WATER CONFLICT AND GOVERNANCE IN THE RIO BRAVO BASIN

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Abstract

As the result of a drought and decades of urban growth in the Río Bravo/Rio Grande basin, the distribution of scarce water resources among competing uses has escalated into an international and intranational conflict for Mexico. This conflict comes at a time when Mexico has officially adopted policies aimed at fostering a more transparent, participatory and decentralized approach to water management. After providing an introduction to the factors behind the current conflict, this article describes Mexican water governance and policy options that it provides for addressing the conflict. Particular attention is given to water pricing, quotas, and markets as tools for reducing demand for irrigation water.

1 INTRODUCTION

Clean freshwater is vital for human survival, economic development, and ecosystem health. The need for water induces competing users and nations to devise water regimes regulating use. Once established, cooperative water regimes generally prove resilient (Wolf and Hamner 1998). Tensions, however, may arise as the water context changes. Basins with natural fluctuations in availability are particularly likely sites of tension because allocation among users has significant economic, ecological, and social impacts. The Río Bravo (as known in Mexico, the Rio Grande in the United States) basin has a high degree of natural fluctuation in water availability. Periods of water scarcity in the basin are problematic because the Río Bravo is a binational boundary river with numerous cities and agricultural users in both countries (Figure 1).

Figure 1. Map of the Río Bravo/Rio Grande Basin

Source: Adapted from *The New York Times* [online]. Available at: http://www.nytimes.com/imagepages/2002/05/23/international/24wate.graphic.html

The Río Bravo basin's ongoing ten-year drought has heightened the rivalry among water users. The conflict derives from a combination of factors in addition to natural supply variability, such

as growing urban demand and continuing demands of the natural environment and agriculture. This conflict comes at a time when Mexico has officially adopted policies aimed at fostering more transparent, participatory and decentralized water management. This article describes Mexican water governance and policy options that it provides for addressing the conflict. In particular it discusses what tools are available for reducing irrigation water demand. This article is the result of exploratory research that consisted of an extensive literature review, interviews with Mexican stakeholders, and fieldwork in the Río Conchos basin conducted during the late summer and fall of 2002.

2 PART I: Mexico's International and Intranational Water Conflict

Mexico's Water Debt to the United States

Since 1944, the Río Bravo River, where it separates Mexico from the United States, has been peacefully managed under a "Treaty relating to the utilization of waters of the Colorado and Tijuana Rivers and of the Rio Grande, and supplementary protocol" that regulates minimum flows from tributaries.[ii] Historically, the Río Conchos, an upper-basin tributary, provided the majority of Mexico's treaty-required contribution to the Río Bravo.

The flow reaching the Río Bravo from the Río Conchos has significantly decreased during the current drought that began in 1993. Basin precipitation is extremely temporally variable, with a severe drought of more than a year occurring every five years (HARC 2000). The reduced Río Conchos flow has contributed to Mexico accruing a water debt to the United States under the 1944 treaty. Specifically, as of early 2003, Mexico owed the United States approximately 1.5 million acre-feet because its tributaries did not contribute to the Río Bravo the minimum 432 million cubic meters (350,000 acre-feet) annually during the treaty's last five-year cycle.[iii]

The drought is not only creating a legal problem with the United States, but also severe water shortages in the lower basin. Water supplies for the lower basin are strained not only because of the reduced flows of the Río Conchos, but also because of the reduced precipitation in the Río Bravo's water catchments downstream of the Río Conchos. The shortage has reached such critical levels that the *Comisión Nacional del Agua* (CNA, National Water Commission) has allocated no water to some lower basin irrigation districts during some growing seasons, thereby forcing a shift to less-profitable dry-land crops. Reduced flows have also harmed the river ecosystem and riparian habitats of the Río Bravo.

Drought is only one factor behind the current competition for water. Regional demand for water has grown significantly since the 1950s when the basin's last lengthy drought occurred. In the 1980s and 1990s, the basin's Mexican population grew substantially with an overall average annual growth rate of 3.1% in the 1980s and 4.5% in the 1990s (Peach and Williams 2000, 59). A number of forces, especially the rapid expansion of the *maquiladora* industry, pushed this growth.[iv] The population in the U.S. portion of the basin also increased as the basin's economy expanded beyond agriculture to include industry and services. The preexisting agricultural base still depends heavily on irrigation (particularly in the semi-arid upper basin that includes the Río Conchos). In the Mexican portion of the Río Bravo basin, 87% of all consumed water irrigates 726,750 hectares (CNA, 1999). Ten irrigation districts (ID, *distritos de riego*) cultivate 458,200 hectares with 2,333 Mm^3 of water extracted annually.[v] The natural variability of available water, a strong demand for domestic and industrial water, and continued agricultural water demand indicate that water scarcity will be a recurring problem in the basin.

International and Intranational Water Conflict

A distinguishing factor among the conflict's actors is their views on managing the Río Conchos reservoirs. Users of the Río Bravo, both in Texas and Mexico, downstream of the Río Conchos argue that these reservoirs should release water to the Río Bravo, even during

a drought. The U.S. Section of the International Boundary and Water Commission, the federal entity responsible for enforcing the 1944 treaty, has urged that the operation of Mexico's tributary reservoirs be targeted to meet the annual U.S. allotment under the 1944 treaty. The Mexican government's management of the Río Conchos reservoirs during recent years illustrates its position that the 1944 treaty permits these reservoirs to be operated first to meet water demands in the Conchos basin and then second to satisfy its treaty requirements. Under this management scheme, flows reaching the Río Bravo are generally limited to releases of floodwaters that are in excess of the reservoirs' storage capacities after the Conchos basin's demands have been met. In most years prior to the 1990s, these releases exceeded Mexico's minimum required allotment under the 1944 treaty.

Recently U.S. interests and Mexican irrigators in the lower Río Bravo basin have contested this management policy. Reductions in water available to U.S. irrigators result in quick negative reactions because U.S. irrigators' Río Bravo allocation is already over-appropriated, i.e. allocated water rights exceed the amount of water routinely available. Water supplies for the Mexican basin states are not regulated by interstate compacts. Water allocation decisions during drought are determined almost solely by CNA. Table 1 shows the quantities available for irrigation in four Mexican irrigation districts—two Conchos basin districts (Delicias and Lower Río Conchos) and two lower basin districts (Lower Río Bravo and Lower Río San Juan).[vi] Water provided to three of the irrigation districts has dropped from historic values, with the lower basin districts experiencing a 64% reduction, on average, with some years being more extreme than others. Table 1 includes data for the 1996 and 1997 agricultural years because they illustrate the severity of the drought on water availability during particularly dry years and the variability of availability among districts.

Table 1. Impacts of Drought on Four Irrigation Districts in the Rio Bravo Basin

	Delicias	Lower R. Conchos	Lower R. Bravo	Lower R. San Juan
Avg. Total Production Area 1997-2000 (hectares)	49,980	6,244	185,543	44,624
Avg. Total Prod. Area before 1992	92,679	5,174	236,656	74,743
% change in Prod Area	-46	+21	-22	-40
Irrigated Area 1997-2000	49,980	6,244	113,550	43,396
Irrigated Area before 1992	92,679	5,174	191,261	70,473
% change in Irrigated Area	-46	+21	-41	-38
% change in Depth of Irrigation	+8	-2	-35	-41
Avg. Water Used 1997-2000 (Mm^3)	857	118	325	149
Avg. Water Used before 1992 (Mm^3)	1,462	100	899	414
% change in Water Used	-41	+17	-64	-64
% change in Volume of 1996 Flow from Historic	-78	-47	-90	-94
% change in Volume of 1997 Flow from Historic	-10	+3	-76	-64

Source: Data adapted from IBWC 2002.

3 PART II: WATER GOVERNANCE IN MEXICO

Beginning in 2002, investments in technologies to modernize irrigation constitute the main thrust of the two governments' response to the conflict.[vii] The Mexican federal government has shown interest in also using other tools to confront the basin's water problems, such as water prices and water markets (CNA 1999; Kelly, Solís, and Kourous 2001). Part II of this paper introduces current water governance in Mexico, while Part III identifies available policy options to reduce the competition for water in the basin.

Before the 1990s, Mexico's water resources were administered exclusively by the federal government through a vertical decision-making structure that placed little weight on environmental impacts and public participation. During the 1990s, the Mexican

government worked to modernize water governance. Its actions can be broadly categorized as trying (1) to expand decentralization and public participation and (2) to apply "user pays" principles and market instruments.

Decentralization and Public Participation

Article 27 of the Mexican Constitution establishes water resources as public property under the federal government's control. In 1989, CNA was created as the country's sole federal water authority. CNA has implemented an overarching policy of decentralization based on a belief that management at the lowest appropriate level has the potential for improved incentives for harnessing and conserving water. Two decentralization efforts particularly important for the Río Bravo basin are the transfer of operations of federal irrigation districts to user groups and the establishment of basin councils (*consejos de cuenca*).

Irrigation districts. A principal objective for decentralizing CNA's agricultural water responsibilities is the conversion of irrigation user associations into financially independent organisms that responsibly manage the water resources assigned them. For decades, the Mexican federal government owned and operated irrigation districts under policies aimed at rural and regional development and food security. Beginning in the late 1920s, the government invested extensively in the construction of irrigation districts, particularly in Northern Mexico. In the 1960s, large–scale reclamation and rehabilitation projects were undertaken to increase agricultural productivity. Despite federal subsidies covering 75% of the operational expenses, irrigation districts fell into disrepair, reaching a critical point in the 1980s (Johnson 1997). Beginning in 1988, the federal government laid the groundwork for transferring irrigation districts to federations of user associations. This transfer has been deemed largely successful.[viii] All system operations and maintenance responsibilities in the Río Bravo basin have been transferred to user associations. Nevertheless, CNA continues a dominant role in the irrigation sector because it remains responsible for allocating available supply and managing the hydraulic infrastructure beyond the districts' boundaries.

Basin Councils. Basin councils were created to develop integrated resource management by coordinating the three levels of government (federal, state, and municipal) and the diverse interests of water users, including irrigators, and other stakeholders. These councils are intended as forums to diagnose, analyze, and prioritize problems. Their mandate challenges them to pursue solutions that account for environmental as well as human values and respond to the interconnectedness of surface and groundwater. The 26 basin councils across the country largely remain in the early stages of initiation and definition. The Río Bravo council and related Río Conchos committee were officially established in January 1999 (CNA 2002, 72-75). The Río Bravo council has yet to play an active role in water management. After 70 years of centralized decision-making, to be successful these councils may require considerable investments in strengthening the capacities of involved actors, developing clear roles and responsibilities, and defining mechanisms for implementation and enforcement of decisions. Because most councils are not yet actively functioning, CNA continues to make decisions largely unilaterally and without significant public debate. The lack of transparency in CNA's processes and the paucity of information available to the councils and civil society have reduced CNA's perceived legitimacy for many stakeholders.

User Pays Principles and Market Instruments

For more than a decade, Mexican water law has included provisions for charging for obtaining water rights, abstracting water, and discharging wastewater. Although agriculture is by far the largest water user in the country, agricultural uses are exempted from these charges and receive other subsidies, such as reduced electricity rates for

pumping. For this reason, some are questioning how agricultural water fees could alter demand and raise revenue for investments in improved agricultural water technologies.

Others propose water markets as a mechanism for transferring water from agriculture to urban consumers. As a first step in promoting a water market, the 1992 National Water Law required that all public users register for a concession in a Water Rights Public Registry (*Registro Público de Derechos de Agua*). CNA assigned these concessions largely unilaterally. Unfortunately through the registration process, many illegal or tolerated water users became legal tenants of water concessions (Mestre 2001, 16). As a result of this registry process, many basins such as the Río Bravo are now over-appropriated, which becomes particularly problematic during droughts. Mexico does not have a system of prior appropriations. The 1992 water law gives the federal government broad discretion to impose water use restrictions and allocations in areas of shortage.[ix] All users may have their allocations reduced during shortages, but domestic uses are given priority.

Every year the CNA determines the quantity of water available in each basin and sub-basin. Using information on the registered concessions, CNA determines if there is enough water to meet the full concession amounts or if reduced quantities are necessary. Surface water concessions provide holders with a right to a *proportion* of the basin's available surface water. Concessions are written for an *average* quantity and are in force for 5 to 50 years. For a given year, the allotment for each irrigation district is determined by the anticipated water supply for that agricultural year. This flexibility in the annual allocation of water is useful during shortages, but cannot be used to address growing competition for limited water resources as urban demands expand in an over-concessioned basin.

Provisions of the 1992 National Water Law permit the temporary or permanent transfer of water concessions. To date, the quantity of water transferred has remained low. Most transfers occur among members of subunits of irrigation districts called modules. In irrigation districts, concessions are communally held. Generally, the district's water is allocated proportional to the size of the user's plot. In times of water scarcity, module managers may distribute water with an emphasis on equity among users. Large landholders may receive sufficient water to irrigate only a proportion of their land holdings rather than a land-based proportional amount of the available supply.

This exploratory research revealed that in recent years within Río Bravo irrigation districts transfers were generally temporary and represented 5-10% of the total water quantity allocated to the district, with smaller irrigators selling to larger landholders. The transfer price is negotiated directly between buyer and seller with some transactions facilitated by module managers. These transactions are considered simple transfers that occur between known individuals and do not represent a mature water market. Field research in the Delicias irrigation district revealed that the annual quantity assigned each concession has been as high as 72,000 m^3 in high availability years. In 2001, when concessions were for only 27,000 m^3, water was being sold within modules for between 5,000 and 6,000 pesos (i.e., between 185 and 222 pesos per 1,000 m^3, the exchange rate was approximately 1 peso for 0.09 to 0.1 U.S. dollars).

In conclusion, efforts to decentralize and expand public participation have been incomplete with CNA dominating most hydraulic infrastructure and water allocation decisions. The agricultural sector has been exempted from paying for its water use, but irrigation districts are responsible for the funding and operation of their systems. The registry of water concessions has helped clarify property rights; however, more work is needed to have a sound water rights framework. Until then, it is unlikely for a true water market to develop. What exists are some initial movements in that direction through simple transactions between known actors. The drought has fostered interest in these simple transfers and increased the appreciation of water as an

economic good. Current water governance provides opportunities for a more integrated approach to water resources management, such as the basin councils and economic instruments, that have to date been underexploited and are still under development.

4 PART III. POLICY OPTIONS FOR REDUCING IRRIGATION WATER DEMAND

As urban populations and industrial development grow, the challenges before Mexico are how to redistribute water toward the urban users and systematically reduce the amount normally used. The agricultural sector, as the largest water consumer in the country, has received much attention in the search for solutions. Part III considers tools to reduce irrigation water demand that use economic incentives that alter choice (prices and markets) and that restrict choice (quotas).[x] Selecting an option and defining its implementation is the responsibility of basin stakeholders (a likely forum being the basin council) because the available tools represent tradeoffs among the objectives of economic efficiency, equity, and sustainability. Judgments are also necessary on allocating water to ecological and in-stream uses and addressing indirect impacts, return flows, and intrinsic values of the river and its ecosystem (Rogers, Bhatia, and Huber 1998, 10-14).

Increasing water prices is often mentioned as a means to decrease water demand because prices are low compared to the resource's scarcity value. Unlike domestic and industrial users in Mexico, irrigators do not pay for the right to use the nation's waters; collected fees are only for the operation and maintenance of irrigation systems. Analysis of data compiled during this exploratory research on Río Bravo irrigation districts found that the current operation and maintenance fees paid by irrigators represent 6-8%, on average, of the district's total revenue.

Can irrigation water pricing promote conservation in the Río Bravo basin? Research conducted by other researchers working in many countries provides insight. In most cases, an increase to the price level sufficient to induce conservation has been politically impossible to implement because it would have dramatically reduced small farmers' net income (de Fraiture and Perry 2002; Ray 2002; Perry 2001). Furthermore, fieldwork revealed that irrigators in the Río Bravo basin, most of who are competing directly with U.S. producers, worry that higher water use fees could make them uncompetitive. A less drastic price increase would probably not significantly decrease demand, because the short-term water demand curve for agriculture is highly inelastic at low water prices, especially when current water use is quantity-restricted as in the Río Bravo basin. A contributing factor to this inelasticity is that water is often a minor part of the overall crop budget, and a fraction of net revenue.[xi]

Risk remains a principal obstacle in the efficient use of water. Because of the potential reduction in crop yield if water deprived, irrigators often prefer to over water crops as long as the cost of the additional water is low. Price increases could accelerate adoption of more efficient irrigation technologies; however, other factors such as land quality, agricultural product prices, and the cost of the technology strongly influence these investment decisions (OECD 1999) as well as access to capital and farmer net income. Pricing to induce conservation does not appear to be a feasible option for the Río Bravo basin. However, charging irrigators for full cost recovery of system operation and maintenance and for system conservation projects is important to the sustainability of irrigation in Mexico as federal subsidies decrease and become increasingly uncertain.

Rationing water allotments through quotas forces conservation. Rationing forces the irrigator into a more efficient water use pattern, such as shifting to crops that require less water. For these reasons, volumetric quotas are recommended by some researchers as more effective mechanisms to achieve conservation than price increases (Ray 2002). This conservation, however, is achieved in a less economically efficient manner than through water pricing.

Quotas are attractive to water users because they are not required to make an out-of-pocket payment. For quotas to be successfully implemented, transparent and enforceable allocation rules are essential. CNA's reduced allotments to irrigation districts during the present drought functioned in many ways as a quota, but the establishment of the allotments lacked transparency.

Water markets, like pricing, are an often promoted reform (Briscoe 1997). Markets do not conserve water per se; markets *distribute* through trading water to more economically efficient uses (Hurlbut 1999). A prerequisite to a functioning water market is a clear framework and strict enforcement of water concessions. As previously described, Mexico made some advancements in defining water rights in the 1990s and allows for the temporary or permanent transfer of these rights. However, there remain many uncertainties regarding how water concessions will be applied and enforced in Mexico especially because of the over-allocation in some basins. For example, there are few precedents on how long-term water rights will be protected when numerous short-term trades are conducted.

Even when these issues are resolved, the question remains whether water markets can reduce agricultural water demand and redistribute water to urban consumers. In a case study of an active water markets in the U.S. portion of the Lower Rio Grande Valley, Hurlbut (1999) found that the water market, rather than promoting conservation by all users with the lure of being able to sell saved water, instead encouraged more water-intensive farming among some users, thereby causing reservoir levels to fall faster during droughts. The economic incentive to make long-term investments in more efficient irrigation was reduced by the ability to buy water during periods of scarcity. At the same time, there was a stronger economic push to plant high-profit (often water-intensive) crops. In the end, the market resulted in a more economically efficient use of water with many small farmers switching to dry-farming or fallowing or quitting altogether, but it was unsuccessful as a water conservation measure.

Promoting a water market in the Río Bravo basin would likely improve the economically efficient use of water. However, further research is needed to predict if a market would result in the redistribution of water from agriculture to urban users and if the market would exacerbate the perceived cost of drought. Moreover, the market would need careful construction to account for water loss and third-party impacts, particularly because the basin represents a large geographic area characterized by high evaporation rates. A promising area of policy research for the Río Bravo may be combining water markets with quotas. Together they might allow for reductions in water used for irrigation while also promoting the more economically efficient use of water without a potentially significant decline in farmer income.

5 PART IV. CONCLUDING REMARKS

Water distribution and the policy tools implemented to affect water use have significant social (including equity), economic, and ecological impacts. Past management of the basin's resources favored allocating water to Mexican agriculture as a means to promote rural development and food security for the nation. Subsequent urban and industrial growth and an extended drought have resulted in this allocation scheme contributing to an international and intranational water conflict for Mexico. Notwithstanding efforts to decentralize and open up decision-making, CNA continues to dominate management of the basin's water resources. In an integrated approach to water resources management that recognizes the human and natural processes at work in the basin, policy decisions are best made in a context defined by transparent and inclusive decision-making, where stakeholders select policy tools to reflect collectively defined objectives. The current framework of Mexican water governance allows for the application of a broader set of policy tools than the strictly technological solution currently being pursued. This article presented preliminary results of exploratory research on irrigation districts in the Río Bravo basin that aimed to identify policy tools—pricing, quotas,

and markets—that could potentially be used to reduce agricultural water demand. Of these, combining water markets with quotas appears to be the most promising for further research.

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[i] Nicole Carter is currently working for the Congressional Research Service (CRS) of the U.S. Library of Congress. This paper and the research supporting it are products of work that Dr. Carter performed while a professor at CIDE. The content does not necessarily represent the views of CRS or the Library of Congress. The contents are wholly the responsibility of Dr. Carter. Mireille Linares, Courtney Riggle, and Gustavo Mendoza performed supporting research.

[ii] Treaty signed at Washington February 3, 1944; entered into force November 8, 1945. 59 Stat. 1219; TS 994; 9 Bevans 1166; 3 UNTS 313. See United States Department of State, *Treaties in Force. A List of Treaties and Other International Agreements of the United States in Force on January 1, 2000. Bilateral Treaties and other Agreements: Mexico – United States*.

[iii] According to Article 4, paragraph B of the Treaty, the U.S. is entitled to one-third of the flow reaching the main channel of the Río Bravo from the Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers and the Las Vacas Arroyo. This third shall not be less, as an average amount in cycles of five consecutive years, than 350,000 acre-feet (432 million cubic meters) annually. In the event of extraordinary drought or serious accident to the hydraulic systems of the Mexican tributaries, any deficiencies existing at the end of the cycle shall be made up in the following cycle.

[iv] Maquiladoras are plants, largely owned by U.S. and Asian companies that conduct a variety of light manufacturing and product assembly operations. Mexico implemented the "Border Industrialization Program" in 1965, which granted its northern border region a special economic status that permitted the establishment of maquiladoras with special tax incentives. The economic growth resulting from the success of the program has not been accompanied by proportional investment in urban infrastructure or planning or consideration for natural resource constraints. To date there are more than 800 maquiladoras, employing 500,000 people, in the basin.

[v] The 2,156 irrigation units (*unidades de riego*) in the basin, which are distributed among 25 rural development districts, cultivate 277,450 hectares with 4,311 Mm^3 of water extracted annually (CNA, 1999). Irrigation units are generally more dispersed and smaller than irrigation districts. As a consequence, they typically rely heavily on groundwater wells and have less extensive distribution systems than the districts. Irrigation units have always been collective organizations managed by their users. The exploratory phase of the research program discussed in this paper focused on irrigation districts with the hope to investigate in future phases the water demand of irrigation units.

[vi] The two upper basin irrigation districts are in a semi-arid region where crops are not grown without irrigation. The two Lower Río Bravo districts are in a semi-tropical region where both irrigation and dry-land crops are farmed. With the reduction in irrigation water, many of the lower basin district farmers switched to less-profitable dry-land crops. Upper basin farmers reduced the irrigated acreage (Carter et. al, 2002, 290-292).

[vii] Investments in irrigation conservation technologies may produce primarily "dry" water savings at the basin-level. See Seckler 1996 for a discussion of wet and dry savings. When establishing policies based on these technologies, special attention should be given to avoid overestimating wet savings. This requires that the links between surface water, groundwater, and runoff be clearly understood. For example when applying these technologies in Delicias, Chihuahua, it is important to account for the technologies' impacts on aquifer recharge. The Delicias aquifer receives 20% of its recharge from irrigation water infiltration. The irrigation district, irrigation units, and communities in the area use the aquifer. Another area of concern is the impact on water quality of runoff and groundwater recharge due to the more intensive use of irrigation water.

[viii] As part of the preparation for the transfer, water charges for operation and maintenance in the districts were increased significantly, often by 400%. Although less subsidized than before, districts continue to be partially subsidized, with the districts in the Río Conchos basin receiving around 20% of their budgets from federal sources. For example in the Delicias district, the minimum fee for irrigators is 80 pesos per 1,000 m^3 and is expected to

increase to 100 pesos in the near future. Basing fees on the quantity of water delivered creates financial problems for the districts when water availability is low because the districts must maintain systems even when water is unavailable or restricted (Palacios V. 1999). Another financial problem for the districts is that Mexico's Treasury Department will not allow districts to maintain balances from one fiscal year to the next.

[ix] Use restrictions can also be imposed to protect or restore an ecosystem as well as to prevent overexploitation of aquifers, preserve potable water sources, and prevent contamination.

[x] Due to time and resource constraints, equally important policies that alter preferences and behavior (such as voluntary conservation and education) and the full range of policies that alter or restrict choices were not evaluated as part of this exploratory research. For example, removal of agricultural subsidies for water-inefficient crops is a policy tool that may reduce irrigation water demand that was not included in this research.

[xi] There are examples of other observed, but unanticipated results of water price increases. For example, price increases, combined with more efficient irrigation, have increased total water consumption in some basins (OECD 1999).