been a slow upward trend with pronounced increases during the peak drought years of 1988-91. At the peak volume of transfers, 890,000 acre-feet in 1989, the two types of transfers documented here represented about 3 percent of total annual agricultural and urban demand for water in California. Combined with unreported transfers, this volume represents an important degree of flexibility in water allocation at the margin. However, many analysts have argued that restrictive policies have kept the volume of water transfers far below what is needed for efficient water use. (see, for example, Reisner and Bates 1990; Vaux and Howitt 1984; Gardner and Warner 1994). The remainder of this paper will explore the potentials for and constraints to enlarging the market for water transfers, beginning with a discussion of the existing system of water rights in California.

Table 1. Water transfers using facilities of the State Water Project and temporary transfers approved by the State Water Resources Control Bound, 1982-93.

	SWP Transfers	SWRCB-approved Transfers	Total[a]
		acre-feet	
1982	162,947	5,000	167,947
1983	187,461	0	187,461
1984	324,122	2,366	326,388
1985	425,169	5,868	430,937
1986	193,511	5,000	198,511
1987	488,619	83,144	488,663
1988	742,640	111,950	744,590
1989	626,950	274,700	894,650
1990	620,424	229,950	850,274
1991	619,194	249,950	861,644
1992	387,719	52,000	439,719
1993	323,304	188,500	451,804

[a] SWRCB approved transfers using SWP facilities are counted only once in total.

Source: DWR and SWRCB files.

Water Rights In California

Appropriative and Riparian Rights

California operates under a dual system of water rights for surface water that recognizes the doctrines of both riparian and appropriative rights. Under the riparian doctrine, a landowner has the right to divert a portion of the water naturally flowing by his land for reasonable and beneficial use on his land adjacent to the stream and within its watershed, subject to certain limitations. Under the appropriative doctrine, a landowner or other water user has a right to divert, store, and use water regardless of whether the land on which it is used is adjacent to a stream or within its watershed, provided that the water is used for reasonable and beneficial purposes and is surplus to water from the same stream used by earlier appropriators. These rights and restrictions are embodied in Article X, Section 2 of the California Constitution, which places significant limitations on water rights by prohibiting the waste, unreasonable use or method of use, or unsuitable method of diversion of water.

Water Rights, Permits, and Licenses

The Water Commission Act of 1914 codified and consolidated existing water law, recognizing that all water within the state is the property of the people of the state, but that the right to use the water may be acquired in the manner provided by law. The act established a system of state-issued permits and licenses to appropriate water and placed the responsibility for administering appropriative water rights with what is now the State Water Resources Control Board (SWRCB). The act also provides procedures for adjudication of water rights, including court references to the SWRCB and statutory adjudication of all rights to a stream system.

Groundwater Rights

Groundwater is available to any person who owns land overlying the groundwater basin. Groundwater management in California is accomplished either by judicial adjudication of the respective rights of overlying users and exporters or by local management of rights to extract and use groundwater as authorized by statute or agreement. Most of the larger groundwater basins in Southern California, where water is relatively scarce, are managed according to court adjudication or by an agency with statutory powers. Most basins in Northern California, where water is relatively plentiful, are not adjudicated or under agency management.

In 1992, the legislature authorized local water agencies to adopt groundwater management plans, which were subject to the approval of landowners holding 50 percent of the assessed valuation of land within the local area. Plans may include control of saline water intrusion; identification and protection of wellhead and recharge areas; regulation of the migration of contaminated water; provisions for abandonment and destruction of wells; mitigation of overdraft, replenishment, monitoring, and facilitation of conjunctive use; identification of well- construction policies; and construction of cleanup, recharge, recycling, and extraction projects by the local agency (DWR 1993a).

Water Rights in Federal Water Projects

Another type of water right is exercised within federal water projects run by the U.S. Bureau of Reclamation. The reclamation water right, like most other water rights, begins with an appropriation of water to the bureau under prevailing state water code requirements. Initially, the Bureau of Reclamation holds the legal title (the appropriative water right). The bureau then enters into a service agreement with (or turns its legal title over to) a delivery entity, such as a special water district or an irrigation district. Finally, the irrigators who contract to receive reclamation water own equitable title to the water right and thus are entitled to continued delivery by the federal government throughout the duration of their contracts.

Appropriative Rights Doctrine

This paper focuses almost exclusively on appropriative rights, because most of the water in the tradable margin is held according to these rights. The historical development of appropriative rights has defined the fundamental characteristics of modern water rights in California, which permit water to be traded while imposing strict requirements for determining tradability. This section reviews the development of the appropriative rights doctrine in California, relying heavily on the excellent treatment of Western water law by Johnson and DuMars (1989).

The first appropriative water rights statute was enacted in California in 1872 and codified existing traditional rights. A landowner could acquire such water rights by posting, at the point of diversion, a document stating the intended amount of the right and its purpose, filing for the right in the county recorder's office, and taking the necessary steps to "perfect" the right (put the water to beneficial use) with "due diligence." Appropriative water rights originated with gold mining, which required the diversion of large amounts of water from rivers and streams. A basic tenet of mining law is that the miner who initially stakes a claim ("first in time") is protected in development of the claim against other miners ("first in right"). This practice carried over to the use of water, becoming a recognized tradition that was protected by the courts.

The appropriative rights doctrine defines tradability of water as having several essential characteristics. The first of these is the requirement of beneficial use: the water user is entitled to only the amount of water which he can put to beneficial use, whether for mining gold or irrigating crops. The second defining characteristic is the principle of priority: "first in time is first in right." A chronological hierarchy is created, and in times of shortage senior rights holders are protected up to the available supply, while junior users (who established rights later) receive no water at all. A corollary to the "first in time" principle can be called "use it or lose it." Water rights holders who fail to use the water to which they are entitled receive little protection. When water rights were relinquished through non-use, the water returns to the watercourse and is available to meet the needs of junior users.

Another characteristic of prior appropriation is the need for a diversion, which establishes intent to use the water and provides a limited means for measuring the water used. The amount of water that can be extracted from the stream is based on a "water duty" (the amount of water a user needs per acre to successfully irrigate his crops) multiplied by the number of acres he

irrigates, and is defined in terms of diversion amounts (flows). Because downstream irrigators depend on the water that is not consumed, the "return flow," or excess water flowing off the field, is "owed" to the watercourse and downstream users. This principle forms the basis for definition of the "transferable portion" of water rights in terms of consumptive use, which will be discussed extensively below. Note that under the diversion doctrine, instream uses were not originally recognized as sufficient to demonstrate intent to use, although modifications to the law now allow instream flows to be considered beneficial use.

The appropriative rights doctrine firmly established the principle of water tradability. In 1859 (even before codification of the appropriative rights law), the California Supreme Court recognized the right to use and trade water under the appropriation doctrine as "substantive and valuable property".

Under the law of this state as established at the beginning, the water-right which a person gains by diversion from a stream for a beneficial use is a private right, a right subject to ownership and disposition by him, as in the case of other private property. All the decisions recognize it as such. (Johnson and DuMars 1989, 372)

An appropriative water right thus became a constitutionally protected property interest. It can be sold, leased, or transferred in other ways. Transfer of water rights need not be permanent: water rights can be leased for a season, a year, or many years. Protection of the water right as a property right was deemed necessary to promote investment of capital and to protect long-term financing of economic development activities that depended on water use.

The implications of the appropriative rights doctrine to the potential for water transfers today will be explored in detail below. First, however, the physical setting that conditions water transfers in California will be described briefly.

The Physical Setting

If water transfers are to be made on a large scale in California, a substantial portion will be transported by either the California State Water Project (SWP) or the federal Central Valley Project (CVP). These projects will pump the water through the Sacramento-San Joaquin Delta, a 1,153 square-mile region located where California's two biggest rivers converge and flow into San Francisco Bay. Forty-two percent of the state's annual runoff flows through the delta. The SWP and CVP water facilities in the south delta pump water to supply farms and cities in Central and Southern California, providing water to about two-thirds of the state's population. About 60 percent of the water used in the San Francisco Bay area is provided by these projects and by local facilities. The delta is a rich agricultural region, where a combination of flat topography, mild climate, and abundant water enable the production of $375 million worth of farm products in 1987. Delta waters support 28 native and 28 non-native fish populations, in addition to the salmon and steelhead populations that migrate through the delta on their journey to the ocean. Only if a fair balance can be found among these urban, agricultural, and environmental uses is significant growth in water trading likely to occur in California.

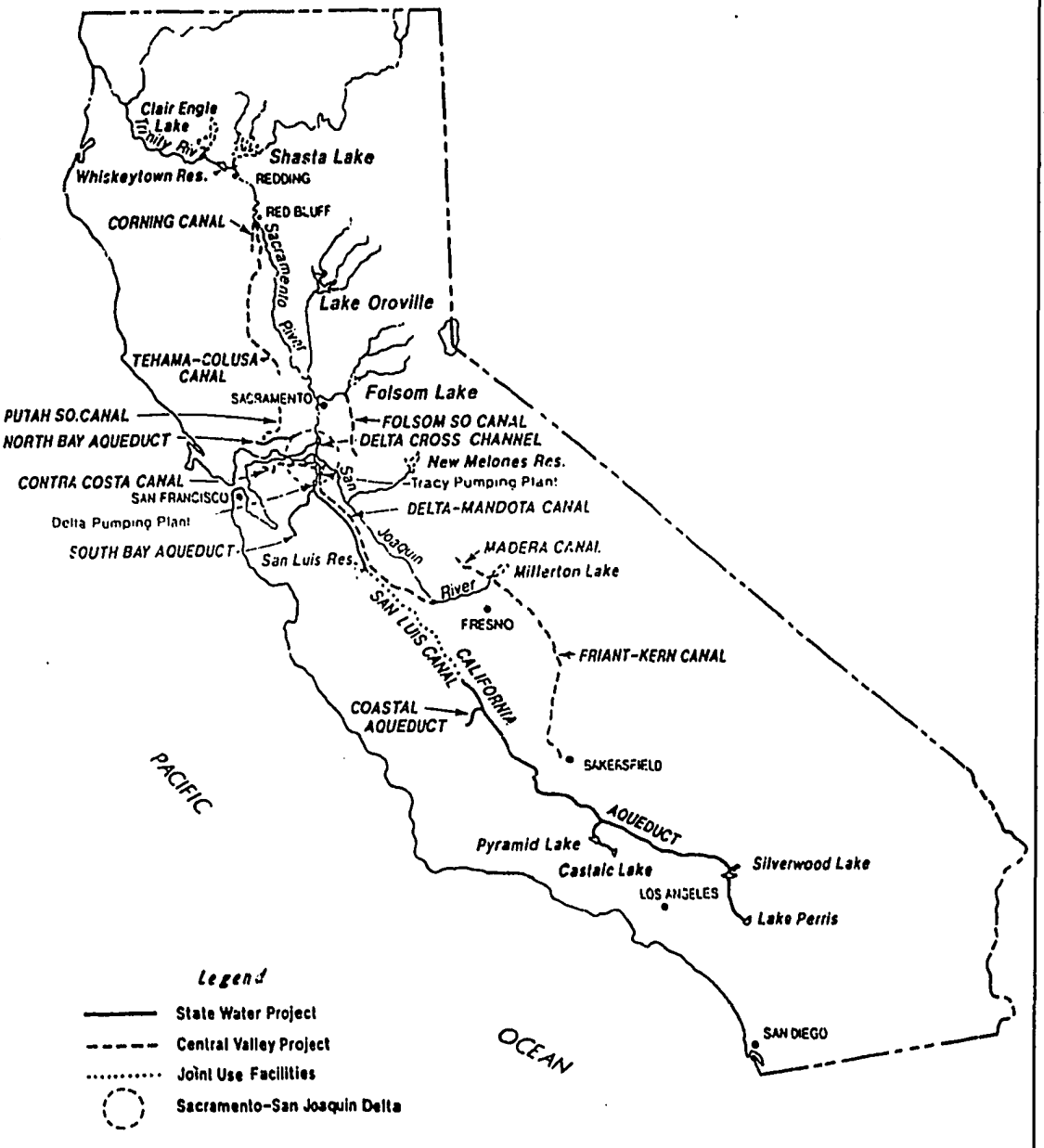


Figure 2. California State Water Project and Central Valley project

Source: State Drought Water Bank: Program Environmental Impact Report

State Water Project

Planning for the SWP began soon after the Second World War, when it became evident that local and federal water development could not keep pace with the state's rapidly growing population. The SWP's major components include the multipurpose Oroville Dam and Reservoir on the Feather River, the California Aqueduct, South Bay Aqueduct, North Bay Aqueduct, and a portion of San Luis Reservoir. Delta water transfer facilities were part of the original plan, which envisioned additional Sacramento and North Coast basin supply reservoirs. Contracts have been signed for an eventual annual delivery of 4.23 MAF. Figure 3 shows service areas of the present 29 contracting agencies. Generally, San Joaquin Valley use of SWP supply has been near full contract amounts since about 1980 (except during very wet and deficient supply years), whereas Southern California use has only reached about 60 percent of full entitlement.

The central importance of the SWP to the future of water transfers is virtually assured by the stipulation in the Water Code (Section 1810) that neither the state nor other public agencies may deny a bona fide transferor of water the use of a water conveyance facility that has unused capacity, provided that fair compensation is paid by the transferor. However, the law also states that persons or public agencies with existing long-term service contracts or other rights to receive water from the conveyance facility have the right to use any unused capacity before any bona fide transferor. In practice, therefore, existing delivery contracts of the SWP (or any other conveyance facility) must be satisfied before the facilities can be used to transfer water. Given the importance of pumping water through the delta when it will not cause environmental harm, the constraints of simultaneously moving contract water and transfer water can cause great difficulties.

Central Valley Project

The Bureau of Reclamation's Central Valley Project is the largest water storage and delivery system in California, covering 35 of the state's 58 counties. The project includes 18 federal reservoirs, plus 4 additional reservoirs jointly owned with the SWP. The 4.6 MAF Lake Shasta Reservoir is the largest in California. The reservoirs in this system provide a total storage capacity of slightly more than 12 MAF, nearly 30 percent of the total surface storage in California, and deliver about 7.3 MAF annually for agricultural, urban, and wildlife purposes.

About 90 percent of the CVP water has gone to agricultural uses in the recent past, including water delivered to prior right-holders. CVP water is used to irrigate some 19,000 farms covering 3 million acres. Increasing quantities of water are being delivered to municipal customers. Urban areas receiving CVP water supply include Redding, Sacramento, Folsom, Tracy, most of Santa Clara County, northeastern Contra Costa County, and Fresno. Recent steps taken to ensure adequate environmental supplies, under the provisions of the CVP Improvement Act of 1992 (CVPIA), are described below.

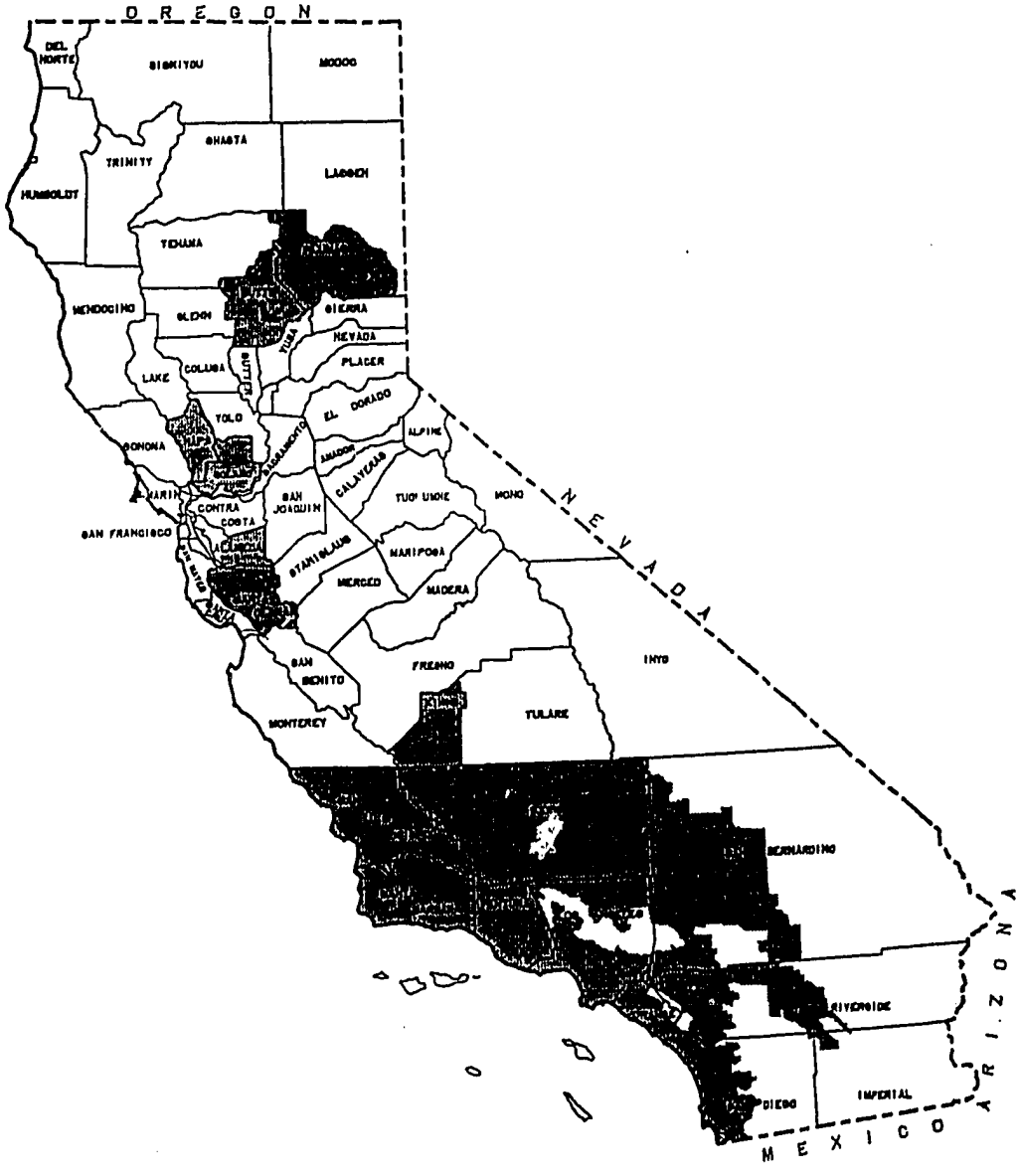


Figure 3. State Water Project Service Areas

Source: Draft California Water Plan Update, 1993.

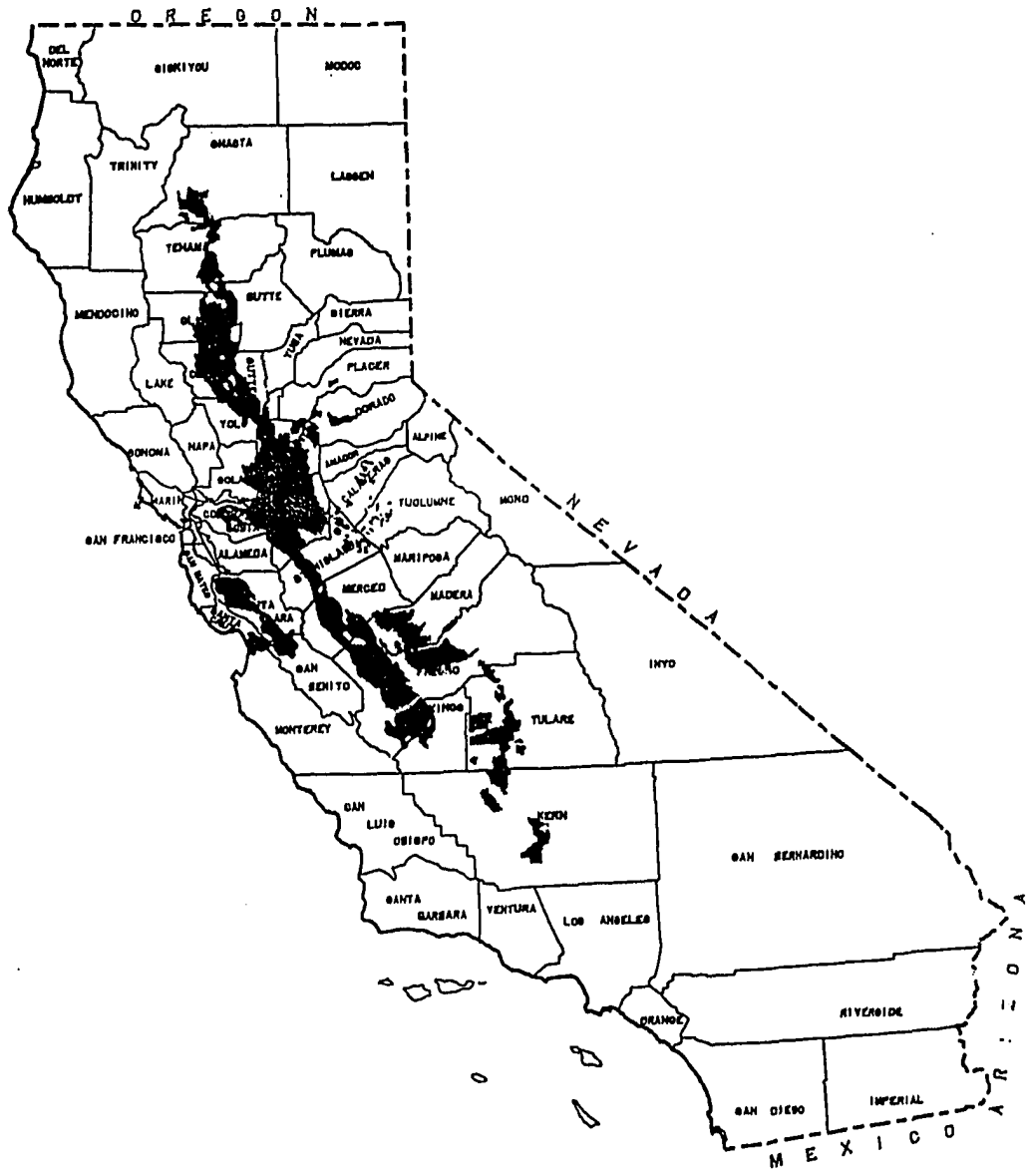


Figure 4. Central Valley Project Service Areas

Source: Draft California Water Plan Update, 1993.

The Delta

The Sacramento-San Joaquin Delta is the linchpin for water transfers in California. Under a 1986 state appeals court ruling, the SWRCB is required to balance all beneficial uses of San Francisco Bay and the delta waters, including fishery and other instream uses, and to modify existing water rights if necessary to achieve that balance. Public hearings to help set these standards, called the Bay-Delta proceedings, have often featured conflicting testimony from competing water-user groups. Environmentalists and some fishery biologists have argued that the export of fresh water from the delta is responsible for declining fish populations, particularly striped bass, delta smelt, salmon, and steelhead, and that the restoration of significant freshwater flows is necessary for the health of the estuary. But water-user groups and other biologists have responded that factors other than fresh water exports deplete fish stocks. Increased outflow would be wasted, they have argued, when this water is sorely needed for agriculture and a growing population.

Following withdrawal of draft water quality control plans in 1988 and 1991 due to objections from the public and the U. S. Environmental Protection Agency (EPA), the SWRCB decided in 1992 to establish interim Bay/Delta standards, which would last five years and provide immediate protection for fish and wildlife. Water-rights hearings were conducted from July through August 1992, and draft interim standards (proposed Decision 1630) were released for public review in December 1992. Concurrently, under the broad authority of the Endangered Species Act, the federal government was moving toward developing standards and upstream measures to protect the threatened winter-run chinook salmon. In February 1993, the National Marine Fisheries Service issued a biological opinion governing CVP and SWP operations and environmental regulations in the delta that in certain months were more restrictive than SWRCB's proposed measures. On April 5, 1993, the U.S. Fish and Wildlife Service officially listed the delta smelt as a threatened species and on May 24 issued a biological opinion on CVP and SWP operations with conditions designed to protect the delta smelt and its habitat for 1993-94. Once again the conditions generally were more restrictive than SWRCB's proposed measures for CVP and SWP operations.

In April 1993, the governor asked the SWRCB to withdraw its proposed Decision 1630 and to focus efforts instead on establishing permanent standards for delta protection, since the recent federal actions had effectively preempted state interim standards and provided interim protection for the Bay/Delta environment.

Strict delta protection requirements may severely constrain the potential for an increased volume of water transfers through the delta. In order to minimize impacts on the winter-run chinook salmon, delta smelt, and striped bass and to avoid disruption of service to existing contractors, pumping of water by the SWP and CVP through the delta to meet transfer agreements has been mainly limited to the months of August through October.

In the short-term, SWP and CVP contractors relying on the delta for all or a portion of their water supplies face an uncertain outcome from the results of the Bay-Delta Proceedings. For example, in 1993, an above-normal runoff year, environmental restrictions limited CVP deliveries to Westlands Irrigation District to only 50 percent of contracted supply. Until solutions to the

complex delta problems are identified and put into place, even existing contractors relying on transport through the delta will experience more frequent and more severe water supply shortages, and the potential for more active trading of water, which would increase flows through the delta, will be highly problematical.

Many observers argue that even if firm standards are eventually established, they will not solve the long-term problems of declining fisheries, water quality, and poor water-transfer conditions. These observers contend that the long-term solution lies in the construction of a peripheral canal that would skirt the eastern edge of the delta, carrying Sacramento River water directly to project pumps. Proponents argue that a canal would improve water quality and reduce problems associated with "reverse flows," when project pumps actually reverse the natural fresh water flow pattern, drawing fish into the pumps and poorer quality water into southbound channels. Canal opponents contend that a canal would further harm fish and lead to greater water exports from Northern to Southern California (Brickson and Sudman, 1992).

The merits of a peripheral canal are still being debated, more than a decade after voters defeated a controversial 1982 canal/water-development package, effectively ending large water projects in California. Since then, DWR has sought to develop smaller delta improvement projects. These plans include dredging and widening key delta channels to improve fresh water flow to the pumps and constructing new storage facilities or enlarging existing facilities south of the delta to hold winter runoff. Four new pumps have also been added to the SWP delta pumping plant for increased peak-flow pumping. Successful resolution of the complex problems of balancing competing demands in the delta will be a key to future expansion of water trading in California.

General Regulatory Framework

Under existing law, holders of both pre-1914 and modern appropriative water rights (established under the terms of the Water Commission Act of 1914) can transfer water. Holders of pre-1914 appropriative rights may transfer water without seeking approval of SWRCB, provided no other legal water user is injured. As shown in Table 2, holders of modern appropriative rights may transfer water, but SWRCB must approve any transfer requiring a change in terms and conditions of the water right permit, such as place of use, purpose of use, or point of diversion. Short-term (one year or less), temporary transfers of water are exempt from compliance with the California Environmental Quality Act (CEQA), but SWRCB must find no injury to any other legal users of the water and no unreasonable effect on fish, wildlife, or other instream beneficial uses. CEQA compliance is required for long-term transfers. Because of the complex environmental problems in the delta, the SWRCB has announced that it will not approve long-term transfers that increase delta pumping until completion of an environmental evaluation of the cumulative impacts. In addition, permits from fish and wildlife agencies may be required if a proposed transfer will affect threatened or endangered species.

Water held pursuant to riparian rights is not transferable from place to place, although downstream appropriators may contract with riparians to leave water in a stream for potential downstream diversion. Transfers of ground-water, and ground-water substitution arrangements

Table 2. California water code requirements for water transfers.

Transfer Type	Water Code Section	Requirements	Environmental Actions	Comments
Temporary Urgency Change (one year or less)	1435	1. Urgent need 2. No injury to vested rights 3. No unreasonable impact on fish and wildlife 4. Use in public interest 5. Show diligence in seeking the permit	Normal CEQA process	1. Petition must be filled with SWRCB SWRCB 2. Change good for 180 days 3. Can be renewed 4. Board notice and action
Temporary Change for Transfer (one year or less)	1725-1732	1. If applicable, petitioner must have been diligent in petitioning under the provisions 2. Involves only water consumptively used or stored 3. No injury to vested rights 4. No unreasonable impact on fish or wildlife	Exempt from CEQA	1. Permittee notifies SWRCB of change 2. SWRCB must make findings 3. Hearing may be required 4. Effective 5 days after SWRCB approval 5. Good for 1 year or less
Long-term Transfer (more than one year)	1735	1. No injury to vested rights 2. No unreasonable impact on fish or wildlife	Normal CEQA process	1. Petition must be filed with SWRCB 2. SWRCB provides notice and opportunity for hearing 3. Good for any period in excess of 1 year

Source: DWR, 1993a.

whereby ground-water is pumped as a substitute for transferred surface water, may be subject to restrictions designed to protect ground-water basins against long-term overdraft and to preserve local control of ground-water management.

In an important modification of the appropriative rights doctrine, Water Code Section 1707 allows the SWRCB to authorize conversion of an existing appropriative right into an "instream appropriation" to benefit fish or wildlife or for other instream beneficial use. The potential of this new code section is just beginning to be explored.

Water obtained pursuant to a water supply contract is also potentially transferable. However, most water supply contracts require the consent of the entity delivering the water. Almost all types of water rights can also be transferred in California, but typical transfers are structured so that the original holder retains the water right. Several statutes provide that transfers of water do not impair or cause forfeiture of water rights.

Protection Against Adverse Impacts

Embedded in this regulatory structure are very strong protections against possible damages that could arise from water trades. This section describes in detail how regulations protect direct third-party effects, general economic effects, and environmental impacts and discusses how shortages are allocated under the appropriative doctrine.

Protection Against Direct Third Party Effects: Real Water and Paper Water

Because the appropriative right is defined in terms of diversion, but the transferable portion of the appropriative right is determined by consumptive use, there is a strong burden of proof on the part of the prospective water seller when determining how much water is tradable. The DWR recognizes six sources of tradable water: fallowing (not irrigating crops); shifting to less water-intensive crops; substituting groundwater for surface irrigation water; direct delivery of groundwater; conserved water; and water from reservoir storage. In regulating each of these types of transfer, the DWR distinguishes between new water, which is water previously not available to the system; real water, which is water available for transfer that is not derived at the expense of other water-rights holders; and paper water, which is water proposed for sale that does not actually increase system supply. Each category contains strict requirements for identifying the new or real water available for transfer.

Fallowing. Water saved by withholding irrigation water from the field for an entire irrigation season can be transferred to another use. Although this concept appears straightforward, determination of tradable water requires verification of farmer intentions, adequacy of water supply, and computation of consumptive use. What would farmer planting intentions have been without the fallowing agreement? To determine farmer cropping intentions, the DWR uses long-term crop and water records and personal knowledge of extension agents and other experts.

Determining availability of water requires information about the rights and contracts pertaining to the fallowed farm, together with an estimate of actual availability of irrigation water during

the period of transfer. Arriving at this estimate for short-term transfers, is relatively easy, but not for long-term transfers, since future availability can vary due to droughts, operational restrictions, or legal and policy changes affecting future contracts.

The final step in determining tradable water is computing consumptive use. In California, the concept of "consumptive use" has evolved over time, and there is still some uncertainty in interpretation. However, the generally accepted definition is actual crop evapotranspiration plus percolation of water lost to further use. Under the 1992 CVPIA, water available for trade includes "water that would have been consumptively used" and water "irretrievably lost to beneficial use." Thus, water which would otherwise percolate to the degraded groundwater in parts of the San Joaquin Valley would be tradable, but water draining to wetlands or used by vegetation that provides significant wildlife habitat would not be tradable (DWR, 1993b).

Recently adopted Water Code sections have added some uncertainty to the definition of consumptive use. The new sections define "consumptively used" as " the amount of water which has been consumed through use by evapotranspiration, has percolated underground, or has been otherwise removed from use in the downstream water supply as a result of direct diversion." However, the DWR has interpreted the phrase "has percolated underground" to mean only water that has been irretrievably lost to beneficial use, which is consistent with the CVPIA definition.

Shift in cropping patterns. Shifts from water-intensive crops to crops which use less water (i.e., from tomato to safflower or corn to wheat) can also produce tradable savings in consumptive use. The verification process is basically the same as for fallowing, but becomes even more complicated if the substituted crop grows during a different season than the original crop. Wheat, planted in late fall and harvested in late spring, relies mainly on rainfall, but may utilize one or more applications of irrigation water in dry years. Corn grows during the summer and depends almost entirely on irrigation water. The amount of water that is saved by a wheat-to-corn shift therefore depends on how dry the spring wheat season is (DWR 1993b).

Groundwater substitution. Tradable water is also generated if a farmer grows the same crop but utilizes groundwater instead of rights to surface water. For the sake of efficient operations in an emergency situation, the Water Bank groundwater substitution contracts allowed the transfer of one acre-foot of unused surface water for each acre-foot of groundwater pumped. In fact, DWR recognizes the interconnectedness of groundwater and surface water: pumping creates a local depression in groundwater levels that creates a draft on future surface flows. Thus, groundwater recharge can deplete future surface flows, causing in effect an involuntary reallocation of surface water rights, depending on whether recharge occurs during periods of surplus water availability or during periods when water would otherwise be used beneficially. The precise, location-specific relationships between groundwater and surface water are complex and poorly understood, and future groundwater substitutions are likely to require more detailed hydrologic examination, with the possibility that considerably less than one acre-foot of surface water could be sold for each acre-foot of groundwater substituted.

Direct groundwater delivery. Groundwater can also be pumped for transfer, but there are generally significant opposition and strong legal limitations to out-of-basin transfers. All overlying landowners have superior rights, and groundwater management plans that have been

adopted in many regions limit or prohibit out-of-basin transfers. The potential for in-basin sales to higher-valued uses appears greater, but again the hydrologic complexities involved in estimating actual transferable groundwater must be addressed.

Conservation. Water conserved through a reduction in crop consumption, canal lining, use of improved irrigation technology, and an environmentally acceptable reduction in consumption by nonagricultural vegetation can also be traded. An example is the 1987 contract by which the Metropolitan Water District of Southern California (MWD) paid for the lining of canals and other physical and management improvements in the Imperial Irrigation District (IID) in exchange for most of the water conserved through the improvement (Keller et al. 1992).

A key to the success of the MWD-IID arrangement is that in this case, conserved water is clearly new water, because it otherwise would have drained to the Salton Sea, a salt sink (DWR, 1993b). While conservation may be of significant benefit to a given farmer or irrigation district, the contribution of conservation to overall system water supplies must be carefully analyzed to determine how much "conserved" water is actually tradable. To the extent that conservation simply reduces drainage that has beneficial use downstream, new water is not generated.

Storage withdrawals. The amount of stored surface water that would not otherwise be released can also be traded. If the storage is refilled from future surplus flows, this represents new water. However, once again, complicated verification procedures can be involved. If the transferred storage water is replaced with water that otherwise would have been available for downstream water-rights holders, the transfer will harm these downstream holders. To protect downstream rights holders, Water Bank contracts for storage withdrawals included a refill clause, in which reservoir owners agreed to defer refill until high-runoff periods, when additions to storage would cause no detriment to others.

Protection Against Negative Indirect Economic Effects

Water transfers can negatively affect business activities, local government fiscal capacity, and the quality of public services in areas from which water is being transferred, because of the reduction in irrigated area or production and associated reductions in agriculturally linked economic activities in the area-of-origin and in the property tax base. In addition, permanent transfer of water rights may limit future economic development in the area-of-origin. If, in the future, economic conditions make expanded irrigated agriculture, new industrial activities, or residential development economically attractive, then water may not be available locally to pursue these opportunities. Although some studies suggest that direct and indirect economic impacts of water transfers on the area-of-origin from the perspective of a state's economy generally are small, such impacts are a significant concern to area-of-origin residents (Colby 1988).

Evidence from the only recent large-scale water transfer in California, the Emergency Drought Water Bank, indicate that general economic effects were small. According to a Rand Corporation study, farmers who sold water reduced farm operating costs by $17.7 million, or 11 percent, and crop sales by $77.1 million, or 20 percent. These reductions adversely affected the suppliers of farm inputs and the handlers and processors of farm outputs, but the impacts were not large when

compared to the agricultural economy in the selling region. The study estimated that operating costs, crop sales, and agribusiness revenues dropped 2 to 3 percent in selling counties because of the bank (Dixon, Moore, and Schechter 1993).

Despite these relatively small impacts, both state and federal law contain protections against general economic impacts, and more have been proposed. During the years when the CVP and SWP were being developed, area-of-origin legislation was enacted to protect Northern California supplies from being depleted as a result of the projects. County of origin statutes provide for the reservation of water supplies for counties in which the water originates when, in the judgment of the SWRCB, an application for the assignment or release from priority of state water-right filings will deprive the county of water necessary for its present and future development. Watershed protection statutes require that the construction and operation of elements of the CVP and the SWP not deprive the watershed, or area where water originates, or immediately adjacent areas that can be conveniently supplied with water, of the prior right to water reasonably required to supply the present or future beneficial needs of the watershed areas or any of its inhabitants or property owners.

In 1984, additional area-of-origin protections were enacted covering the Sacramento, Mokelumne, Calaveras, San Joaquin, the combined Truckee, Carson, and Walker rivers, and Mono Lake. The protections prohibit the export of groundwater from the combined Sacramento River and Sacramento-San Joaquin delta basins, unless the export is in compliance with local groundwater plans. Also, Water Code Section 1245 holds municipalities liable for any economic damages that result from their diversion of water from a watershed.

Further restriction on aggregate amounts of water that can be transferred are embodied in recently enacted provisions requiring that water *suppliers* limit the amount of transferrable water made available by fallowing to 20 percent of the water that would have been applied or stored by the supplier. State law also prohibits the use of public agency facilities to transfer water unless a finding is made of no unreasonable impact on the overall economy of the county from which the water is being transferred. At the federal level, P.L. 102-575 prohibits the Secretary of the Interior from approving any transfer of CVP water that would have a long-term adverse effect on groundwater conditions in the transferor's service areas. It also prohibits transfers that would unreasonably impact the water supply, operations, or financial conditions of the transferor's district or its water users.

Environmental Protection

State law prohibits water transfers that would have an unreasonable impact on fish, wildlife, or other instream uses. A wide range of environmental and water quality laws affect the feasibility of water transfers. Among these are (1) environmental review and mitigation regulations, which make water transfers for a duration of one year or more subject to review under the California Environmental Quality Act (CEQA), necessitating a state environmental impact report (EIR) that requires documentation of the environmental impacts of their actions, and identification and implementation of measures to avoid or reduce environmental damage; (2) minimum fish flow protection, which requires that the owner of any dam allow sufficient water at all times to pass

through the dam to keep in good condition any fisheries that may exist below the dam; (3) protection of wild and natural areas, through the federal national and state Wild and Scenic Rivers Acts, which set aside many California rivers to preserve their free-flowing conditions; and (4) protection against water transfers that would significantly reduce water quality through a comprehensive water quality control law administered throughout the SWRCB. However, the environmental measure likely to be the most limiting to future expansion of water trading is endangered species protection.

Under the federal Endangered Species Act (ESA), which also governs state agencies and private individuals, an endangered species is one that is in danger of extinction in all or a significant part of its range, and a threatened species is one that is likely to become endangered in the near future. As noted earlier, the 1993 declaration of the smelt as a threatened species under the ESA tightened the required restrictions on delta water management. In general, Section 9 of the ESA prohibits the "take" of endangered species and threatened species for which protective regulations have been adopted. Take has been broadly defined to include actions (including water transfers) that could harm or harass listed species or that cause a significant loss of their habitat. State agencies and private parties are generally required to obtain a permit under Section 10(a) of the ESA before carrying out activities that may incidentally result in the take of listed species. The permit normally contains conditions to avoid take of listed species and to compensate for habitat adversely impacted by the activities. The California Endangered Species Act is similar to the federal ESA and must be complied with in addition to the federal ESA. Listing decisions are made by the California Fish and Game Commission.

Endangered species protection is especially significant for the future of water trading in California because of the existence of listed species in the crucial Sacramento-San Joaquin delta. As described above, protection of the winter-run salmon and delta smelt severely limits the window of opportunity for pumping water through the delta. With a limited time frame within which water can be transferred through the delta and limits on pumping volume during that time, the amount of water that can be traded from the relatively water-abundant north to the water-scarce south of the state is subject to physical limitations.

Flexibility to Respond to Water Shortages

The appropriative rights doctrine also limits the flexibility of reallocating water to the most productive purposes in response to shortages induced by drought. The "first in time, first in right" principle in the appropriative rights system ensures that, when shortages occur, senior rights holders receive first priority to available water, whether or not the water is being utilized for high-valued purposes. However, because these priorities are not based on economic returns, but on chronological time of water right establishment, considerable economic inefficiencies can occur.

Water shortages in federal projects in theory are handled differently from privately acquired appropriative rights, in that water users within a reclamation district share the effects of drought. Thus, even the most "senior" irrigator in a water district may have to reduce water usage by the same percentage as every other user in the district. However, often the burden is deliberately

shared unequally. In the San Joaquin Valley, for example, most water districts allocate surface water on the basis of acreage served, and during shortages, many give preference to lands growing permanent crops (Reisner and Bates 1990).

Thus, under either state or federal water rights, top-down rationing of water is often invoked during droughts. The inability to get water to where it is most needed during shortages would be a serious limitation for any allocation system. The desire to facilitate the transfer of water to higher-valued uses during the severe drought of 1987-92 was a fundamental driving force behind the establishment of the biggest and most innovative step forward in developing more flexible water marketing in California: the Emergency State Drought Water Bank, described in the next section.

Recent Developments in Water Transfers

Given a rather severe regulatory framework, which puts a strong burden of proof on the potential water seller, and the generally rather limited number and volume of water transfers, what is the long-term potential for water trading to "close the gap between water demands and dependable water supplies over the next ten years," the expressed goal of the California Water Plan Update? Two recent developments appear to offer cause for some optimism for the future expansion of water trading: the Emergency State Drought Water Banks of 1991, 1992, and 1994, and the Central Valley Project Improvement Act of 1992.

State Drought Water Banks.

The creation of the State Water Banks of 1991 and 1992 was a direct result of the 1987-92 drought, and was designed to move water from areas of greatest availability to areas of greatest need. The temporary changes to the law, enacted in 1991 designed to facilitate the State Drought Water Bank, were made permanent in 1992. The law now authorizes water suppliers (local public agencies and private water companies) to contract with water users to reduce or eliminate water use for a specified period of time and to transfer the water to a State Drought Water Bank or other water suppliers and users. It also provides that water proposed for transfer need not be surplus to requirements within the supplier's service area and specifies that use for a transfer is a beneficial use. There were three sources of water for the 1991 State Drought Water Bank: temporary surplus in reservoirs, surface supplies freed up by the use of groundwater, and surface supplies freed up by fallowing agricultural lands. Substitution of groundwater from an overdrafted groundwater basin for transferred surface water is prohibited unless the water was previously recharged to the basin as part of a groundwater banking program. The amount of water made available by land fallowing is limited to 20 percent of the amount applied or stored by the water supplier, unless the supplier approves a larger amount at a hearing.

In operation, the Water Bank assumed a very active role as certifier, broker, financial banker, and public interest advocate in facilitating water transfers (Keller et al. 1992). The Water Bank executed standard one-year contracts with agricultural water users, who agreed to sell their water and either to leave land fallow for the season or to irrigate with groundwater rather than surface

water. In addition, the Water Bank purchased some water stored in reservoirs. The purchased water was stored and then released as needed to water districts that qualified to receive the emergency supplies. The Water Bank attempted to monitor local conditions in the sellers' areas to assess the third-party effects, if any, of the transfers.

Tables 3 and 4 summarize operations of the 1991 and 1992 Water Banks. The 1991 Water Bank paid sellers a price of $125 per acre-foot, based on an analysis of farm budgets and discussions with potential buyers, sellers, agricultural economists, and other advisors. Buyers were charged $175 per acre-foot to cover the purchase price, the cost of water released to meet incremental delta outflow requirements, and associated administrative costs, plus the additional actual conveyance costs from pumping stations located in the southern part of the Sacramento-San Joaquin delta. The actual delivery price at a water district near Fresno was slightly more than $200 per acre-foot (Keller et al. 1992). Validation of consumptive use as the measure of tradable water followed the principles described above.

To be eligible for the emergency water, buyers were required to document that they had "critical need," that they were using available water fully and judiciously, and that they had implemented a water conservation program. When planning the Water Bank, the DWR set the purchase target from 750,000 to 1,000,000 acre-feet (Keller et al. 1992). Despite concern that the target would not be achieved, after a short initial delay, purchase contracts were quickly completed. By the end of the season, the department purchased 820,000 acre-feet of water for the Water Bank, 50 percent from fallowing, 33 percent from groundwater and 17 percent from existing storage (Table 3).

Most fallowing commitments came from the Sacramento-San Joaquin delta rather than from rice, as had been expected. Rice farmers in the Sacramento Valley were subject to pressure from the local community and rice farmer cooperatives not to participate in the Water Bank. The northern rice growing regions opposed water sales for several reasons. Cooperatively owned rice processing organizations feared loss of volume, while some growers wanted a higher water price. In addition to these economic reasons, regional political leaders wanted to assert the independence of the area-of-origin of much of the state's water (Gardner and Warner 1994). Thus, identification of short-term sellers even for short-term transfers to the Water Bank encountered constraints raised by concerns over indirect economic impacts and area-of-origin problems.

The Water Bank sold and delivered 390,000 acre-feet, 47 percent of the amount purchased, and had an estimated 265,000 acre-feet (33 percent) available for carryover storage for 1992 in the SWP. Water allocated to maintenance of delta flows, conveyance losses, and evaporation accounted for the remaining 165,000 acre-feet (20 percent) of the purchased amount. The carryover storage was higher than expected, because substantial rains in March 1991 reduced anticipated demand, giving the Water Bank a greater margin for carryover than expected. About 80 percent of the water was delivered to urban areas in Northern and Southern California and 20 percent to agriculture in the San Joaquin Valley (Table 3).

The 1992 Water Bank operated under less stressful water availability conditions, and in anticipation of less demand for water, prices were set considerably lower, at $50 per acre-foot.

Table 3. 1991 Drought Water Bank: purchases, allocations, and prices.

	Amount
PURCHASES	acre-feet
Water Source	
Fallowing	410,000
Ground water	260,000
Surface water	150,000
Total	**820,000**
Delta Water Quality Requirements, Technical Corrections	-165,000
Net Supplies	**655,000**
ALLOCATIONS	
Urban uses	307,000
Agricultural uses	83,000
State Water Project (storage)	265,000
WATER PRICE COMPONENTS	$/acre-foot
Basic purchase price	125
Other purchase costs, Delta requirements, Technical corrections	45
Administration	5
TOTAL	**175***

* Plus delivery costs.

Source: California Department of Water Resources, files.

Table 4. 1992 Drought Water Bank: purchases, allocations, and prices.

	Amount
PURCHASES	acre-feet
Water Source	
Fallowing	0
Ground water and conservation	161,000
Surface water	32,000
Total	**193,000**
Delta Water Quality Requirements	-34,000
Net Supplies	**159,00**
ALLOCATIONS	
Urban uses	39,000
Agricultural uses	95,000
Department of fish and game	25,000
WATER PRICE COMPONENTS	$/acre-foot
Basic purchase price	50
Other purchase costs, Delta requirements	17
Administration	5
TOTAL	**72***

* Plus delivery costs.

Source: California Department of Water Resources, files.

A total of 193,000 acre-feet were purchased and 159,000 acre-feet were sold, the remainder being allocated to delta flow. The Water Bank has been reactivated in mid-1994 as water supplies have tightened. As of August 1994, the Bank had contracted for supplies of 202,000 acre-feet from water agencies and irrigation districts and for deliveries of 159,023 feet for short-term leases for irrigation and municipal use. Purchasers will pay $67.50 per acre-foot for water delivered to the SWP or CVP pumping facilities in the delta, plus an average of about $30.00 per acre-foot to cover transportation costs and the 20-percent requirement for delta outflows. A total of 39,756 acre-feet of water has been allocated to augment delta streamflows to control salinity intrusion (Smith and Vaughan 1994).

Although the changes initiated under the State Water Bank do much to facilitate water transfers by water suppliers, they do not address the issue of "user-initiated transfers," where the water user is not the holder of the water right but has a contractual entitlement to water from the supplier. The Bureau of Reclamation has in the past interpreted water sales as detrimental to project water service, and thus did not allow any CVP water to be sold to the bank. Exceptions were made for water based on water rights that some contractors held before the project was built.

The Water Banks have demonstrated that, with a strong central broker, large water transfers can be made quickly, even with existing restrictive rules on third-party damages. However, there also may be considerable benefits from a more decentralized approach to water trading, one that is acceptable to suppliers, users, and potential buyers, whereby users can initiate transfers subject to reasonable terms and conditions imposed by suppliers to protect their legitimate interests and those of other water users. A step in this direction was taken with the CVPIA in 1992.

The Central Valley Project Improvement Act of 1992

The CVPIA is intended to increase the use of water transfers by providing that all individuals and districts receiving CVP water (including that under water-right settlement and exchange contracts) may transfer it to any other entity for any project or purpose recognized as a beneficial use under state law. The Secretary of the Interior must approve all transfers. The affected district must approve any transfer involving more than 20 percent of the CVP water subject to long-term contract with the district. With this clause, allowing farmers to sell up to 20 percent of their water without approval of their local irrigation or water district or agency, the CVPIA has, for the first time, vested the property right to the first 20 percent of contract water directly in the individual user. The section continues by specifying that the transfer must be between willing buyers and sellers and based on mutual agreement. The conditions continue with the stipulation that "All transfers...shall be subject to the right of first refusal on the same terms and conditions by entities within the Central Valley Project service area" (Howitt 1994).

These conditions contrast sharply with the incentives facing potential water sellers in Bureau of Reclamation districts before passage of the CVPIA. Water transfers required permission from existing irrigation and water districts in the project, and the transfer could not be detrimental to the project or to any senior appropriator. In effect, as long as any users in the district could use the water at its nominal cost, individuals could not sell water at market prices. With these

legislative restrictions on gains from trade, water districts and groups of members often obstructed water trades (Howitt 1994).

The CVPIA also sets forth a number of conditions on the transfers, designed to protect the CVP's ability to deliver contractually obligated water or meet fish and wildlife obligations because of limitations in conveyance or pumping capacity. Transfers are deemed to be a beneficial use by the transferor, and are only permitted if they will have no significant long-term adverse impact on ground-water conditions within the transferor district and will have no unreasonable impact on the water supply, operations, or financial conditions of the district.

A three-tiered pricing system for federal water, introduced under the CVPIA, facilitates water marketing by increasing the opportunity cost to the farmer of holding water in relatively low-valued uses. The prices for each of the three tiers depend on the contracted price, the quantity of water used, and the CVP's full cost, with second tier prices when water use reaches 80 percent, and the third tier prices beginning when water use reaches 90 percent of total water contracted to the individual. The marginal price on the third tier is at the full cost of delivery of CVP water, including interest costs on capital, and is much higher than prices ordinarily paid. The full cost of a federal project includes interest costs on project capital that have traditionally been excluded when determining repayment charges for irrigation. As a result, irrigators are likely to reduce substantially the quantity of water diverted as the marginal price increases. However, it is not clear how much *consumptive use* will be affected by the tiered pricing system. To the extent that reduced diversions would have simply returned to the canal as return flow, there may be little savings in real water. Nevertheless, while farmers may respond initially to higher prices by maintaining consumptive use while reducing diverted amounts, in the longer run, the tiered pricing system should encourage investment in more significant on-farm water conservation, which would reduce consumptive use as well, freeing up water for trading to higher-valued uses.

The CVPIA also reflects the ambivalence embedded in California law over allocation of water by markets, by its nonmarket reallocation of water from agricultural to environmental purposes. Gardner and Warner (1994) argue that, while the act appears to promote water transfers in principle, it also gives fish, game, and wildlife interests special powers not accorded to other uses. Fish and wildlife interests are not required to compete in the market for water resources as are municipal, industrial, and agricultural users because the act guarantees water even if other uses suffer. The CVPIA mandates that 800,000 acre-feet of CVP water, about 13 percent of the total, be dedicated annually for fish, wildlife, and habitat restoration. This amount could irrigate over 200,000 acres of cropland producing cotton or tomatoes. Due to differing water-right priorities, this cut in project water only affects a third of the CVP irrigation regions, and in many years represents a 33 percent reduction in surface supplies in these areas (Gardner and Warner 1994).

CONCLUSIONS: FUTURE DIRECTIONS FOR WATER MARKET TRANSFERS

The trend toward increasing use of market and market-like transfers of water to meet growing demand in urban, environmental, and high-valued agricultural uses is likely to continue. Recent developments pointing in this direction include (1) the continued commitment of the State to increasing the flexibility of water transfers, exemplified by passage of a series of laws gradually easing restraints on transfers; (2) the successful implementation of the Emergency Drought Water Banks in 1991, 1992, and 1994 and market-like conservation measures such as the MWD/IID agreement, which have built up expertise and operating procedures for evaluating and making transfers; (3) liberalization of rules for trading water under the CVPIA, which should encourage increased user-initiated trading of federal water; and (4) the recent completion of the State Drought Water Bank Program Environmental Impact Report and near-completion of a more comprehensive EIR governing future "non-emergency" and long-term transfers. These documents will identify potential transfer pathways and transport schedules of interest to DWR, SWP, SWRCB, Department of Fish and Game, and other interested agencies, and identify likely impacts in the delta and elsewhere. Completion of these EIRs should streamline future analysis of individual transfer requests, reducing the costs of verification and approval.

The growth in water markets is likely to be moderate, markets will remain highly regulated, and implementation of market transfers will require considerable central participation from the DWR and other state and federal agencies and projects. This is because of (1) the strong burden of proof placed on potential transferors to verify consumptive use, and lack of direct and indirect damage to third-party and environmental interests under the appropriative doctrine as it has evolved under California law; (2) the necessity to balance powerful interest groups and competing demands for agricultural, urban, and environmental purposes, a challenge which is accentuated by (3) the unique hydrological/geographical conditions governing water transfer in California, especially the fact that a large share of future water transfers will need to be transported through the delta, which will require complicated environmental trade-offs; and (4) the related need for careful timing of water transfers, which will be made in most cases through storage and delivery infrastructure that is already heavily committed to existing contractors. The DWR (and the federal CVP) will therefore be expected to play a major role in facilitating transfers, including identifying transfer opportunities, determining the amount of water available for transfer under individual transfer proposals, certifying that trades do not cause third-party damages, and scheduling the actual transport of traded water in the SWP and other projects while meeting environmental requirements and contractual commitments.

Further legal and policy reforms could create a more decentralized and less regulated approach, even under the unique conditions existing in California. Reforms that could move water policy in this direction include the following:

Reduction in the transaction costs of water trades through simplification of the process for determining the amount of water available for trade. Simplified procedures, which would increase the probability of reduction of return flows due to trades, could be coupled with provision of financial compensation and/or reservation of a portion of the traded water to the SWP, water districts, or other water suppliers to be allocated to compensate for actual damages due to reduction in return flows not detected by the simpler procedures.

The simplest procedure would be to create a uniform presumption regarding consumptive use and return flows, which eliminates the need to determine consumptive use on a case-by-case basis. The Wyoming statute authorizing temporary water transfers creates a presumption of 50 percent return flows, with the remainder considered to be the transferable quantity. Although attempts to rebut the presumption could be made, these would likely be infrequent if the presumption is a reasonable approximation. If, as is likely, a uniform state-wide presumption is not feasible due to different agroclimatic conditions, regional presumptions could be established (Gould 1989). However, the uniform presumption of return flows has a serious flaw: it would tend to discourage investment in on-farm water conservation. Any return flow presumption generous enough to avoid challenges across a wide range of environments would likely considerably overstate return flows (and understate recoverable real water losses from the system) in a significant subset of environments. The approach used in New Mexico appears to be an interesting compromise between the detailed case-by-case analysis of consumptive use and the uniform presumption of return flows. In New Mexico, the State Engineer's Office determines transferable water quantities utilizing standard formulae together with historical and secondary data. Consumptive use (and transferable quantities) are computed based on existing data on cropping pattern, type of irrigation (drip, sprinkler, flood), temperature, percent daylight hours, and effective precipitation in the area. The farmer or applicant for transfer is required to supply only information on cropping patterns and type of irrigation. In the absence of historical records of cropping patterns, the most recent information is used or obtained from aerial maps. Field visits by the engineer's office to verify the information given by the potential user are rare. Reliance on standard transferable quantities for specific regions and irrigation types reduces the transaction costs incurred by applicants for hydrologic and engineering experts, saves water agency staff time, and creates more certainty in the transfer process (Colby 1988).

Reservation in major delivery systems, such as the SWP, of a portion of transport capacity rights for water transfers that have equal priority with existing contractual rights. However, this policy would be strongly opposed by existing SWP contractors, who would vigorously defend against any weakening of their access to a conveyance system they utilize on a fully costed basis. The rights of contractors have already been weakened by limitations on delta pumping in order to meet delta outflow requirements and to protect endangered and threatened species, limitations that have in recent years made it difficult to meet existing contracts.

Reconsideration of construction of the peripheral canal skirting the Sacramento-San Joaquin delta, which could reduce environmental problems while relying on existing regulations to protect areas-of-origin and other third-party interests against possible damages from water transfers. The peripheral canal could improve water quality and reduce problems associated with reverse flows in the delta, which increase salinity and harm endangered fish species. However, the peripheral canal remains a highly divisive issue in California. Despite the various regulations controlling water transfers, there would be strong opposition on the grounds that the canal would cause a rapid expansion in water exports from Northern to Southern California.

Reduction of mandated water allocations for environmental purposes and a requirement that these interests compete for scarce water in the market combined with allocation of a portion of state revenues to fund purchases of water for environmental purposes. The primary argument in support of mandated environmental allocations is that water allocations to fish and wildlife benefit

a large number of people, so it is very difficult to form coalitions to purchase water rights. However, private groups have in fact begun to purchase instream water rights in California and elsewhere in the western United States. Allocation of some portion of public funds (the amount of which would be subject to public determination) for purchase of instream water would also facilitate a market allocation approach to environmental uses of water. The latter policy has already been implemented on a small scale in California. The Department of Fish and Game purchased 41,000 acre-feet of water from the 1991 Water Bank and 16,000 acre-feet from the 1992 bank for instream flow. Again, it must be noted that at least the first part of this policy would meet with strong opposition from environmentalists. Environmental groups have won substantial gains in mandating water for environmental purposes and would likely oppose a policy that rescinds some of these gains.

Many of these reforms would be highly controversial; some would require changes in interpretation of the Water Code; and many would require significant new legislation to modify existing law. In the final instance, the evolution of California law and policy toward water transfer markets will be determined by the political process balancing agricultural, urban, and environmental interests. The dynamics of the political process suggest that the flexibility and volume of water market transfers will gradually expand, but that transfers will continue to be characterized by strong central direction and oversight.

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Annex D

EVOLUTION OF AGRICULTURAL AND URBAN WATER MARKETS IN TAMIL NADU, INDIA

Kuppannan Palanisami

ACRONYMS

CADP	Command Area Development Program
ha	hectares (1ha=2.471 acres)
LBP	Lower Bhavani Project
mhm	millions of hectares per meter
mld	million liters per day
PAP	Parambikulam Aliyar Project
PWD	Public Works Department
Rs	rupees
TAKC	Thadapalli, Arakkankottai, and Kalinkarayan
TMC	thousand million cubic feet

EVOLUTION OF AGRICULTURAL AND URBAN WATER MARKETS IN TAMIL NADU, INDIA

THE SETTING

Continued progress in India's future water resources development will depend on the use of the country's existing irrigation potential. A sizable gap currently exists between potential and actual land irrigation due to inefficient water management practices. Furthermore, rapidly escalating construction costs constitute a growing drain on state finances and increase the already high financial subsidy given to irrigated farms. In Tamil Nadu specifically, limited groundwater replenishment along with heavy power cuts have characterized groundwater use during years of poor rainfall. Additionally, private exploitation of groundwater by numerous individual farmers has tended to result in the indiscriminate and unregulated proliferation of wells and, consequently, a decreased water table in several regions of the state.

In terms of water sources in Tamil Nadu's irrigated areas, water tanks were used in 25 percent of the areas in the 1980s and 22 percent in 1990-1991. The relative share of wells rose from 42 to 45 percent during the same period. Canals did not register a change, remaining at 32 percent. Although the growth in well resources is attributed to rural electrification and the institutionalization of credit, diminished tank irrigation is considered the result of neglect on the part of the Government of India and the local community during the 1980s.

During the 1980s, rice was the single largest crop produced in Tamil Nadu, normally accounting for 75 percent of the total area irrigated under food crops. In general, since the 1980s, nonfood crops have shown an increasing trend toward replacing food crops, an indication of the commercialization of state agriculture. The impact of deficit rainfall on area irrigated under principal crops shows that irrigated areas under rice, cotton, and groundnut are more sensitive to poor rainfall.

Increasing demand for water for nonagricultural purposes has compelled the Government of Tamil Nadu to divert adequate water supplies from the agricultural sector to the nonagricultural sector on a priority basis. The World Bank-aided water diversion works for nonagricultural purposes also underscore the increasing pressure on the state's irrigation systems.

Deforestation coupled with inadequate and erratic rainfall in Tamil Nadu's catchment further complicate water allocation in many of the state's medium-sized and large projects. By 2000, many of the medium-sized irrigation projects will become domestic water supply projects. Agricultural intensification within the projects and expansion of area outside them are further stretching available supplies to larger areas.

Demand for water in Tamil Nadu will continue to increase in coming years, resulting in a supply deficit of about 24 percent by the year 2000 (see Table 1). Demand for water for nonagricultural purposes will approximate 1.8 million hectares per meter (mhm), which will increase at a rate of about 2 percent per year beyond 2000 due to industrialization and urbanization. Increasing demand for water for nonagricultural purposes has implications for developing markets for water

to facilitate transfers from the agricultural to the urban sector, with appropriate compensation for farmers.

Given that only 54 percent of Tamil Nadu's groundwater potential and little more than 15 percent of its surface water potential remain unexploited, the challenges facing the future are many. The prospects for any significant increase in area under tank-based irrigation are not promising. Furthermore, ultimate irrigation potential in Tamil Nadu in per capita terms is the lowest among India's major states. Estimated at 0.08 hectares (ha), it is less than half of India's average of 0.17 ha. Thus, not only are the prospects for further development limited, but Tamil Nadu's irrigation endowment relative to its population is also very poor in comparison with other major states. In such a context, the importance of striving for greater economy and efficiency in water use, and greater equity in sharing available water resources, cannot be overemphasized. Appropriate allocation mechanisms are thus highly warranted.

Table 1. Demand for and Supply of Water in Tamil Nadu in the Year 2000

Item		Quantity (mhm)
Total Supply:		5.5
■	Surface flows	2.5
■	Groundwater	1.5
■	Interbasin transfers	1.5
Demand for nonagricultural purposes:		1.80
■	Industry	1.38
■	Domestic use	0.37
■	Livestock	0.05
Demand for Agricultural Purposes		5.0
Demand-Supply Deficit		-1.3 (23.6%)

Note: mhm = million hectares per meter.
Source: R.K. Sivanappan and K. Palanisami. 1982. *Demand for Water in Tamil Nadu in 2000 AD—Future Focus and Policy Issues*. Coimbatore, India: TNAU Press.

THE PEOPLE'S WATER RIGHTS

According to the Indian Constitution, water is placed at the disposal of the states. In actual practice, however, the central government/state relationship is more complex in nature, since the central government allocates revenue for development purposes and the states depend on the government for national and international funds (Chhatrapati Singh, 1989).

State sovereignty over water began with the Easement Act of 1882, which legitimized customary rights regarding surface water and provided two rules for recognition of those rights: length of usage (prescription) and local custom (Chhatrapati Singh, 1991). Thus, the act recognized customary water rights that allow certain people to take surface water from another's land. It did not, however, grant natural or customary rights over groundwater, whether collected from a well, from springs, or from undefined sources. The Limitation Act of 1963 reduced the easement period from 60 to 30 years.

Statutory Rights

The laws subsequent to the Easement Act slowly shifted the emphasis on people's water rights from natural to proprietary or usufruct rights. In general, 84 percent of the total land in India is owned and held under proprietary rights: 71 percent is owned by proprietors with rights to transfer the title, and 13 percent by proprietors without such rights. Only 2 percent of land is held in the form of land tenure. The principle that there should be an absolute limit to the amount of land one individual may hold was accepted in the country's first Five Year Plan (1951-1955).

In the case of command area of surface irrigation systems, farmers have the right to get water from a water project, depending upon its availability; water charges are linked to land revenue. In the case of areas benefited by rivers and streams, farmers have riparian rights for getting water supplies.

Riparian Rights

Riparian owners—those who own land abutting a body of water—have the right to use water from the body of water that flows past their land equally with other riparian owners. Riparian owners also are entitled to have the water come to them undiminished in flow, quantity, or quality, and to have it go beyond their land without obstruction. Therefore, the upstream riparian owner is subject to the downstream riparian owner's right to have water flow down to him or her in the customary manner. The courts do, however, recognize the custom that the upstream riparian owner has the right to use as much water as convenient for irrigation, as long as the owner does not diminish the amount the downstream owner can use. Similarly, the downstream riparian owner does not have the right to inundate or submerge the land of the upstream owner by obstructing or building a dam on the body of water in question.

Groundwater Rights

The basic rights for groundwater in India are riparian rights: Ownership of the overlying land rights allows farmers to tap underground water. However, there are significant statutory limitations on these rights in Tamil Nadu. For example, spacing norms for pumps have been prescribed based on guidelines issued by the National Bank for Agricultural and Rural Development (NABARD) for the area between two minor irrigation structures. These range from 150 m for any two dug wells to 600 m for any two deep tube wells. These rules apply even to new wells that have been financed with commercial loans, or to existing wells that have been deepened. In Tamil Nadu, however, groundwater development is mostly done by private individuals with their own finances, so very few groundwater rules are being followed (Public Works Department, 1994).

In coastal areas, groundwater development has been extensive because of the areas' favorable hydrogeological conditions. As a precautionary measure, certain restrictions have been imposed on financing minor irrigation schemes that involve groundwater located up to 10 km from the coast of Tamil Nadu.

A comprehensive proposal for groundwater management and regulation has been sent to the Government of Tamil Nadu and, as of this writing, is under consideration.

STUDY OBJECTIVES

The general objective of this study was to examine the existing water rights and function of informal and formal water markets in the irrigated and nonirrigated sectors of Tamil Nadu. Specifically, the study team aimed to do the following:

- examine Tamil Nadu's existing laws and agreements on water regulation and water rights;
- analyze the evolution of existing water allocation policies;
- examine the prevailing forms of property rights and the roles of institutions governing water rights and allocation procedures; and
- derive lessons for the future from various water markets.

The development of informal water markets in Tamil Nadu has a number of important implications. First, all water sellers obviously become interdependent as each farmer's well-deepening tactics reduce the water available to neighboring farmers. Second, efficiency of water use is becoming a private issue, as farmers are not accountable to each other. Third, water demands are changing over time, reflecting changing population and industry activities coupled with high levels of investment. Increased demand affects water quantity, quality, and availability at a given location and price. The interrelationship between these variables dictates the market mechanism that is used at a given point.

METHODOLOGY

This analysis uses a case-study approach to examine and compare the role of water markets in two irrigated sectors of Tamil Nadu:

- Sector 1, canal irrigation: the Lower Bhavani Project (LBP) and the Parambikulam Aliyar Project (PAP); and
- Sector 2, well irrigation: Coimbatore and Tiruppur.

Selecting these areas to represent irrigation systems in Tamil Nadu offers several advantages:

- Different canals with different (riparian) rights are functioning in them.
- Water diversion for domestic and industrial uses is increasing in these areas, creating fear among farmers about their future irrigation supplies. (For example, the World Bank has funded the Pillur Diversion Scheme from Bhavani River to extract water for nonagricultural uses.)
- Several different water allocation mechanisms at the canal level have already been attempted here.
- Farmer councils in these sectors were formed in several distributaries on the main canal, and feedback for analysis of water markets can be obtained easily from such established institutions.
- Active water selling has been reported at several locations in these sectors.

SECTOR ANALYSIS

This section presents an analysis of the development and characteristics of water rights and water markets in the two irrigated sectors the study team investigated in Tamil Nadu.

Sector 1: Canal Irrigation, Conjunctive Use, and Water Markets in the Lower Bhavani Project (LBP) and the Parambikulam Aliyar Project (PAP)

Water Rights in the PAP

Farmers' water rights in the PAP have been subject to considerable controversy. Following a series of interstate agreements between the governments of Kerala and Tamil Nadu in 1958, the PAP was created. Initially the PAP was designed to benefit 80, 939 ha in three zones in the Coimbatore and Periyar districts with 30.5 thousand million cubic feet (TMC) of water. However, an expert committee formed by the Government of Tamil Nadu identified a fourth zone in need of irrigation facilities. This zone included land from the first three zones. Farmers from the first three zones objected to extending supplies to a fourth zone, and went to court to prevent it. In February 1994, after the government had already invested about 300 million rupees (Rs)

in infrastructure for the fourth zone, the farmers obtained a stay of the land. Nevertheless, in April 1994 the government issued a notification establishing the current four-zone system in the PAP area, bringing the entire command area under the PAP up to 152,631 ha. Two of the zones are scheduled to be under irrigation in one irrigation year, and the other two in the subsequent year (The HINDU, 1994).

Water Rights in the LBP

The flexibility in the LBP's canal system operations is constrained by the structure of water rights and farmers' organizations in the Bhavani Basin. Riparian rights under an old project comprising the Thadapalli, Arakkankottai, and Kalinkarayan canals (TAKC) are prevalent in the basin. These rights allow farmers to draw extra water from the Bhavani River and Reservoir. (These farmers were enjoying a greater amount of water supplies before the LBP was constructed in 1953.)

The informal farmers' organization in the TAKC project is constraining LBP authorities from diverting excess water from the old project. Meanwhile, the government is making efforts to divert considerable quantities of water from the Bhavani River for municipal and industrial uses, giving domestic requirements top priority. The government has also increased the water rates for different crops and purposes in the basin, making agricultural interests more vulnerable.

As for any other basin in the state, the most crucial issue facing the Bhavani Basin is supply. With demand for water exceeding supply, basin authorities are addressing the problem by reallocating available water between the old and new projects by modifying the rights of farmers in the old project, changing crop patterns, and fostering conservation through improved water use efficiency.

Farmers along the three TAKC canals have riparian rights from the Bhavani River and receive irrigation supplies in two seasons (10 to 12 months total). Mostly wet crops, such as rice, sugarcane, banana, and turmeric, are grown in the region. Total water availability is based on the duty concept. (Duty refers to the continuous rate of water flow desired to irrigate a certain area according to its crops' irrigation needs during the growing season. For example, 60 duty means 60 cusec of water, or 60 cubic feet per second, are to be maintained in a canal continuously over the growing season to irrigate a certain area in the command.) In the TAKC canals, total water availability based on 60 duty is about 34 TMC, compared with the total water availability of about 60 TMC in the Bhavani Reservoir.

The LBP irrigates about 83,800 ha. Irrigation is based both on river flow and reservoir storage, and the project's main canal runs 198 km to feed 124 distributaries. The entire command area is irrigated in two turns—half the area in each turn. A uniform duty of 60 and 120 in the wet and dry seasons, respectively, is adopted throughout the command. Total water available in the LBP amounts to 36 TMC (24 TMC in the wet season and 12 TMC in the dry season) (Palanisami, 1984).

Conservation through Irrigation Charges

Normally, crops like rice, sugarcane, and banana are grown in the wet season (August to December). In the dry season (December to April), mostly semi-irrigated crops, like groundnut, maize, cholam, ragi, and pulses, are grown. However, farmers who have wells grow wet crops in the dry season as well, exacerbating the LBP's water shortage problem.

Current water rates are Rs 37.5 per ha for rice, Rs 50 per ha for sugarcane, Rs 25 per ha for groundnut, and Rs 19 per ha for pulses. Along with the water rates, other charges are collected from farmers, including taxes and surcharges. In January 1992, the government increased total water charges to meet increasing operation and maintenance costs. Farmers have refused to pay them, however, because the water supply is inadequate. They pay the old charges instead (see Table 2).

Table 2. Old and Revised Water Charges in the LBP (in Rs/ha)

Crop	Water Rate	Old Total Charges	Revised Total Charges
Rice	37.5	163.0	505.0
Sugarcane	50.0	212.3	655.0
Groundnut	25.0	113.5	355.0
Pulses	19.0	88.7	280.0

The LBP *Ayacut* (command area) farmers' association has obtained an interim injunction from collecting the revised water charges. Taking into account the quantity of irrigation water (excluding rainfall) required for various crops, the association has calculated that the effect of the new charges on the cost of water would be significant (see Table 3).

Table 3. Effect of Revised Water Charges as Calculated by the LBP Farmers' Association (in Rs/1,000m^3)

Crop	Prior to revision	After revision
Paddy	6.5	20
Sugarcane, banana, and turmeric	8.4	26
Groundnut and gingelly	4.5	14

Since January 1992, the state government has also substantially increased the water charges for both authorized and unauthorized use of water for lift irrigation. The increased rates have been fixed crop-wise; thus, for paddy, the rates are Rs 126 and Rs 532 for authorized and unauthorized pumping, respectively. For sugarcane, the rates now are Rs 210 and Rs 742, respectively. The higher charges for unauthorized pumping, as well as increases in water rates for both agricultural and nonagricultural users, clearly reflect the government's use of pricing mechanisms to conserve resources.

In declaring its rate increases, the government has agreed not to charge for drinking water. However, the Coimbatore Corporation, which supplies water to users, has increased water charges from the existing Rs 1.11 per every 1,000 liters to Rs 2 per every 1,000 liters. Free supplies have also been reduced, from 270 liters per day to 100 liters per day. Even so, these rates are considered cheap.

For water used industrially, the charge was Rs 60/1,000 m^3 until recently. The rate has since been increased to Rs 500/1,000 m^3. However, industrial users have obtained a court stay order and currently pay only Rs 200/1,000 m^3 (Palanisami, 1994).

Historically, increased water rates have failed to stimulate water conservation. This may be the reason the public utility has had no incentive to develop and deliver water efficiently. However, in recent years water scarcity has resulted in improved pricing mechanisms both for agricultural and nonagricultural users. It is expected that increased reliance on efficient water allocation in anticipation of future scarcity will ensure efficient water markets.

Evolution of Water Allocation Mechanisms

Water for irrigation was first made available in Sector 1 in 1952. In 1952 an intermittent (rotational) system was used in which canals were opened for 5.25 days and then closed for 5.25 days. This was followed by a crop restriction on rice, because the system was designed for semi-irrigated crops only. The government abandoned the intermittent system in 1959-1960, and introduced a new method, called the Zonal System, in August 1959. According to this method, an entire project was divided into two halves and water was made available for wet crops continuously for 3.5 to 4 months; this method was followed until 1968-1969.

Because surplus water builds up in the reservoir after wet crops have grown, the government made a slight modification in the crop allocation pattern in 1959, mixing both wet and dry crops. Accordingly, 50 percent (the first turn) of the command area was given water for both wet and dry crop seasons in one year, and in the following year, the rest of the command area (the second turn) was given water. This policy indicates how the allocation of water in Tamil Nadu has evolved to become user based, which is a prerequisite for market-based water allocation.

Today, water allocation up to the distributary level is controlled by the Public Works Department (PWD), while farmers are responsible for farm-level water distribution. In the wet season, water is distributed via continuous flooding of the fields; in the dry season, farmers rotate their turns based on water being available in the canal during alternate weeks only.

The Agricultural Engineering Department has encouraged the formation of farmers' organizations through the Command Area Development Program (CADP) because informal water rights trading has been observed in the command area, as farmers trade their water use time with other farmers.

In an eight-day period of water supply to a distributary from the canal, water allowance to a farmer is calculated in terms of ha (WA), where water allowance (WA) is multiplied by the area owned (in hectares).[16] This determines the total time of water use allowed for each farmer. Farmers who have wells and farmers whose water requirements are few exchange their turns with their neighbors using the concept of water allowance defined in terms of number of hours per unit area. Water allowances in the Thindal distributary of the LBP indicate that farmers trade for water allowance shares according to their field location and size. It has been observed that farmers accept this procedure and that it has eliminated conflicts.

The implications of such informal arrangements in Tamil Nadu will form the basis for tradable water rights in the future, as farmers are given economic incentives to use water efficiently based on the full opportunity cost of water. These arrangements could indicate a level of control adequate to run a market-based water allocation system in the state. Such arrangements are more or less common in many major projects, particularly where water shortages are experienced.

Currently, two chief forms of water transfer have been observed in the LBP canal command: exchange between farmers and sales from river pumping.

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[16] WA = (8 days × 24 hrs × 60 minutes)/total area in the distributary (ha)

Exchange of water between farmers:

The following observations characterize the exchange of water between farmers in the LBP:

1. Water is commonly exchanged between LBP farmers on humanitarian grounds, not for money or other purposes such as is the case with exchanges of tractors, implements, and labor. This is done particularly in the head and middle regions, where canal water supplies are adequate. However, in the tail region, such exchanges are much more limited.

2. Exchange of water occurs mostly between farmers of the same sluice and to a limited extent between farmers of different sluices.

3. When farmers are not irrigating their turns, they give them to relatives or neighbors who may return the turn the next time.

4. Farmers whose fields are located near canals receive seepage water rather than canal water for irrigation. In such cases, they give their canal turns to other farmers and wait to use their turn another time.

5. In many cases, farmers who grow sugarcane instead of rice give their excess water to neighbors who grow rice.

6. One farmer in Thindal with whom the study team spoke suggested that water saved from his allocated turn could be credited for a deduction in his water bill. By this method, farmers could enjoy the benefits of saving water through reduced water bills and increased yield.

7. According to a farmer from Chitode, about 10 percent of the farmers in his distributary exchange water. When the farmers in the tail end have acute water shortages, well owners use their well water and leave their canal turns to others in the sluice without expecting compensation.

8. According to a man in Allampalayam Village (Muthur), canal turns are given to others only because electricity is free. Were farmers charged for electricity, they would ask the recipients to pay the electricity bill according to the number of hours pumped. This practice was common seven years ago, when farmers were charged for electricity.

9. A farmer from Velliangavalasu Village (Muthur) told the team that he has the right to use the water allowance of a person whose land is far away who cannot get canal water. As compensation, he pays corresponding water rates to the government.

Selling water from river pumping:

Another form of informal water trading in the LBP canal command entails selling a small plot of land adjacent to a river to persons who can dig a well and pump the water either from a shallow well or directly from the river or canal to fields located 5 to 15 km from the well. In this case, land rights are essentially translated into unlimited water rights. This practice is illegal,

however, because wells within 200 m of the river are considered to be recharged directly from the river. Thus, pumping from these wells diverts water to which the pump owner has no rights.

In most cases farmers use diesel pumpsets in these types of operations, although some use electricity by transferring their existing electric connections to the new wells. This practice further compounds the illegality of river pumping: Selling water from pumps that use electrical power is prohibited because electricity is provided free for direct agricultural purposes only. Despite the illegality of the practice, farmers/pumpers often simply pay the necessary penalties and continue the water selling business, which generates more than adequate revenues to cover the modest fine. This phenomenon is common in and around Sathiamangalam, where water is pumped out from a well dug near Bhavani River and travels up to 10 to 15 km through underground pipelines to sites where water use efficiency is considered high.

The nature of water selling is demand oriented, and farmers who see a need for this service and want to provide it can form a group and invest in the land and other infrastructure needed to deliver water. Although the business can be lucrative, a group typically must pay about 10 times more for the water than canal farmers pay to the government through water charges. The major cost component involved is the cost of pipelines.

Intersectoral Water Markets in the LBP

Intersectoral water markets are operating in and around the LBP basins, particularly near the tail region of the canal system. Farmers/well owners sell water to tanker operators, who transport the water to urban centers and sell it to barrel operators, who in turn sell it to households. These water markets are described below.

Tankers supply water to textile industries, households, and other groups in Vellakoil within a radius of 5 to 10 km from the pumping point. They currently cover a distance of about 25 km, but during peak demand may cover up to 40 km. Each tanker has a capacity of 13,500 liters and makes six to seven trips per day (up to 22 trips per day during peak demand).

The number of tanker trips on a given day depends upon the price of water as well as demand. Initially farmers sold water for Rs 10 per tanker, and tankers would sell it for about Rs 100 per load. Because of the recent increase in diesel-fuel prices, however, farmers have increased the price to Rs 15 per load, which in turn is sold in town by tanker operators at Rs 125 per load. (Farmers use diesel engines to pump the water they sell because of the government's ban on using electricity to pump water for commercial sale.) Depending upon demand, farmers may increase their rates during some seasons to Rs 40-50 per load. Because farmers own both the land and the well, they face no legal constraint in pumping out well water to sell, and, the government does not interfere in the process.

In several cases, tanker operators deliver water in huge tanks to barrel operators, who then sell it in small quantities, such as Rs 4 per barrel of 200 liters, to bullock-cart owners. The bullock-cart owners in turn sell the water to households at about Rs 10 per barrel. The following cost analysis shows the profit margins farmers make from selling water from their wells. Farmers

whose wells are near cities and are serviced by relatively good road facilities have the best market potential to sell water.

Quantity of water pumped in a day	= 283.5 cubic meters
Average cost of water to the farmer	= Rs 7/tanker
Farmer's selling price	= Rs 15/tanker
Profit to farmer	= Rs 8/tanker
Profit to farmer per day (@ 21 loads on normal day)	= Rs 168

As noted above, demand for water varies depending on the season, but it also changes according to the level of water in the wells and the pricing mechanisms used. For example, in the summer season, each well has water sufficient for only 10 to 15 tankers, as canal water is stopped during this time and recharge is comparatively less. (Actually these wells are capturing the canal flows indirectly, as evidenced from the recharge pattern and the quantity of water sold.) However, markets handle variability in supply and price very well. During water scarcities, farmers will activate wells located farther away. Similarly, tanker operators will reduce their intake from farmers who have increased their rates. In the rainy season, demand is comparatively less.

Table 4 illustrates the profit margins other sellers make in Sector 1's intersectoral water markets.

Table 4. Profit Margins among Intersectoral Water Market Sellers

Tanker Operators	
Normal period:	
Farmer's selling price	= Rs 15/tanker
Tanker operator's selling price	= Rs 125/tanker
Operational costs (include driver and cleaner per diem, service charges, fuel charges, and so on)	= Rs 50/tanker
Profit	= Rs 60/tanker
Profit per day (@ 7 loads per day)	= Rs 420
Demand period:	
Farmer's selling price	= Rs 40/tanker
Tanker operator's selling price	= Rs 210/tanker
Operational cost	= Rs 80/tanker
Profit	= Rs 90/tanker
Profit per day (@ 15 loads per day)	= Rs 1,350/day
Barrel Operators	
Tanker operator's selling price	= Rs 125/tanker
Barrel operator's selling price	= Rs 4/barrel (1 barrel= 200 liters)
Total income (one tanker accommodates 65 barrels)	= Rs 260/tanker
Profit	= Rs 135/tanker
Bullock-cart Owners	
Barrel operator's selling price	= Rs 4/barrel
Bullock-cart owner's selling price to households	= Rs 10/barrel
Final price of water to households	= Rs 650/tanker (or) = Rs 50/1,000 liters
Profit	= Rs 390/tanker (or) = Rs 6/barrel (or) = Rs 49/1,000 liters

The study team surveyed LBP farmers in Chitode and Thindal, and Allampalayam, Velliangavalasu, and Manthapuram villages to examine their attitudes toward water markets in canal-irrigated areas. According to the farmers, water selling as such is uncommon in agriculture, particularly in the head and middle regions of the system, because water is sufficient even during scarcity periods. Also, it is difficult to take water to farmers who need it, as their locations may be too distant to transfer the water cost-effectively. Conversely, in the tail region of the LBP command area, water selling has been quite common. For example, farmers in Manthapuram Village, located 4 to 5 Km from Muthur, are familiar with water selling. There, water is being sold from six wells, with four tankers operating.

When asked about their freedom to reserve their quota for reservoir water to use later as they choose, whether for agricultural or nonagricultural purposes, the farmers indicated they understood the importance of such water rights.

Many farmers in the area say that selling water for nonagricultural purposes is more profitable than using it for agricultural purposes, due to labor problems and unfavorable crop prices (see Table 5). In several cases, farmers have grown coconut and other perennial crops that consume less water, thereby releasing water for sale. Of farmers who are selling water, about 55 percent have been growing coconut and other orchard crops mainly to minimize labor and water consumption. When well-owning farmers were asked why they had begun to sell water, most said they did so to alleviate labor problems (for example, hiring and keeping farm workers) and because the high demand for water in urban markets makes the market promising (see Table 5).

Table 5. Why Farmers Sell Water

Issue	Percent of Farmers Responding (N=12)
Inadequate water for irrigation	9%
High input prices and low crop prices	18%
More water in the wells than required for irrigation	23%
Labor problems	34%
Wells are close to roads	16%
Greater urban demand for water	26%

Sector 2: Well Irrigation and Agricultural/Urban Water Markets in Coimbatore and Tiruppur

Background

The Pillur diversion of 2 TMC of water —the estimated demand in the Coimbatore District—from the Bhavani River to Coimbatore and adjoining town *panchayats* involves the interbasin transfer of water from the Bhavani to the Noyyal Basin.[17] Since both the Bhavani and Noyyal are tributaries of the Cauvery River and lie within Tamil Nadu, controversy over the transfer does not arise. The Noyyal River is often dry, and thus Coimbatore depends heavily on groundwater as well as water from the Siruvani sources.

The diversion of water for urban uses indicates an increasing trend toward competition between urban and rural water users in Sector 2. Water for various sectors must, to a large extent, be supplied via groundwater extraction. Initially Coimbatore City depended completely on dug wells and few bore wells, which were once used for agricultural purposes. Now, however, many of the city's open wells have dried up; as a result, drilling bore wells up to depths of 750 feet recently has been common. The heavy withdrawal of groundwater, mostly for irrigation purposes, has resulted in a significant lowering of the water table. It has been reported that Coimbatore's well water level has declined by as much as 1m per year during the last three to four decades (Lundqvist, 1993).

Two towns in Sector 2, Coimbatore and Tiruppur have particularly active water markets.

Water Markets in Coimbatore

In Coimbatore City, there are approximately 53,290 house connections and 1,075 public taps. The public taps mainly serve the poorest sections of the city. All individual household connections have been fitted with water meters. The private market meets 35 to 40 percent of the drinking-water needs of the town panchayats and probably meets 3 to 4 percent of the water demand in Coimbatore City, where institutions and industries rely more heavily than households on the private supply of water. The municipality meets the remaining 96 to 97 percent of city demand. Because the municipal supply fails to meet demand fully, selling water for domestic use is a common phenomenon and has been in practice for the last 25 years in Coimbatore.

Coimbatore's water is pumped by electric motors, and bullock carts and lorry tankers are the main modes of distributing it to households and other customers. (Bullock-cart owners meet the city's household requirements, while tanker operators cater to the construction industry and other large institutions.) Within the city, households buy water mainly for gardening, washing, and—rarely—drinking. Households in new residential areas and those in the tail end of the public distribution system (which experiences water shortages) buy water for all purposes, including drinking.

[17] A panchayat is a local, or village, administrative setup.

The functioning of water markets in Coimbatore resembles that of the water markets described under the LBP canal system. However, compared with the canal systems, the urban sector maintains a better-defined market structure. Water is purchased from bore wells at the rate of Rs 3 per bullock cart and Rs 20 per lorry tanker.

As in Sector 1 (see Table 4), the pricing mechanism among farmers, tanker operators, barrel operators, and bullock-cart owners in Coimbatore affects the price the end consumer pays. Other variables, such as distance of the consumers from the well, the quality of water (potable versus nonpotable), competition, and seasonality (summer versus rainy season), also may affect the price of water in Coimbatore.

The rates the municipality charges for water are far below the prices charged in the private market. The municipality charges the following rates for every 1,000 liters of water: residential, Rs 2; industrial, Rs 4; commercial, Rs 6. For every additional 1,000 liters of water consumed, the same rate is charged. In contrast, the private market charges more than 10 times these amounts, indicating the supply-demand gap that plagues the municipal water distribution system. This situation is particularly inequitable for the poor, who have limited access to the municipal water supply and must therefore pay the higher rates to have water delivered to them from private sellers.

The water supply situation in the surrounding suburban towns differs significantly from that in Coimbatore City. The Pillur diversion is largely meant to alleviate the acute scarcity these towns face. Out of 20 towns, only 2 receive 20 lpcd of water through the public water supply, and in the worst case, 5 towns receive less than 10 lpcd. The main source of supply is through bore wells, which vary in depth from 100 to 200 m. Unlike Coimbatore, the towns do not draw water from surface sources.

Tiruppur

Tiruppur in Coimbatore District covers an area of 27.5 km^2 and is located 50 km east of Coimbatore City. It is an important commercial and industrial town in which various yarn and knitwear manufacturers maintain their headquarters. Most of the district's hosiery and dyeing units are located in and around the town, as Tiruppur is well connected to nearby districts.

Tiruppur is developing into one of Tamil Nadu's major industrial centers, having grown rapidly from an old ginning mill town early in the century to its current status as a textile manufacturing center. The town's garments export units earn a foreign exchange of about 20 billion per year.

Functioning of the urban water market

Water supply to Tiruppur largely depends on private tankers. Industries receive water only from the private market, and account for 90 percent of its sales. The remaining 10 percent goes to domestic and commercial establishments. It is estimated that about 250 tankers with an average capacity of 12,000 liters each sell water in Tiruppur, with each averaging up to four trips per day. Wells in the villages around the town serve as the main source for this water. The water table in the wells ranges from 80 to 90 feet; total water required for industries is 91.6 million

liters per day (mld) (Kalaimani and Sathiah, 1994). Yields from the wells are beginning to diminish during summer. As a result, the wells get recharged when the Parambikulam Aliyar Project is opened for cultivation once every 18 months.

The charges for private supplies in Tiruppur vary according to the distance between the water sources and the consumer, but the average cost to the final user is Rs 17.5 per 1,000 liters (Dyers Association, 1993). Public water supply, both from Kovilvazhi and Mettupalayam headworks constitutes about 46 percent of the town's water, which represents the potable water supply and bore wells. Private tankers provide the other 54 percent.

The water market in Tiruppur is competitive, as there are many buyers and sellers and price is determined by market forces. Farmers generally increase their prices during peak demand periods and reduce them during lean months. Water sellers' area of operation also increases with demand, particularly during the peak season. Reduced well recharges further fuel demand.

There are several reasons for Tiruppur's emerging water markets. Many farmers told the study team that the main constraints to irrigated crop production are dwindling well water supplies and increased labor problems, both in terms of wages and availability (see Table 6). Furthermore, the increased cost of inputs compared with output prices discourages the irrigation of several crops. Consequently, farmers often switch to selling water after satisfying the water requirements of their standing coconut crops and cattle. In several cases, farmers have cultivated only about 20 percent of their cropland, mainly with fodder crops that require less labor.

One of the farmers' main objectives in selling water, then, is to maximize their profits. Since water supplies are very limited, farmers' options vary with the level of water availability. Farmers who grow crops that demand low amounts of water and sell their remaining allowance of water earn about 50 percent more net income per hectare than farmers who grow only traditional crops. Farmers who sell water and grow crops that consume moderate amounts of water earn 23 percent more net income than farmers with traditional crops. However, farmers who depend on water sales alone earn only about 48 percent of the net income of farmers who sell no water (see Table 7).

Table 6. Reasons for Tiruppur's Emerging Water Markets

Reason	Percent Responding (N=12)
1. Inadequate well water	35%
2. Labor unavailability	42%
3. High input costs	23%
4. Low output prices	15%
5. Domestic demand for water	19%
6. Greater income from water sales than from farm products	8%

Table 7. Tiruppur Farmer Income Based on Water Use

Option	Net Income (Rs/ha/year)
1. Growing traditional crops and selling no water	3,410
2. Selling water and growing	
a. crops consuming low amounts of water	5,125
b. crops consuming moderate amounts of water	4,208
c. no crops	1,624

Tiruppur's water markets are more active in the town's industrial and commercial sectors, where industry demand is about 3,000 tankers. Current supply, however, varies from 1,500 to 1,650 tankers per day.

Peak demand occurs from April to September (see Table 8). Area of operation depends on demand as well as water availability in the wells. During peak season, tanks have to go for a longer distance because water availability is reduced as a result of poor recharges in the wells. Several farmers with whom the team spoke said they could not sell water because available water was sufficient only to irrigate the standing coconut crops and to meet livestock water requirements.

Normally the tankers take water from wells located a radius of 5 to 35 km from town, depending on season and water availability (see Tables 8 and 9). As noted earlier, because the use of electricity for nonagricultural purposes is prohibited, most farmers use diesel pumpsets to pump and sell water. In a few cases, farmers have electric pumpsets and are charged Rs 2.15/kwh; the minimum charges to be paid are Rs 600 every two months. The average cost of water to farmers is Rs 5.86 per tanker. Only big textile firms that use a lot of water own tankers and wells and, in addition, use electricity to pump water.

Table 8. Tanker Operators' Water Sale Characteristics by Month

Season	Number of Tankers (per day)	Location of Wells from Town (km)	Buying Price[1]	Selling Price[1]
April	1,650	10-15	30	275
May	1,600	10-20	35	275
June	1,520	15-25	50	350
July	1,520	15-30	65	475
August	1,550	20-30	65	475
September	1,550	20-25	65	450
October	1,450	10-15	35	285
November	1,500	5-10	25	225
December	1,500	5-7	25	225
January	1,500	5-7	25	235
February	1,550	5-7	25	235
March	1,600	5-10	25	250

[1] In Rs per tanker

Note: Average expenses for each tanker operator are around Rs 6/km. Thus, at a radius of 10 km, total expenses would be approximately 20 km × Rs 6 = Rs 120 per trip.

Table 9. Tanker Operators' Water Costs by Well Location and Season

Distance of Wells from Town (km)	No. of Trips/Day	Buying Price[1]		Selling Price[1]		Expenses	
		L[2]	P[2]	L	P	L	P
5	10	3	25	35	225	250	62
7	8	4	25	40	235	275	84
10	7	6	30	50	250	325	120
15	2	7	35	55	275	350	180
20	0	8	0	60	0	350	240
25	0	8	0	65	0	425	300

[1] In Rs per tanker
[2] L=lean demand period; P=peak demand period

CONCLUSIONS

Despite significant restrictions on the tradability of water in Tamil Nadu, active informal water markets have developed in response to increasing water scarcity and to the value of water across sectors. Particularly active trading takes place between the agricultural and urban sectors. These markets serve a useful function by supplying water for high-value uses to users who would otherwise remain unserved by the highly subsidized municipal water systems. However, the markets would be far more effective were legal restrictions and excessive electricity and municipal water subsidies removed. The subsidized municipal system, which leaves out many of the poor, has particularly negative welfare implications. The study team's results indicate that it would be very useful to undertake a careful examination of the feasibility, costs, and benefits of reforming Tamil Nadu's water laws and allocation systems to permit more flexible trading of water, and to remove subsidies for municipal water systems and for electricity for agricultural purposes.

A number of questions would need to be addressed in such a study:

1. How best can demand-driven water allocation be introduced while taking into account farmers' interests?

2. How would alternative water and power charges influence the achievement of efficient water allocation mechanisms?

3. How could existing rights restricting water transfers be relaxed in the context of increasing demand for nonagricultural purposes?

4. What is the role of farmers' organizations in efficient water distribution and establishment of tradable water rights?

5. What are the constraints in introducing different canal operating rules that would give farmers more flexibility in choosing their own crops?

6. What will be the impact of future water system modernization (to be achieved via World Bank funding) on the certainty of water supply, and how will this influence the functioning of water markets?

7. What policies could control overexploitation of groundwater due to excessive pumping?

8. How effectively could a market-based water allocation system balance surface water and groundwater withdrawals, keeping in mind rural and urban interests? How could such a system minimize future withdrawals from the Bhavani River?

9. How would incentives to the agricultural sector balance agricultural and nonagricultural activities in the region? What agricultural adjustments have resulted from increasing demand for water by industries?

10. How best could wastewater be reused? What are the environmental costs of groundwater overexploitation and pollution?

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Annex E

WATER RIGHTS IN JORDAN

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and
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PREFACE

This annex aims to analyze tradable water rights in Chile, California, and Mexico in order to examine the possibilities for similar water allocation mechanisms in Jordan. An overview of Jordan's water resources and demand projections is presented to illustrate the extent of water shortage the country is suffering. Historical developments in Jordan's water laws are outlined to analyze trends in water legislation, and water pricing policies in all sectors are discussed and their effectiveness analyzed. Water rights for all water uses (domestic, agricultural, and industrial) are reviewed, as are opportunities and challenges for water rights based on the views of policymakers and the public. Finally, lessons learned are outlined along with a conceptual framework to address water issues in Jordan.

Policymakers say future water scarcity should be addressed through management and efficient pricing of water resources for the short and medium terms. However, as this paper shows, tradable water rights warrant examination for the long term as well.

ACRONYMS AND ABBREVIATIONS

CIDA	Canadian International Development Agency
GDP	gross domestic product
JVA	Jordan Valley Authority
l/c/d	liters per capita per day
MCM	millions of cubic meters
m^3/c/y	cubic meters per capita per year
MWI	Ministry of Water and Irrigation
UFW	unaccounted for water
WAJ	Water Authority of Jordan

WATER RIGHTS IN JORDAN

INTRODUCTION

Background

Jordan has faced acute water problems since the early 1960s, because the country's demand for water has grown more rapidly than has the development of new water supplies. The water problems have periodically emerged as full-fledged socioeconomic crises when severe shortfalls in supply have failed to meet domestic and agricultural demand. Inadequate management of the water crises and the absence of appropriate water policies have resulted in a failure to generate solutions for water shortage and distribution problems. Crisis management solutions to date have ignored the sustainability of resources and adequate, sound planning.

In addition, water problems in Jordan have been affected and influenced by hostile natural and external factors. The volume of water resources is affected by the prevailing climatological conditions, which are related to erratic rainfall distribution from one year to another. Additionally, large portions of Jordan's water resources that flow to main rivers do not fall within the borders of the country, so they are difficult to control and manage. There is no doubt that financial and political constraints have hindered the execution of major water resources projects, which has resulted in Jordan's inability to develop and enhance its water resources. These factors, as well as unexpected population increases, are the main causes of Jordan's water crisis.

Jordan's water resources have always been scarce, but the most recent growth in demand has led to groundwater extraction beyond replacement and the rationing of municipal and irrigation supplies. By overdrawing groundwater resources, Jordan is losing an irreplaceable supply and faces increasing water costs and deteriorating water quality.

The future only looks bleaker. The annual deficit of total water resources may increase to nearly 1,200 million cubic meters (MCM) by the year 2015. Gains in supply increments and severe demand reductions will not hold the deficit to the present level (Buskirk, 1992). With the shortfall of Jordan's water resources threatening in the near future, the country should implement a water policy that employs cost-effective means to narrow the gap between water supply and demand. However, those who consider options only to enlarge the water supply should take into account the high costs of the necessary investments to do so, such as long-distance conveyors, new dams, and desalinization plants (Schiffler, 1994). The high cost of generating new water supplies warrants careful attention to demand management.

Physical Characteristics

Jordan is an arid country covering 90,000 km^2 with an average rainfall of approximately 8.4 billion m^3. About 94 percent of the area receives less than 200 mm of annual precipitation. A good percentage of rainfall waters appear as surface- and groundwater.

Jordan's surface drainage system is simple and consists of two parts: the eastern part drains rainfall into desert depressions, and the western part drains water toward the Jordan Valley, which ultimately discharges into the Dead Sea. The high percolation rate in many areas of Jordan results in relatively good rates of groundwater recharge.

As noted above, Jordan's potential for future water resources is limited and its population has been growing rapidly. During the past 46 years, the population has increased ninefold, from about 425,000 in 1948 to about 4 million today. The increase has not been natural, due to successive waves of refugees and displaced Palestinians in 1948 and 1967. Additionally, as a result of the Gulf War (up to 1991), Jordan received more than 3 million returnees from Kuwait and the Gulf States.

Objectives

The objectives of this study are (1) to assess institutional, economic, social, and legal contexts in Jordan to examine the possibilities for and constraints to tradable water rights; (2) to review current policies in other areas (specifically Chile, Mexico, and California) for a comparative perspective with regard to water rights; and (3) to examine lessons learned from policy efforts in the aforementioned areas to help in policy formulation in Jordan.

The methodology used in this study includes (1) interviews with public officials, policymakers, consultants, and users to assess their views of Jordan's water markets and possible future policies; (2) field visits to farms and industries to study water use, conservation strategies, and issues related to water pricing; and (3) a review of three cases in Chile, Mexico, and California to explore policies and lessons to apply in Jordan.

OVERVIEW OF WATER RESOURCES IN JORDAN

Potential for Water Use

The potential for Jordan's water supply ranges from 1,000 million cubic meters (MCM) to 1,200 MCM, including recycled treated wastewater. ***Currently about 862 MCM of water resources are being exploited annually by different sectors. Renewable and nonrenewable groundwater contribute about 511 MCM, while surface water contributes 308 MCM; the remaining 43 MCM come from treated wastewater.*** Additional resources may come from restoration of water rights from the Jordan River. Incremental water supply can also be increased through expensive measures such as cross-boundary transfer of water and desalination.

The potential for surface water is about 680 MCM without Jordan's share of the Jordan River. This figure includes about 65 MCM of surface water in the desert basins, which are difficult to use for sustainable development because of their erratic occurrence. On the other hand, most of the groundwater basins are suffering from overabstraction. In 1991, the rate of withdrawal from Jordan's renewable aquifer exceeded the safe yield (276 MCM) by 150 MCM. Nonrenewable groundwater resources produced 87 MCM in 1991 with a future potential of 143 MCM.

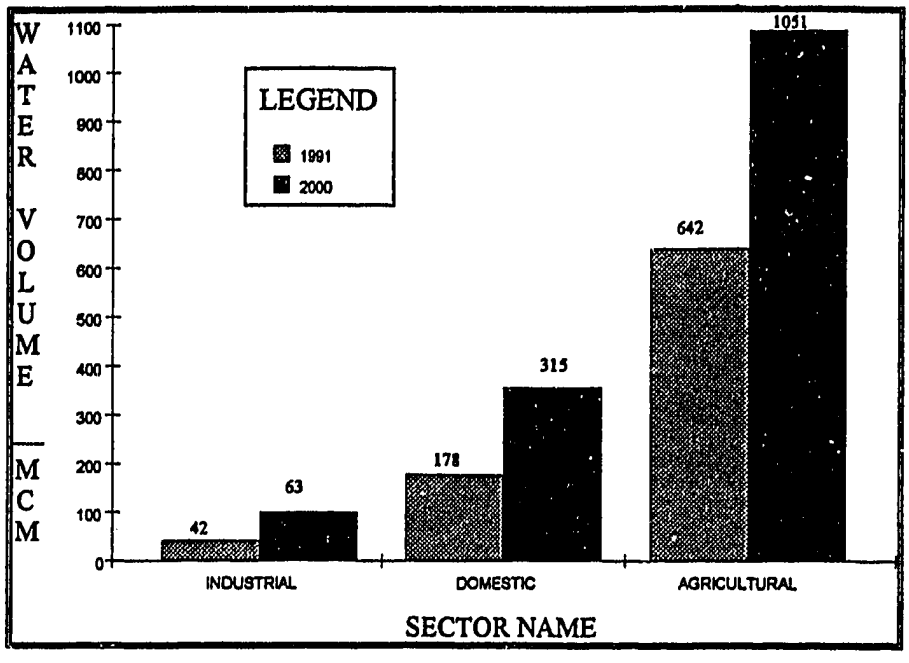
Water supplied from all resources in 1991 was 178 MCM for municipal (domestic) purposes, 42 MCM for industrial use, and about 642 MCM for agricultural use to irrigate about 62,500 hectares (ha). A summary of the development and use of Jordan's water resources from 1986 to 1991 is presented in Table 1. Data on the water balance of 1992 and 1993 have not yet been released, but the Water Authority of Jordan (WAJ) 1992 annual report indicates that domestic consumption for 1992 had reached 208 MCM. Figure 1 shows actual water consumption in 1991 and projected consumption in 2000 by sector.

Table 1. Development and Use of Jordan's Water Resources (in MCM)

Year	1986	1987	1988	1989	1990	1991
Agricultural	428	520	574	598	630	642
Municipal	147	154	165	170	178	178
Industrial	23	24	30	36	38	42
Total	598	698	769	804	846	862

Source: Shatanawi, 1993a

Figure 1. Water Consumption by Sector (MCM)



The following sections review the current water resources demand and supply situation in Jordan, with municipal, agricultural, and industrial uses examined separately.

Current Water Use

Irrigation (Agricultural) Water Use

As noted previously, the supplied amount of water in 1991 for irrigation, or agricultural, purposes was 642 MCM, 158 short of what was needed. This amount included 46 MCM of treated wastewater. About 310 MCM were used in the Jordan Valley, including southern Ghors and Wadi Araba, to irrigate around 29,500 ha. An additional 6,000 ha in the southern part of the Jordan Valley have been equipped with irrigation distribution systems that have not been supplied because water is unavailable. The remainder of the supplied water for irrigation in 1991, 332 MCM, was used to irrigate about 33,000 ha in the upland area. Most of this amount was pumped from privately owned wells; little came from surface water resources. This amount also included about 55 MCM of nonrenewable groundwater (fossil water) from the Disi-Mudawara area (Qasem et al., 1993).

Jordan's irrigation requirements in 1991 were estimated based on adopted cropping patterns and the calculated crops requirement per unit area of total irrigated land. Part of the deficit was met through overabstraction from aquifers. However, a portion of the irrigable area was left fallow, and cropping intensities had to be reduced due to water fluctuations and the lack of regulated hydraulic structures on the major irrigation water source, the Yarmouk River.

In 1980, irrigation water's share of total water use was 78 percent. By 1991, however, that share had decreased to 74 percent, and it is projected to decrease to 53 percent by the year 2010.

The shortages in irrigation water that occurred in the late 1980s and early 1990s had their most pronounced effect on the Jordan Valley in 1989, when water was unavailable to irrigate the fall planting. In the fall of 1991, the government had to compensate farmers for not planting part of their lands with vegetables in the middle and southern parts of the Jordan Valley; the government subsidized farmers with 80 dinar (JD)/ha, or $120/ha, for not planting vegetables and annual crops during the spring and summer seasons.[18]

Groundwater's share of total irrigation resources ranged from 43 to 53 percent from 1986 to 1991 (see Table 2), a much higher share than in the 1960s and 1970s. In the highlands, groundwater resources available for irrigation were even greater, reaching 76 percent of total resources in 1980 and an average of 86 percent in the late 1980s and early 1990.

Qasem et al. (1993) reported that total agricultural value represented 6 to 9 percent of Jordan's GDP during the 1980s. In 1990, irrigated agriculture represented 62 percent of total agricultural value, and total agricultural value represented 7.6 percent of GDP; the irrigated value represented 4.7 percent of GDP. Other values and benefits (environmental, social, and political) of agriculture are also important, but cannot be measured in monetary terms.

Municipal Water Use

The supply of municipal water in 1991 amounted to about 178 MCM (about 125 liters per capita per day, or l/c/d), of which 30 to 35 percent is estimated to have been lost to leakage in the pipe network and only 45 percent to have been metered and billed. The remaining unaccounted for water (UFW) went untabulated due to errors in metering and to illegal connections. The actual per capita consumption, therefore, did not exceed 82 l/c/d, compared with domestic use in Europe and the United States of 250 to 350 l/c/d.

Jordan has one of the lowest per capita water consumption rates in the world, and has the lowest compared with other countries in its region. This low rate is due not only to insufficient water supply but also to specific measures taken in water pricing and water conservation policies.

Starting in 1988, water supply rationing was implemented in Jordan. Supply shortages relative to minimum requirements varied from 6.7 MCM in 1986 to 46 MCM in 1991, assuming a water demand of 60 cubic meters per capita per year (m^3/c/y) and a population of about 4.0 million. Part of the shortages encountered after 1991 were attributable to demands from the Gulf and Kuwaiti returnees to Jordan. These shortages were met by severe rationing.

[18]The current exchange rate is US$1 = JD0.66.

Table 2: Water Resources Available for Irrigation

Water Source	Volume of Water (MCM)				
	1980	1986	1989	1990	1991
Surface Water	147	224	242	257	275
Groundwater	138	183	318	329	321
Recycled Water	--	21	38	44	46
Total	285	428	598	630	642
% Groundwater	48%	43%	53%	52%	50%
% Share of Ghors	53%	55%	46%	46%	49%
% Share Groundwater of Total Ghors	21%	12%	14%	13%	13%
% Share Surface Water of Total Ghors	79%	88%	86%	87%	87%
% Share of Highlands	47%	45%	54%	54%	51%
% Share Groundwater of Total Highlands	76%	80%	86%	87%	85%
% Share Surface Water of Total Highlands	24%	20%	14%	13%	15%

Source: Qasem et al., 1993, and Shatanawi, 1993a

Industrial Water Use

Industrial water requirements in 1991 were 42 MCM, and projections for the year 2000 suggest that a demand of about 65 MCM is likely (Shatanawi, 1993a). The largest portion of water in the industrial sector is consumed by the Arab Potash Company, the Phosphate Mining Company, the Jordan Petroleum Refinery, the Al-Hussein Thermal Power Station, the cement factories, the glass factories, and various chemical and pharmaceutical companies.

Approximately 75 percent (31 MCM) of the consumed water for industry is derived from groundwater sources, and about 65 percent (20 MCM) of that amount is abstracted from the Dead Sea groundwater basin. In addition, some industries use their own wells.

Almost all industries in Jordan suffer from water shortages, and many recycle their wastewater, but recycling is in many cases too expensive and beyond the economic capabilities of small industries. For example, the cost of treating water at the Al-Hussein Thermal Power Station is 2.5 JD/m^3, and 1.25 JD/m^3 at the Aqaba Thermal Station.

Wastewater Treatment

In order to cope with the growing amount of raw wastewater in Jordan, several treatment plants are under construction or study. One problem facing all wastewater treatment plants is the poor quality of the domestic wastewater they receive. The poor quality is attributable to low water consumption, which in turn is due to the national water shortage. The water shortage also imposes several operational problems and, as a consequence, plants are being biologically overloaded and are running at only a portion of their hydraulic capacity. The cost of domestic wastewater treatment ranges from 15 to 250 fils/m^3 or \$0.02 to \$0.35.

Wastewater treatment plants reduce surface water pollution problems. In some areas, the quality of water supply improves drastically because of increased sanitation and regulated management. For example, the water quality of Ain Sara Spring, average discharge of about 579 m^3/hr, has been significantly improved, with the nitrate concentration at the site having been reduced from 95 mg/l in 1987 to 41 mg/l in 1993 (Gedeon, 1993).

Water Demand Projection

Water demand in Jordan is rapidly increasing due to increasing demand for development and the high growth rate of population, which presently stands at 3.4 percent. With the current trends in water use, it is anticipated that within the next few years, Jordan will use all of its potentially available water resources.

Municipal Demand

In general, the projection of municipal water demand for any country depends on future growth in population, growth in per capita water demand within acceptable social and health limits, and the percentage of projected losses from the municipal water system.

Jordan's present level of water consumption for domestic purposes (about 125 l/c/d) includes water losses during delivery and within the distribution network. It is estimated that only 45 percent of charged water is delivered. The 55 percent in losses are not actual physical losses because 20 percent are considered as unaccounted for losses. Therefore, the actual water distribution efficiency is calculated as 65 percent, indicating that the actual consumption at the household level is 82 l/c/d.

Future domestic water requirements are calculated as related to the expected average per capita consumption and the projected population. From 2000 to 2010, the rate of population growth in Jordan is projected to be 3.0 percent, and from 2011 to 2020, 2.8 percent (see Table 3). As for

the rate of water consumption, it will gradually increase from the current (1991) rate of 45 m^3/c/y (125 l/c/d) to 75 m^3/c/y (180 l/c/d) by the year 2020. In addition to population growth, this increase is projected as a result of expected improvement in standard of living and the adequacy of services to most communities. Despite this improvement, however, the proposed level of consumption will be less than the average international water consumption level. Furthermore, even this low figure can be achieved only if accompanied by better guidance, improved efficiency, and good management of the operation and maintenance of Jordan's water systems. Based on these projections, the annual water quantity used for domestic purposes in Jordan will increase from 178 MCM in 1990 to 315 MCM, 497 MCM, and 705 MCM in 2000, 2010, and 2020, respectively, as shown in Table 4.

Industrial Demand

Future industrial water demand in Jordan naturally depends on future industrial development. Prior to 1989, industrial water demand was estimated to grow from 42 MCM in 1990 to 63 MCM in 2000. It is now expected that industrial development will exceed its anticipated growth rate in the next few years, resulting in an increase in the projected industrial water demand.

The level of water consumption for industrial purposes reached 37.6 MCM in 1990, which is about 10 m^3/c/y. To estimate future consumption, the present level of 10 m^3/c/y is gradually increased to 16 m^3/c/y by 2020, which amounts to a total requirement of 150.3 MCM (see Table 5).

Table 3: Projected Population and Growth Rate, 1990 to 2020

Year	Projected Population (in millions)	Projected Growth Rate in 5 Year Period
1990	3.76	3.4 % (1990 - 1995)
1995	4.44	3.4 % (1995 - 2000)
2000	5.25	3.1 % (2000 - 2005)
2005	6.12	3.0 % (2005 - 2010)
2010	7.09	2.9 % (2010 - 2015)
2015	8.18	2.8 % (2015 - 2020)
2020	9.40	-----

Source: Shatanawi, 1993a

Table 4: Projected Municipal Water Consumption, 1990 to 2020

Year	Consumption Rate ($m^3/c/y$)	Total Consumption (MCM)
1990	47.5	178.4
1995	55.0	244.0
2000	60.0	315.2
2005	65.0	397.7
2010	70.0	496.6
2015	75.0	613.8
2020	75.0	704.7

Source: Shatanawi, 1993a

Table 5: Projected Industrial Water Requirements, 1990 to 2020

Year	Average Requirement (m^3/c/y)	Total Requirement (MCM)
1990	10	37.6
1995	11	48.9
2000	12	63.0
2005	13	79.6
2010	14	99.3
2015	15	122.8
2020	16	150.3

Source: Shatanawi, 1993a

Irrigation (Agricultural) Water Requirements

During 1991, water consumption for irrigation purposes reached 642 MCM to irrigate an area of 62,500 ha, and the per capita share of water for irrigation purposes was 166 $m^3/c/y$. This share had been 200 $m^3/c/y$ during the second half of the 1980s; the decline in 1991 was due mainly to slow development of additional water resources to handle the greater demand resulting from population increases.

Priority in water allocation in the future will be given to municipal and industrial purposes, with the remaining water apportioned for agricultural use. In order to determine the volume of water that will be left for irrigation, it is important to estimate all possible water resources that can be secured.

Irrigation water demand in Jordan depends on the cropping patterns implemented, cropping intensity, soil types, climate, and irrigation methods used. The potential irrigable lands in the Jordan Valley amount to approximately 36,000 ha, and the irrigable area in the southern Ghors and Wadi Araba amount to 6,500 ha. Presently, cropped irrigated area in the uplands amounts to 33,000 ha. Although the potential irrigable lands in the highlands are many, only a very slight increase in irrigated agriculture is anticipated there due to the unavailability of water resources.

Projected irrigation water demand based on crop requirements and estimated irrigation efficiencies in Jordan is expected to grow from 800 MCM in 1991 to 1,051 MCM in 2000. One of the water resources that could be made available for irrigation purposes is recycled water from municipal and industrial wastewater treatment plants. The quantity of treated wastewater is expected to grow from 45 MCM in 1991 to 85 MCM in 2000 (see Table 6).

The above irrigation water demand projections assume that the Jordan Valley can improve its water use efficiency through conversion from a surface irrigation system into pressurized irrigation networks. If irrigation efficiency can be improved by 10 percent in the next decade, a total of 60 MCM of water can be saved to irrigate new land.

Table 6: Projected Agricultural Water Requirements and Wastewater Production, 1991 to 2020

Year	Agricultural Requirements (MCM)	Wastewater (MCM)
1991	800	45
1995	889	65
2000	1,051	85
2005	1,224	113
2010	1,419	144
2015	1,637	184
2020	1,879	219

Source: Shatanawi, 1993a

WATER PRICING

Tariffing

Appropriate tariffing is the financial instrument used to control water demand in Jordan. Current water and wastewater tariffs are listed in Table 7. The tariff structure escalates as the quarterly consumption of the water subscriber increases. The highest tariff (for consumption above 100 m^3) is equivalent to \$1.27 per m^3 of water metered, of which 29.4 percent is allocated to wastewater collection and treatment.

The marginal cost of wholesale deliveries to Amman includes direct costs and agricultural value-added foregone (opportunity) costs. Indicative campaigns conducted by the Water Authority of Jordan (WAJ) through the press have proven fruitful. They show estimates of 285 fils/m^3 (\$0.44/m^3) for the existing Deir Ala pumping station; at least 550 fils/m^3 (\$0.82/m^3) and 770 fils/m^3 (\$1.10/m^3) for a new station, with and without storage; 700 fils/m^3 (\$1.00/m^3) *for the* Disi

Table 7: Water and Wastewater Tariffs in Jordan

Quarterly Water Consumption (m^3)	Water Tariff (fils/m^3)	Wastewater Tariff (fils/m^3)	Total (fils/m^3)
1-20	100	30	130
21-40	190	40	230
41-70	400	100	500
71-100	500	200	700
> 100	600	250	850

Source: Water Authority of Jordan regulation on pricing

(nonrenewable) aquifer; and $1.92/m^3 for seawater desalination (Jordan Agricultural Sector Adjustment Loan, 1994).

Water shortages and the modest per capita amounts consumed limit the impact of tariffing as currently structured. Shortages are addressed via direct rationing rather than through pricing policies, hence producing the low levels of household consumption. Therefore, reduction in demand and higher prices may be quite inelastic.

Public versus Private Water Use and Production

The Ministry of Water and Irrigation charges for water used for irrigation only on publicly developed lands in the Jordan Valley. Irrigation water tariffs (6 fils/m^3) are based on the duration of service and a constant rate of flow into farms. The Ministry charges less than 50 percent of its operation and maintenance costs, and a modest percentage of its capital costs. No such levies are imposed on privately developed lands, whose owners make the necessary investments and carry their own operation, maintenance, and replacement costs.

Irrigation water developed by the public sector is priced at only one-tenth of the actual cost of water produced by the private sector. The price charged to irrigators for water developed by the public sector in the Jordan Valley and southern Ghors is 6 fils/m^3, compared with the average cost of private water, which is 65 fils/m^3. This price variation is due to the fact that about 90 percent of Jordan Valley water resources are surface water and that infrastructure and operation and maintenance costs are paid by the government to promote the socioeconomic and integrated development of the Jordan Valley. Conversely, privately produced water is primarily groundwater, and the cost of operation and maintenance of wells varies with their depth. This is also true for the uplands. There, owners of groundwater wells must cover all capital and operation and maintenance costs for their groundwater supply for irrigation, which is normally abstracted by pumping. Estimates of the cost of 1 m^3 of groundwater depends on the pumping head used and varies from 35 to 65 fils/m^3.

Residential areas not served by domestic water networks are served through tankers operated by the WAJ and the private sector. The WAJ and the private sector fill the tankers from their own wells. The private sector's wells, however, are limited and have been operating with outdated permits. The cost of domestic water delivered by tankers can be as high as 1.00 JD/m^3.

Effect of Pricing on Demand

Some analysts say that, given Jordan's existing water shortages, little water will be saved by imposing higher tariffs. This argument, however, overlooks the effect of subsidies, which distort the market economy. In industry, higher water tariffs would encourage reuse of water and wastewater treatment. In agriculture, removal of subsidies on water could influence the cropping pattern, providing incentives to grow higher-valued, less water intensive crops (Qasem et al., 1993).

Water supplied to industries is taken mostly from private wells that the industries themselves own. Recently the government imposed an annual fee on those industries. However, some, like Aqaba Thermal Station, suffer from low-quality water that requires an additional cost for treatment. A few industries use water from public sources such as the WAJ, and are charged a nominal fee that does not cover operation and maintenance.

The issue of water prices in Jordan is linked to social equity as well as water use efficiency. Many people believe that changing the price structure of water should be accompanied by improved water management and better services by the JVA, as well as a comprehensive public awareness program. Complicating the matter, however, is the fact that no empirical evidence exists that shows the effect of water prices on water demand in agriculture and other sectors in Jordan. Further research is needed to examine these relationships.

INSTITUTIONAL FRAMEWORK

This chapter describes the institutions that oversee Jordan's water sector, along with their corresponding responsibilities and the legal framework within which they operate. The Ministry of Water and Irrigation (MWI) supervises the Water Authority of Jordan (WAJ) and the Jordan Valley Authority (JVA), which are its two operating bodies. Currently the MWI, in cooperation with the Canadian International Development Agency (CIDA), is conducting a study on restructuring this institutional arrangement.

Ministry of Water and Irrigation

As supervisory body, the MWI is responsible for formulating and implementing Jordan's water and wastewater development programs.

The MWI's main functions include the following:

- Formulating policy and strategy regarding water and wastewater, which includes monitoring and evaluating water and wastewater projects and research, development, and exploration in water and wastewater;
- Initiating and supervising socioeconomic and environmental studies concerning the water sector;
- Obtaining financial resources from financing agencies;
- Appraising the nation's water resources (quality and quantity) and preparing plans for water resources development;
- Conducting long-term water supply and demand studies;
- Developing human resources;
- Implementing public awareness programs; and
- Establishing a data bank and information system.

Water Authority of Jordan (WAJ)

The WAJ's main responsibilities are the following:

- Survey Jordan's different water resources and determine the means and priorities for their development, use, and conservation.
- Increase the capacity of Jordan's water resources, improving their quality, protecting them from pollution, and supervising their use.
- Put forth programs and plans to meet future water needs by providing additional water resources from inside and outside the country through the use of water treatment and desalination.
- Regulate and advise on the construction of public and private wells.
- Investigate groundwater resources, drilling exploratory and production wells, and licensing well drilling rigs and drillers.
- Study, design, construct, operate and maintain, and administer water and public sewage projects, including those involving collecting, purifying, treating, and disposing of water.
- Draw specifications and special requirements regarding the preservation of water and sewage structures and public and private distribution and disposal networks. This involves taking steps to ensure their safety, technical control, and supervision, and the performance of any necessary tests.
- Carry out theoretical and applied research and studies regarding water and public sewage.
- Issue permits to engineers and license professionals to perform public water and sewage works.
- Participate in organizing special training courses to qualify public water and sewage works professionals to improve the quality of water works and to reduce water losses and pollution.

Jordan Valley Authority (JVA)

The JVA undertakes the following responsibilities:

- Develops the water resources of the Jordan Valley for irrigated farming, domestic and municipal purposes, industry, hydroelectric power, and other beneficial uses.
- Ensures the development, proper use, protection, and conservation of water resources.
- Develops and improves the environment and living conditions in the valley.

- Plans, designs, and constructs road networks, including highways and village and farm roads.
- Develops tourism in the valley. This involves delineating areas that can be developed for tourism and building recreational facilities ***on these sites*** for such use.
- Develops the social status of the valley's inhabitants. This includes establishing private local institutions to help residents contribute to the valley's development and achieve the JVA's project objectives.

WATER RIGHTS IN JORDAN

Definition and Jurisdiction

Water rights in Jordan are defined as the reasonable and equitable share of water the state can supply its citizens for drinking, agriculture, industry, and all other uses. From a policy and planning framework, the use of water for domestic purposes is given priority over other uses, followed by agricultural and industrial uses. All water resources in Jordan are state (publicly) owned. The law prohibits the sale of water from any sources without approval from the ***Jordan Valley Authority (JVA)***.

The ***JVA*** owns the land within the Jordan Valley and has the right to reallocate water rights due to water shortages or to promote certain conservation measures. However, the rights of use of the land and water are granted to farmers for life and can be bequeathed to the farmers' heirs.

The Water Authority of Jordan (WAJ) is authorized to purchase, acquire, or lease properties, land, related easement rights, and water rights required for its various projects. The WAJ also is responsible for sequestering areas it deems necessary for construction of WAJ water and sewerage networks and related buildings.

Water Rights Laws

The following briefly outlines the laws relevant to water rights in Jordan. Chapter 6 presents a more complete description of these and other rulings.

Disputes

To deal with disputes regarding water rights, Law No. 18, the Water Authority Law of 1988, states that if any disputes occur between the state and landlords concerning the amount of compensation to be paid against the acquisition of properties, land, and related rights, or the rights of water projects and public sewerage, either party may appeal to the court to specify the amount. The parties may also agree to refer the case to arbitration.

Irrigation Rights

Water rights for irrigation may be classified under two main categories: traditional water rights, and institutional water rights after land development by the government.

Traditional, or customary, water rights in Jordan originally were established by farmers based on the base flow and springs for lands that were served by water resources not used for public development.[19] In 1946, Law No. 38 required that traditional water rights be granted by the Department of Lands and Survey (see Chapter 6). This law linked water rights with land area. Under the law, the Department was to issue registration bonds to indicate water share (m^3/hour) per unit of land. Water rights acquired by both individuals and private sectors were to be documented.

About 5,500 ha of land are covered by traditional water rights. All water in excess of irrigation needs of the subject land becomes the property of the state. However, in some cases, certain land has no registration bond. Water rights for such land used to be allocated among individuals by "mutual consent" in the presence of an administrative leader. Examples of such land include Wadi Araba and Ghor al-Safi.

Institutional water rights in the Jordan Valley are governed by Law No. 19 of 1988, the Jordan Valley Authority Law. Under Law No. 19 and its predecessor, Law No. 14 of 1959, the JVA acquired all water rights in the Jordan Valley (see Chapter 6). Developed lands in the valley include areas for agricultural development under the administration of the JVA, with a total area of 60,000 ha.

Under Law No. 19, the JVA has eminent domain and the power to take over land and water resources for social and economic development purposes. The law stipulates the following:

> "Water acquired by means of projects constructed by the Authority (Jordan Valley Authority) that was not used or exploited in irrigation purposes in any area prior to the declaration of a water settlement in accordance with the Land and Water Settlement Law in effect shall be considered State property. Such water may be sold, leased or otherwise dispensed with as may be decided by the Authority."

The law also stipulates that the JVA has full authority regarding the allocation or usage of all surface water and groundwater developed under its supervision. With ministerial approval, the JVA can, within the Jordan Valley or the basins of the Jordan River tributaries, expropriate and acquire land, water shares, or both as necessary for its projects, and "any other benefits pertinent to land or water, either by absolute expropriation against compensation or by lease for any period it deems appropriate."

Law No. 19 of 1988 further stipulates that, "When the Authority constructs an irrigation project, it shall first consider the rights to water registered in the water Register, and any excess water shall be considered State property."

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[19]Traditional, or customary, water rights are created informally in a community as a means of establishing social structure. They are distinguished from formal, government-sanctioned rights or laws.

By the above legal provisions, land with registered water rights is included in JVA irrigation projects and will thus be irrigated. Savings in irrigation water are expected on JVA project land because the JVA irrigates more efficiently than did the previous, private users of the land. The water saved becomes state property and the JVA is entitled to dispense with it as it sees fit. Water rights owners are compensated financially for their water rights and are charged for the irrigation rights under the new project. Settlement of financial accounts is also provided for under the law.

The strategy the JVA uses to take over land, whether it be either irrigable or nonirrigable (hilly), is to divide the irrigable land (both previously unoccupied and newly developed) into small units (4 to 5 ha each) and offer them for sale to farmers. Each unit of land is given a share or "entitlement" for water resources. This means that there will be no separation between water and land and that the land is privately owned. The JVA issues documents of each share and the Department of Lands and Survey issues the registration bond that contains the land number and location without specifying the amount of water to be allocated. (The amount of water is left unspecified so as to enable the government to enforce cropping patterns according to fluctuations in the available water supply.)

Outside the Jordan Valley, the water rights on streams and springs are limited and are on the decrease because of the drying up of springs as a result of increased groundwater abstraction.

THE HISTORY OF WATER LAWS IN JORDAN, 1937-1993

The first water law enacted during the Mandate Period in Jordan was Law No. 17, of 1937 to preserve public water. Under this law, every water resources development project under the supervision of the government or municipality is considered a public project. Thus, no one is eligible to carry out either of the following acts without a license from the local governor within the region: (1) to dig a new well or pump water by any means; or (2) to make any changes to existing wells or pumping devices that may enlarge the diameter or depth of a well or discharge. A license to perform these acts includes the names and addresses of the people entitled to do so. In addition, the license includes a detailed description of the acts permitted, along with a map illustrating the specific locations at which they may be performed. Law No. 2 of 1938 was subsequently issued to authorize officials to investigate water resources for possible exploitation.

In 1946, several laws were issued for the purpose of regulating and monitoring water resources. One, Law No. 38, addressed water rights issues for the first time. This law mandated that water rights must be registered in the Department of Lands and Survey in a record called the Water Record. Law No. 38 also called for the establishment of a special court in which to resolve water disputes over irrigation projects. It gave priority to land with entitlements to water rights, and gave authority to water managers to ration water to farms in cases of water scarcity.

In 1949, Law No. 10 mandated the election of a water committee formed from landowners of irrigation projects. In 1951, Law No. 87 was enacted to settle disputes and receive complaints on water rights. It instituted a court of disputes settlements whose ruling is considered final. In 1952, Law No. 40, covering settlement of lands and water, was enacted. This law aimed to resolve all disputes and issues related to landownership and water rights. It gave authority to the

director of the Department of Lands and Survey to assign water shares for irrigation lands based on the area of irrigated land.

In 1959, Law No. 14 was issued to establish the East Ghor Valley Authority. This institution was in charge of planning, managing, and maintaining the East Ghor Canal project. It was also responsible for land reclamation, development, and land subdivisions. That same year, Law No. 51 created the Central Water Authority (CWA) to be responsible for all matters related to water in Jordan, excluding those under the auspices of the East Ghor Canal Authority (the administrative body that ran the canal project once the East Ghor Valley Authority established it). In 1966, under Law No. 37, the CWA became the Natural Resource Authority (NRA).

In 1973, the Drinking Water Corporation was established under Law No. 56. This institution was in charge of planning, designing, operating, and maintaining water projects for domestic purposes. It was also responsible for the use, purification, distribution, and sale of water.

The above laws have been subsumed under the following laws:

- No. 26 (1977), the code for monitoring underground water resources,
- No. 18 (1988), the Water Authority Law,
- No. 19 (1988), the Jordan Valley Authority Law, and
- No. 54 (1992), the Ministry of Water and Irrigation Bi-law.

The historical development of Jordan's water laws shows a trend toward more institutionalized water organizations. Public participation in legislation was not emphasized after the 1940s. Even current laws do not consider public involvement in policy formulation and the decision-making process.

OPPORTUNITIES AND CHALLENGES FOR WATER RIGHTS IN JORDAN

Meeting the Demand for Water

Based on the water budget in Jordan and projections of water supply and demand, studies indicate that demand to meet minimum household and industry needs and expected crop requirements exceeds supply, and that the gap between demand and supply is widening. It is expected that by the year 2010, the deficit will approximate 650 MCM annually. The amount of agricultural land in Jordan that needs irrigation also exceeds the amount of water available, and even more important, nonagricultural water users are rapidly increasing their demands. Accordingly, agriculture's share of total water resources will decrease.

Another concern is the depletion of aquifers that has occurred in recent years due to the overextraction of groundwater. To address this problem, which threatens the sustainable productivity of these aquifers, water management strategy has called for a lowering of the present levels of pumping from these aquifers by 100 MCM a year.

Historically, Jordan has adopted strategies to construct massive infrastructure projects, dams, and treatment plants. With the increasing cost of such investments, however, policymakers are now considering how to promote efficient use of water resources by managing water supply and demand, and enhancing water supply through the following strategies:

- Institutional reform: The Ministry of Water and Irrigation (MWI) is planning to restructure its operating bodies, the Water Authority of Jordan and the Jordan Valley Authority. The rationale for this endeavor is to enhance efficiency, communication, and responsiveness to the pressing needs of water resources management.
- Efficient management of water resources: Attention is being paid to a variety of measures that will promote a more efficient use of water resources. These measures include analyzing the current conveyance system and on-farm efficiency, adopting new water pricing policies that encourage conservation, using technology to recycle wastewater, using management and optimization techniques that reduce water supply system losses, improving irrigation efficiencies and crop yield, using treated water for irrigation and in industries, and improving water use efficiency in households.
- Restoration of Jordanian water rights from the Jordan River.
- The use of artificial water recharge, and further studies on developing new resources.
- Importation of water from the Euphrates.
- Other strategies, including unconventional water resources development such as water harvesting, desalination of brackish water, and cloud seeding.

Potential for Tradable Water Rights

While the use of efficiency pricing to influence the allocation of water has received prominent attention, very little notice has been given to the potential for markets in tradable water rights. This oversight reflects some policymakers' distrust of market mechanisms. Policymakers have in the past expressed strong reservations regarding market decisions on intersectoral transfers because of the importance of water to the Jordanian economy.

The concerns of Jordan's policymakers and analysts regarding water markets are similar to those expressed by officials in other countries. Many say that, given the significance of water to life and security in the region, water is simply too important to be given over to free-market forces. It is also argued that if supply and demand were the only forces that governed the allocation of water, these two mechanisms could eliminate diversified agriculture and drive out small farmers in the competition for scarce water. However, other market analysts note that water markets could instead encourage the use of a variety of water-saving crops that are more appropriate to the agroclimatic environment of Jordan.

Another reason why a free-market system may be politically problematical in Jordan is that it is difficult to justify why current users should have the right to initiate sales of such water,

considering the problem of ensuring intergenerational equity. Some say water use policy is not best achieved by deeming water or water rights to be a commodity.

Given these reservations about a full market approach to water allocation, an appropriate approach in the short to medium term might be a combination of integrated water resources planning with market incentives to induce water users to consider the true opportunity costs and social value of water.

The study team found some challenges or uncertainties in achieving tradable water rights in Jordan. First, the weakness of existing organizations prevents farmers and other water users from exerting effective pressure on the government to bring about favorable changes in policy and services provided. Strengthening farmers' organizations or establishing decentralized irrigation districts could significantly overcome this constraint. Second, many farmers, especially those in the highlands and southern Ghors, belong to no organization at all, and therefore lack the means to lobby for their interests. This problem is exacerbated by the fact that all other stakeholders in the agricultural sector are organized. Third, the absence or weakness of farmers' organizations compromises farmers' ability to participate in the policy decision-making process as well as in the management of important aspects of production, such as cropping patterns that are consistent with the size and type of demand for various commodities. Absent or weak farmers' groups also hurt farmers' chances of gaining a voice in the planning and resource allocation process for services provided to their subsector.

Despite these concerns and challenges, there appears to be a new openness to considering market-type solutions, and policymakers interviewed indicated that research to assess the conditions and regulations that would govern intersectoral water transfers in Jordan would be valuable. The increased openness to market approaches is at least partly a result of the failure of government intervention to address the incentives that determine how farmers and irrigators allocate their scarce resources. Two programs that were particularly ineffective were the enforcement of certain cropping patterns for some vegetables in 1985-1986, and the promotion of cereal production in 1986.

In 1985-1986, the Ministry of Agriculture decided to limit the area cropped with tomatoes, eggplant, cucumbers, and squash. The objectives of this program were to ration supply, increase the price of targeted vegetables, and promote production of certain vegetables, such as potatoes and onions, that were in short supply in domestic markets. The program was partially terminated in 1989 and totally abandoned in 1990. The area planted with the targeted vegetables, especially tomatoes, was reduced by 15 to 25 percent during the years of the plan's enforcement, but the prices of these vegetables did not increase. In addition, the area of promoted vegetables did not substantially increase. In fact, production of potatoes and onions increased when the program was terminated.

In 1986, the Jordanian government decided to lease lands in Disi and Mudawara, an area known to have rich soil and good-quality groundwater resources. The land, together with approved licenses to drill wells, was leased for 25 years to private sector companies at nominal rents, with the condition that they grow wheat and barley and sell it to the government at predetermined and promotional prices. The area cropped with cereals in this scheme increased in the first three years of operation but stabilized at about 4,000 ha after 1989. Although the prices given to companies

prior to 1989 were acceptable, they were not viewed so favorably after 1989, when the Jordanian dinar was devalued by about 50 percent against hard currencies. The overall objective of the government's cereal production plan was to reduce cereal imports, mainly wheat imports, but production was insubstantial, never exceeding 5 percent of the amount of wheat imported.

In both of the above cases, the fundamental incentives governing farmer resource allocation were not addressed, including the problem of highly subsidized water prices, which induce farmers to grow crops that use too much water relative to the true scarcity value of water. Problems with these types of nonmarket-based policies have increased the willingness of policymakers to consider price policy reforms, including reductions in subsidies and the introduction of market incentives.

LESSONS LEARNED FROM CHILE, MEXICO, AND CALIFORNIA

Policy Considerations

Before analyzing lessons the team learned regarding tradable water rights in Chile, Mexico, and California, a number of basic considerations should be outlined. First, the ultimate objectives of water policies are to be viewed at a societal level as opposed to an individual level. A key goal of public policy is therefore to establish incentives so that private choices are consistent with social welfare. Water policies must combine integrated planning with the provision of appropriate incentives for individual decisions. Second, constraints on social choice are not only economic but are also influenced by social norms that may not be subjected to conventional economic analysis. Third, time considerations are of central importance to the analytical frameworks employed. This implies that future water policy research must address dynamic and intergenerational resource allocation issues. Finally, the severe water scarcity in Jordan necessitates special consideration of political and socioeconomic factors for policy formulation regarding water rights. This fact stresses the need for interdisciplinary research in water policy and planning.

General Lessons from Chile

Based on its review of a case study of Chile, the study team learned that in shifting from a regulated system of water rights to a private, market-oriented one, sufficient time should be allowed for a transition period. This time will be needed to recognize the existing users of state-owned water, to issue public notices, and to inform other prospective applicants about the request for water rights and objection procedures. Moreover, time will be required to settle disputes of people who claim their rights to the same water. This means that appropriate water institutions should be structured to carry out these functions. Additionally, criteria for rights of use must be defined by law and by the implementing regulations of the water authority. Public bidding was a mechanism used to establish some rights of water use in Chile, but customary rights were dominant.

Under Chile's market-oriented system, underground water resources are governed by special regulations to avoid overexploitation or depletion and deterioration. For example, the country's

water authority is permitted to establish a temporary and proportional r 'uction of the rights of use at the request of one or more of the affected par'

Even in a private water rights system, third-party rights should be considered in water allocations. In Chile, any transfer of the rights of use of natural watercourses requires prior authorization to ensure the absence of third-party effects. Market mechanisms are still allowed to operate efficiently, but third-party effects and externalities require government regulation and possibly direct intervention in cases of misuse of water or to declare drought zones during extraordinary dry periods.

Other key features of the Chilean legislation are the establishment of user associations in cases in which two or more persons hold the right to use water from the same source; privatization of water and city services through the sale of shares of government-owned services to the public, municipalities, and private companies; and subsidization of the tariff on urban water to low-income sectors through supply of a certain monthly free quantity of water. One of the most important achievements of Chile's water policy is its social impact, through removal of subsidies to relatively wealthy water users, and the provision of better and cheaper water service to the poor.

General Lessons from Mexico

Reform and implementation of the water law in Mexico to assign private, tradable water rights is at very early stage, so it is difficult to draw general conclusions from the Mexico case study the team reviewed. Early indications, however, are that decentralized Mexican institutions involved in market-like exchanges of water rights have proven more efficient than centralized institutions.

In Mexico, the government water institutions may be evolving to play the role of "brokers" in water trades, particularly in intersectoral trades. This process may result in market-like institutions that also protect third-party interests. In addition, establishment of water user associations for the operation and maintenance of irrigation facilities may be essential to the development of Mexico's water rights market.

General Lessons from California

The idea of "emergency allocation" through markets, which has been applied in California, may be a promising option for Jordan to satisfy water demands during dry seasons. However, appropriate institutional mechanisms and legal guidelines must be devised to apply this approach.

Based on California's experience, tiered water pricing is likely to be a reasonable policy for Jordan to adopt to encourage farmers to reduce their water use and thus increase agriculture's water use efficiency. In some areas of California, the tiered system means that farmers pay for water at two price levels. At the base rate, they receive an amount of water that corresponds to 90 percent of historical applications for specific crops. Above that level, they are charged at a much higher rate.

As California's system shows, a critical factor for the success of any water resources development program is the real involvement of all users of water resources in a region. This implies that the planning and implementation of water programs, plans, and policies must be viewed as a public activity, involving the widespread participation of all interested parties. This necessary condition requires institutional structures conducive to public concerns.

Based on its review of California's experience with water rights, the study team realized that the American water rights system serves to underscore that water rights are actually tangible, vested in individuals, and subject to change and verification through permits and litigation. This implies that individuals have active and long-term interests in water supplies that are supported through due process.

California's "special districts" are legal entities that have autonomy and a financial base, which permits them to hire staff who are accountable to members and enables them to undertake capital investments. These features of autonomy and accountability are not reflected in water institutions in most developing countries.

Emphasis on integrated planning of water resources development and conjunctive use (surface and underground water) is critical for developing countries. This requires consideration of all potential water uses and their environmental impacts, including use to preserve natural habitats.

Applying in Jordan Lessons Learned Elsewhere

The lessons learned from experiences in Chile, Mexico, and California, and their adequacy and reasonableness depend on the social and economic contexts, norms, and evolution of institutional structures that support them. Nevertheless, many lessons can be learned from other countries. The important question, however, is "How can these lessons be applied to Jordan?" It is worth mentioning that implementation of water rights in Jordan will be an incremental process that entails social learning on the part of both the public and policymakers. The following discussion attempts to uncover the possible mechanisms, actions, and policies Jordan could undertake to examine tradable water rights. The requirements and conditions for applying lessons learned to Jordan may be grouped in four main categories: economic policies, institutional restructuring, legal reform, and government intervention.

Economic Policies

Tiered water pricing in agriculture should be applied on a pilot basis in Jordan in order to measure the effectiveness and efficiency of such a policy. The rationale behind tiered pricing is optimizing water consumption. Raising prices, however, must be accompanied by better services to farmers (to increase productivity) and better marketing. Any new pricing policy should also consider the centrality of irrigated agriculture in Jordan. In 1990, the share of Jordan's plant products increased to a record high 78 percent of the total added value of the country's agricultural products. The added value of plant products in 1990 was also a record high 141 million JD in current prices and exchange rates. Irrigated agriculture, which represented about one-fourth (24 to 27 percent) of the total area cultivated in Jordan, accounted for 82 percent and

79 percent of the total value of Jordan's plant products in 1989 and 1990, respectively. This means that irrigated agriculture contributed 62 percent of the agricultural sector's total added value in 1990.

Because of the importance of water in Jordan for both agricultural and nonagricultural purposes, application of any innovative water pricing policies should be examined initially on a pilot basis. Evaluation of the impact of efficiency pricing on water allocation, conservation, and efficiency of use could then be used to assess the potential for further gains in efficiency through privatization of water use rights.

Institutional Restructuring

In order to achieve the efficient planning, implementation, and operation of water resources development in Jordan, sound institutional designs are required. This task requires outlining clear directives, responsibilities, and roles. Moreover, the designs must ensure both accountability and access to information.

The concept of water user associations should initially be applied in Jordan for some public wells (desert projects, for example). The government may change the ownership of the wells from public to private hands under the management of a local water user association. Doing so will help to evaluate the possibilities, challenges, and constraints such a policy presents. Moreover, success on a microscale level will give confidence to both members of the public and policymakers to generalize such policies. Similarly, privatization of some underground resources may lead to institutional change at the macro (city, regional, and national) level. It is interesting to note that the last decade witnessed a hot debate about privatization of some public institutions, including airlines and communications entities, so this type of reform should receive considerable support from many Jordanian policymakers.

Another institutional arrangement that warrants some research is the idea of a special district, as discussed in California's case. This district would have its own economic independence and legal authority. The idea of a special district can be applied to areas in the vicinity of water treatment plants where wastewater can be used nearby for irrigation.

Legal Reform

Jordan's future water legislation must deal with externalities, disputes, and third-party effects. Moreover, water laws must address private ownership transfers and criteria for allocating rights of use. The specific implications of water rights and their tradability must also be covered by laws, and rules and guidelines for permits and litigation should be defined. An overall review of Jordan's water laws is essential for better management of the country's water resources and to ensure public input and feedback mechanisms.

Government Intervention

Markets and governments can complement each other to achieve both efficiency and equity. As noted above, the government may intervene to achieve some equity measures, such as to issue special regulations to preserve underground water resources, to control misuse of water, and to protect the environment. Additionally, subsidies for low-income users may be needed to help some people.

An example of how both markets and governments could play a role in water conservation in Jordan would be to lift the ban on banana imports. Such a policy would increase supply while decreasing prices, and compel farmers (especially if the water price were increased) to diversify their crops and explore other options.

CONCEPTUAL FRAMEWORK TO ADDRESS WATER ISSUES IN JORDAN

Based on the study team's interviews with public officials, policymakers, consultants, and users, it became clear that four areas of water resources development in Jordan must be addressed in the future: water legislation, institutional reform, data collection and processing, and research (see Figure 2). To elaborate on these issues, the measures outlined below should be taken.

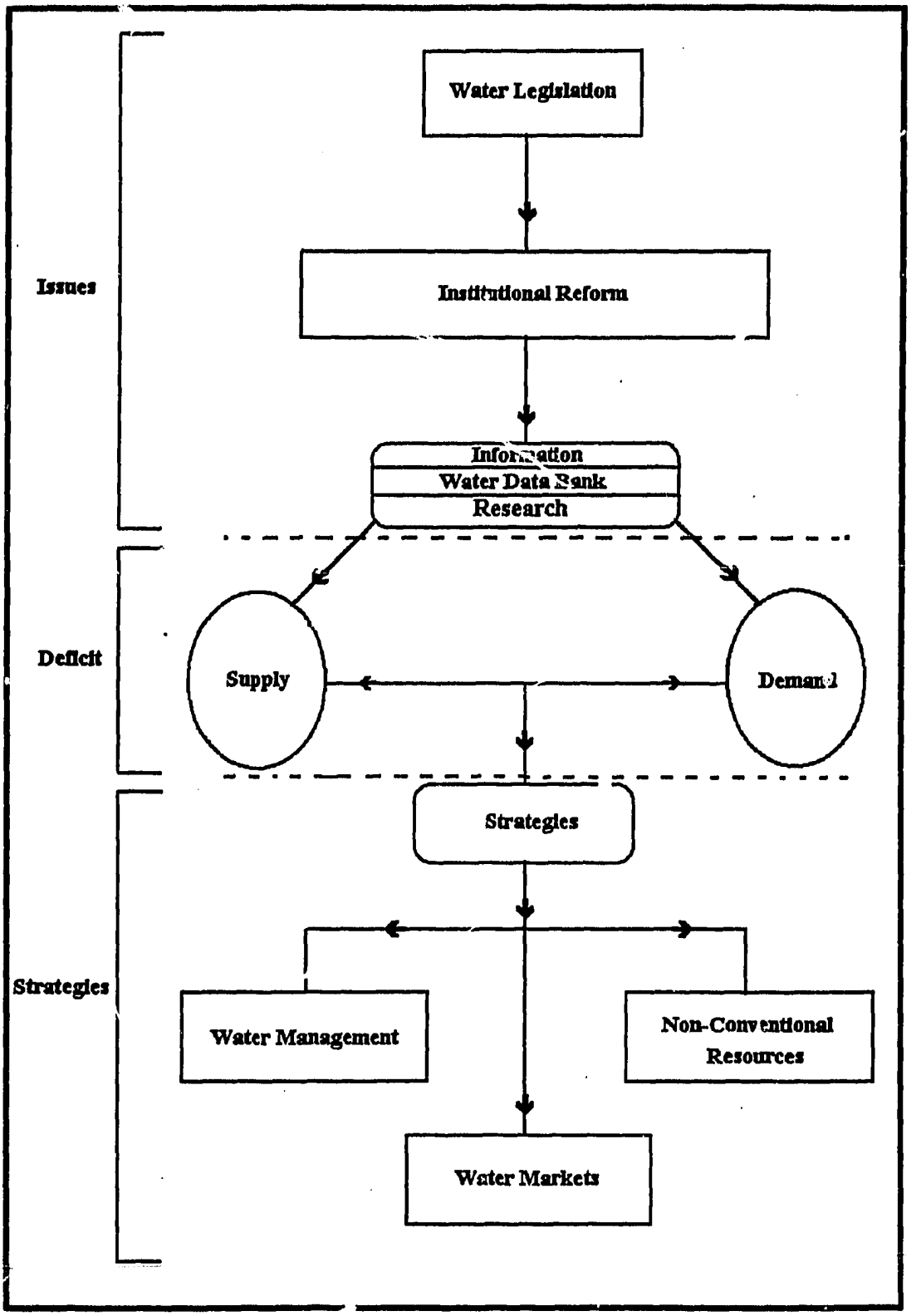
Water Legislation

Based on the historical development of Jordan's water laws, the team found that water legislation evolved from basic rules to decentralized institutions. There exists no explicit consideration of public involvement at the local level, nor any elected community groups to oversee shared water sources. Current laws also neglect to address the interrelationships between surface water and groundwater resources, and they fail to distinguish between renewable and nonrenewable water resources. Moreover, water rights and pricing are not addressed extensively.

Institutional Reform

Some of the fundamental problems with Jordan's existing water institutions include the overlapping of responsibilities among related water organizations, a lack of accountability and access, and the lack of efficient local organizations. For instance, among the 14 public institutions whose responsibilities are related to agriculture, the most critical overlap exists between the Ministry of Water and Irrigation (MWI) and the Ministry of Agriculture. Both ministries provide services important to agriculture, but the lines of responsibility of each institution are blurred. As a result, the scope, quality, and adequacy of some services remain unsatisfactory.

Figure 2: Conceptual Framework



Data Collection and Processing

The credibility of data on Jordan's water resources is a critical issue that must be resolved in a comprehensive manner. One of the MWI's goals is to establish a data bank and information system to address this problem. Achieving this goal will help in policymakers' decision-making process.

Research

Further research on long-term water resource strategies for Jordan is essential for development of appropriate policies. Such research should examine alternative water allocation mechanisms, including different combinations of integrated water planning and market-type allocation. Research could examine the potential social and economic gains from water allocation reform, identify appropriate water institutions for Jordan, and assess the conditions for successful reform. As noted above, action-oriented research, which would examine pilot experiments in efficiency pricing of water, might promise particularly high ***payoffs. Long-term water resource strategies include desalination of seawater and brackish water, importation of water, and examination of tradable water rights and water markets.***

Jordan must also consider short-term water resource strategies. Short-term strategies must also be considered. These deal with water management, and the use of conventional and unconventional resources and management and optimization techniques. Short-term strategies include the development of groundwater resources and the construction of storage facilities. They also include the development of groundwater recharge, use of brackish water, harvesting of rain, cloud seeding, and restoration of Jordan's water rights from the Jordan River.

CONCLUSIONS

Based on interviews with various policymakers and members of the public, and in light of lessons learned in Chile, Mexico, and California, the team offers the following conclusions concerning water rights in Jordan:

(1) Policymakers interviewed say that dealing with future water scarcity in Jordan will be achieved through water management and the use of both conventional and unconventional sources.

(2) The team learned many helpful lessons from the Chile, Mexico, and California case studies with regard to water markets. However, some fundamental challenges remain for Jordan in terms of water legislation, institutional structure, and data collection and credibility. These must be addressed carefully if water markets are to be adopted in Jordan in the future.

(3) Policymakers in Jordan have expressed strong reservations about market decisions on intersectoral water transfers because of the importance of water to the Jordanian economy. However, many interviewed also showed an interest in research to assess under what conditions and with what type of government oversight such transfers could lead to more efficient water use.

(4) Market mechanisms should be introduced on at least a pilot basis in terms of new pricing policies that would provide incentives to economize water use and cover operation and maintenance costs and some capital costs. This action cannot be carried out, however, unless efficient management of water resources at all levels is adopted.

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