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The Use of Water Pricing as a Means for Enhancing Water Use Efficiency in Irrigation: Case Studies in Mexico and the United States

ABSTRACT

The role of water markets in enhancing irrigation water use efficiency is examined. Questions arise, however, concerning equity effects of water markets. A "middle ground" is discussed related to water rights transfers in the western U.S. where a "brokers" role for the BuRec is evolving. The result is a marketlike institution wherein gains in efficiency are achieved and third-party interests are protected. Mexico's concerns with equity implications of water transfers might easily be accommodated with this kind of institution.

INTRODUCTION

Persisting increases in the scarcity of water resources are a major concern in both the United States and Mexico. Growing water scarcity in the United States is manifested in a number of ways, but probably most clearly in the range and nature of increasing social conflicts concerning the manner in which water is allocated.

Interstate conflicts concerning water have sharpened over the last two decades necessitating, in some cases, the entry of the judiciary in the role of a water manager. Some view such conflicts as having the effect of reshaping the Doctrine of Prior Appropriation (first in use, first in right) which has been the cornerstone of water rights law in the western United States since the 1800s.¹ Further, conflicts between groups of water users, e.g., in rural and urban areas, as well as between users and nonusers (envi-

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1. See N. Johnson & C. DuMars, *A Survey of the Evolution of Western Water Law in Response to Changing Economic and Public Interest Demands*, 29 Nat. Res. J. 347 (1989).

ronmental groups) of water have become increasingly common in the western United States.

The demography and geography of Mexico is such that water scarcity has long been an issue of critical importance. More than half of Mexico's land lies in areas which receive less than 20 inches of rainfall each year, and more than 50 percent of the mean annual flow of all major Mexican rivers are in drainage areas that constitute but 10 percent of Mexico's total land area.² The relative scarcity of water in Mexico is being exacerbated by a persistent and rapid growth in population and concomitant needs for foodstuffs, along with dramatic increases in urban populations.

Opportunities for enhancing water supplies through new reclamation projects are limited in both the United States and Mexico. However, substantial opportunities exist in the two countries for easing the pressures of water scarcity by the elimination of waste and the enhancement of water use efficiency. Given that irrigation uses of water will typically account for some 85 percent or more of a region's total water use, interest in the enhanced efficiency of water use in irrigation is of particular importance in these regards.

Reflecting these concerns and opportunities, this paper has as its general theme the pricing of water resources as a means for enhancing the efficiency of water use in irrigation. Our interest in this theme is well-grounded in economic theory. It is well known that economically efficient patterns of resource use are obtained under conditions where (at the margin) the value earned by the resource in any given use equals its scarcity value (alternatively, opportunity cost or shadow value). In theory, these conditions are typically viewed as resulting via one of two resource allocation institutions.

The first is a decentralized institution wherein the resource is obtained by all users within a competitive market; competitive forces result in a market price which reflects the resources' relative scarcity—the market price is a scarcity value—and the value of the resources' marginal product is equated in all uses. The second is a centralized institution wherein the resource is controlled by some kind of a central manager who knows *a priori* the scarcity value of the resource. The manager, assumed to be motivated by the desire to maximize the sum of profits for all users, then either directly allocates water so as to equate value-marginal-product and the scarcity value of water or makes the resource available to users at a price which equals this scarcity value. In theory, the ultimate allocation of resources will be the same under these two institutions.

If our theory is so well understood, then an obvious question arises. Given growing water scarcity in the United States and Mexico, as

2. R. Cummings, *Water Resource Management in Northern Mexico* 1-3 (1972).

well as in many other countries in the world, why is it that (we assert and will later demonstrate) water pricing is *not* commonly used as a mechanism for providing water users with incentives to use water efficiently? As something of a corollary question, we may ask: what sorts of institutional and/or policy changes might result in water pricing becoming an effective and *practical* means by which water resources are allocated? This paper is motivated by our desire to develop responses to these questions, and requires analyses of the following issues.

We must begin with an understanding of current institutions which control the allocation and use of water resources in irrigation. Concern here is with the social mandates which these institutions are to serve, and the implications of these mandates for the institution's flexibility in adopting new policies designed to enhance water use efficiency. For this purpose we have selected as case studies the major agencies in the United States and Mexico charged with the development of irrigation: the Bureau of Reclamation (BuRec) in the United States, and the National Water Commission (Comision Nacional del Agua, CNA) in Mexico. The dramatic differences in the evolution of social mandates which these two agencies have attempted to serve will, we hope, broaden the policy relevance of our discussions to many other countries that are attempting to cope with the problems of growing water scarcity.

Given an understanding of the basic institutional framework which guides the allocation of water used for irrigation in the two countries, we then look to the role which water prices currently play in determining patterns of water use. Within this context, water prices are simply the costs of water which farmers in irrigation districts under the auspices of the BuRec and CNA must pay. Our concern is with two related questions: what are water costs and do they in any sense approximate the relevant scarcity value of water; and is the institutional context within which each agency must operate one which would likely permit the agencies to raise water costs to levels which would approximate a scarcity value for water, or to levels which would provide farmers with meaningful incentives for improved water use efficiency?

Our review of the historical evolution of the BuRec and CNA will suggest that the legal and regulatory settings within which both the BuRec and the CNA now operate impose limits on their ability to directly use any form of scarcity-pricing as a means for improving water use efficiency. We then inquire as to alternative policy changes which would eliminate or reduce these limitations. In this regard, we consider two general policy directions. First, we look for changes in laws and regulations which would lead these agencies toward the use of water prices for efficiency ends. This policy direction follows the 'centralized' paradigm for obtaining optimal patterns of resources use by attempting to have the central manager allocate water via prices known a priori to reflect the relative scarcity of water.

A second policy direction which we consider draws upon the decentralized, market paradigm for resources allocation: allow competition among water users within and outside the irrigation districts to set prices for water. Concern in these discussions will focus on appropriate structures for water markets in the United States and Mexico.

To the ends described above, the paper is structured in the following manner. An historical overview of the evolution of social mandates which have served to define the institutional structure of the BuRec and CNA is given. Present water costs and their implications for water use efficiency in irrigation districts served by the BuRec and CNA are analyzed in the following section. Alternative water marketing institutions are examined in the next to last section. Concluding remarks are offered in the last section.

THE BUREC AND CNA: AN HISTORICAL OVERVIEW

To set the stage for our overview of the evolution of the major irrigation agencies in the United States and Mexico, we begin with a brief description of important characteristics of lands managed by these two institutions. The BuRec is a western regional institution as opposed to a national institution. All lands under the auspices of the BuRec are located in western states. Its mission has been limited primarily to the development and management of surface waters used in irrigation; it has not played a major role in the development and management of pump irrigation. Irrigated land in BuRec projects totaled almost four million hectares in 1987.³ Irrigation in BuRec lands accounts for about 21 percent of all irrigated farming in the United States, and about 1 percent of total land in farms in the United States.⁴ Average farm size in BuRec districts is 31 hectares, compared with a national average for irrigated farms of 64 hectares.

The CNA is very much a national institution with irrigation districts in most Mexican states (Table 2). Moreover, its responsibilities extend to the development and management of all water resources, both surface and subsurface. Indeed, some irrigation districts, such as the Costa de Hermosillo in the state of Sonora, obtain all of their water from ground-water supplies.

There are approximately 3.5 million hectares of land in irrigation districts. Land in CNA irrigation districts accounts for some 20 percent of all agricultural lands in Mexico.⁵ The size of irrigated farms in irrigation districts range from 12.2 hectares in the Northwest to 2.1 hectares in Mex-

3. 1 Bureau of Reclamation, U.S. Dep't of the Interior, 1987 Summary Statistics 10 (1987).

4. U.S. Dep't of Commerce, Statistical Abstract of the U.S. tbl. 1106 (1990).

5. Comision Nacional del Agua, *Dinamica Agricola*, in Programa de Irrigacion y Drenaje tbls. 4 and 8 (no date available) (unpublished manuscript).

ico's central Valley of Mexico, and averages 5.9 hectares (about 20 percent of the size of BuRec farms).

Attention is now turned to the historical evolution of the BuRec and the CNA.

A. The BuRec: A Tool for Achieving Manifest Destiny

Beginning with the Desert Land Act passed by the United States Congress in 1877,⁶ irrigation development in the United States can be viewed as one of national priorities related to the country's manifest destiny to populate and settle the western states.⁷ The Reclamation Act of 1902 made clear the nation's reclamation objectives: the development of arid western lands.⁸ Typical of congressional justifications for appropriations to finance irrigation development during this era was their intent to "create an irrigated empire in the West, providing homes for thousands of citizens."⁹ The Reclamation Service was established within the Department of the Interior in 1902 for the purpose of administering United States reclamation policy in this regard—thus, our earlier description of the BuRec as a western institution. The Reclamation Service was expanded into the Bureau of Reclamation in the early 1920s.

The original 1902 Reclamation Act provided only for irrigation uses of project water. This limitation was quickly removed, however. In 1906 Congress authorized the delivery of project water to towns and cities in the vicinity of irrigation projects, as well as the leasing of surplus hydroelectric power. In 1920 Congress authorized the Secretary of the Interior to expand water services to uses other than irrigation. Restrictions on the use of federal project water have been still further liberalized over the last decade. As discussed in some detail below, there appear to be growing numbers of circumstances wherein the BuRec can facilitate transfers of water (via either sale or lease of water rights) to uses and users well beyond the confines of irrigation districts.¹⁰

At the outset of irrigation development in the western United States, the expectation of the Congress was that the irrigation sector would be totally self-financed. A Reclamation Fund was established through the sale of public lands, and these funds were made available to

6. 43 U.S.C. §§321–339 (1980) (originally enacted as Act of March 3, 1877, ch. 107, §1, 19 Stat. 377).

7. See generally A. Dickerman et al., *Foundations of Federal Reclamation Policy: An Historical Review of Changing Goals and Perspectives* (Dep't of Economics Report No. NRE-B, Colorado State University, Fort Collins)(1970) (providing an excellent general treatment of the social, economic, and political policies adopted by the Congress for achieving these national objectives).

8. Act of June 17, 1902, ch. 1093, §1, 32 Stat. 388 (codified at 43 U.S.C. §391 (1980)).

9. 51 Cong. Rec. 13,453 (1915) (statement of Rep. Hayden).

10. See R. Wahl, *Voluntary Transfers of Federally Supplied Water: Experiences of the Bureau of Reclamation*, in *Water Marketing: Opportunities and Challenges of a New Era* 4–1 (S. Shupe ed., 1986).

farmers as interest-free reimbursable loans for their development of needed irrigation facilities and/or for their contribution to major reclamation projects (the construction of dams, water storage facilities, et cetera).¹¹ The repayment period for such loans was initially set at 10 years; it was extended to 20 years in 1914,¹² to 40 years in 1926,¹³ and to 40 years with an initial 10 year grace period in 1939.¹⁴

While the 'beneficiaries should pay' premise underlying early reclamation policy in the United States was defined rigidly in principle, it could not be enforced in practice. Irrigation farmers were persistently in arrears for loan repayments, necessitating annual legislation by the Congress to forgive or otherwise defer annual payments due from them.¹⁵ The apparent inability of farmers to pay their share of reclamation costs resulted in the congressional creation of a Special Commission in 1937 which was given the mandate to

investigate the financial, economic and other conditions of the various . . . reclamation projects with particular reference to the ability of each . . . project to make payments of water charges without undue burden on water users . . . [and to make recommendations] as to the best . . . and practicable comprehensive permanent plan for such water-right payments with due consideration for the development and carrying on the reclamation program of the United States . . .¹⁶

The Commission's report¹⁷ set the stage for the Reclamation Project Act of 1939¹⁸ which resulted in a complete restructuring of the rules of the game for water reclamation in the United States, and which remains as the legislative cornerstone of contemporary reclamation policy in the United States. Reclamation projects were to be viewed as multiple purpose in scope.¹⁹ Multiple purpose projects were to serve 'beneficiaries'

11. See *id.*; H. Burness et al., *United States Reclamation Policy and Indian Water Rights*, 20 Nat. Res. J. 807 (1980).

12. Act of August 13, 1914, ch. 247, 38 Stat. 686 (codified as amended at 43 U.S.C. 475 (1980)).

13. Act of May 25, 1926, ch. 383, §45 in part, 44 Stat. 648 (codified as amended at 43 U.S.C. §423 (d) (1980)).

14. Act of August 4, 1939, ch. 418, §3, 53 Stat. 1188 (codified at 43 U.S.C. §485 (b) (1980)).

15. Burness et al., *supra* note 11, at 810-11.

16. Act of August 31, 1937, ch. 725, 50 Stat. 737, §1.

17. H.R. Doc. No. 673, 75th Cong., 3rd Sess. (1938).

18. Act of August 4, 1939, ch. 418, 53 Stat. 1187. The full force of the 1939 Act is best appreciated within a context which includes the Flood Control Act of June 22, 1936, ch. 688, 49 Stat. 1570 (codified as amended and supplemented in 33 U.S.C. §§701a, 701b, 701c, 701d to 701f, and 701h (1980)).

19. In 1987, BuRec projects served 12.4 million irrigable acres; with 13,259 MW installed capacity, produced 44,878 GW of electric power; with 25.2 million people served, provided 1.4 billion gallons of water for M&I uses; provided recreational facilities for 53.1 million visitor days; and generated \$53 million in flood control benefits. 1987 Summary Statistics, *supra* note 3, at 2-3.

which include private as well as 'public' entities. Private beneficiaries include irrigators, users of electric power, and municipal/industrial water users. The public, as beneficiaries, derive benefits from those aspects of the project which affect such things as recreation, fish and wildlife preservation, as well as environmental and ecological protection or enhancement.²⁰ Project costs attributable to public aspects served by the project are nonreimbursable.

Thus, for post-1939 BuRec projects, capital and O&M costs are allocated among public and private beneficiaries. Public costs are absorbed by the federal government. Repayment contracts are established with private beneficiaries of the project. Nonagricultural beneficiaries repay the full amount of their allocated costs with interest. Irrigation farmers repay a proportion of their allocated costs which is based upon their ability to pay,²¹ and interest costs are forgiven.

Of primary importance for our later discussions are the following observations related to irrigators rights to water and water costs in BuRec projects. First, it must be noted that the BuRec does *not* control water rights per se. It owns, controls and manages the storage and distribution facilities, but water rights are controlled by state laws relevant for the area in which the project is located. The BuRec's release of water to farmers for irrigation is then determined by state and federal (typically, interstate compacts) laws and the amount of available water in storage for which contracts have been made. Secondly, but inextricably related to the property rights issue, the BuRec has no legislative mandate which would allow it to levy charges on water users for anything other than repayment contracts for capital costs and O&M costs. Its legal responsibilities are limited to the operation and maintenance of the project's facilities—it can neither change water allocations established by contracts and state laws nor impose water prices/costs in excess of amounts required for the repayment of capital and O&M costs. It then follows that these contracted water costs are essentially fixed costs—they do not vary in any real way with the volume of water use.²²

From its creation in 1902 through the mid-1970s, the focus of the BuRec was on the construction of large water reclamation projects and the formation of new irrigation districts. By the mid-1970s, however, at least

20. See U.S. Dep't of the Interior, *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (1983) (discussing procedures presently used to estimate project benefits and costs).

21. The 1939 Act is mute on the subject of how 'ability to pay' is to be determined. BuRec policies for calculating ability to pay involve adjustments of estimated increases in net incomes attributable to the project for a farm living allowance, allowances for farm operation and management, an equity allowance to allow the retirement of land mortgages, and an allowance for production risks and uncertainty. Ability to pay is typically some 33 percent of estimated net income increases. See Burness et al., *supra* note 11, at 813-14.

22. Of course, to the extent that O&M costs vary with levels of water deliveries, some variation may occur.

two developments resulted in substantial changes in BuRec mandates and policies, changes which may be described as a shift from a focus on construction to a focus on management. First, opportunities for the continued construction of new large scaled water projects had dissipated. As noted by then-Secretary of the Interior James G. Watt, "there are no ideal locations left for huge facilities, such as the Grand Coulee Dam . . . [for smaller reservoirs] as with other issues, the best has already been taken, whether it is a site for a dam or for a new national park."²³

Secondly, but inextricably related to the first development, by the mid-1970s, one could perceive in the Congress and in the United States body politic a change in attitudes. The development of the West had been accomplished, and national priorities were focused upon other pressing problems (e.g., pressures for fiscal austerity and environmental concerns). As noted by Stoevener and Kraynick, referring to the historical emphasis of the BuRec on construction, "Even the casual observer of the federal interest in water resources development will have perceived the end of an era."²⁴ The era which has ended in the United States is the era in which the federal government provides virtually all of the up front monies required for reclamation projects, in which large proportions of project costs can be charged to public beneficiaries, and in which substantial subsidies are made available to irrigators. The new, post-1980 era is one in which cost sharing is the relevant principle.²⁵ Host states of proposed projects must now provide substantive shares (typically on the order of 50 percent) of upfront monies, and the feasibility of proposed projects must now be based upon demonstrations of project benefits which largely exclude public benefits.²⁶

B. The CNA: A Tool for Implementing Land Reform

Beginning shortly after the Mexican Revolution until the early 1980s, water reclamation in Mexico was under the auspices of the Ministry

23. *We Can Protect the Environment—and Bring On Development*, U.S. News and World Report, May 1981, at 50.

24. H. Stoevener et al., *On Augmenting Community Economic Performance by New or Continuing Irrigation Developments*, Am. J. Agric. Econ. 1122 (1979).

25. See, e.g., Western States Water Council, *State/Federal Financing and Western Water Resources Development* (1981).

26. Reference here is made to the elevated importance of 'national economic development' benefits in feasibility studies, to the exclusion of most, if not all, of the public benefits which were prominent in earlier feasibility studies. For an overview of the declining role of public benefits in BuRec feasibility studies, see descriptions of procedures used in such studies as Bureau of the Budget, Circular A-47 (1952); *Policies, Standards, and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources: Joint Hearings on S. 2246 Before the Committee on Interior and Insular Affairs and the Committee on Public Works*, 87 Cong., 1st Sess. 17 (1961); *Principles and Standards for Water and Related Land Resources Implementation Studies*, 38 Fed. Reg. 24,777 (Water Resources Council, 1973); Dep't of the Interior, *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (1983) [hereinafter *Economic and Environmental Principles*].

of Water Resources (Secretaria de Recursos Hidraulicos, SRH). The SRH, like its BuRec counterpart in the United States, was largely a construction-oriented agency. Ambitious water reclamation projects were developed during the period extending from the 1930s through the 1970s. With the creation of the National Water Plan Commission (Plan Nacional del Agua, PNA) as an adjunct to the SRH in 1972-73, the SRH initiated a shift in focus from construction to management and planning. In the early 1980s the SRH was combined with the Ministry of Agriculture (forming the new Ministry of Agriculture and Water Resources, SARH) in an effort to more efficiently coordinate water management and development activities of the SRH with those affecting the ultimate clients of the agency: irrigation farmers. Given serious declines in the productivity of Mexico's irrigation sector between the late 1970s and the late 1980s, in 1989 the responsibility for managing the country's water resources was effectively split off from the SARH with the formation of the National Water Commission (the CNA).

The position of land reform as a centerpiece of the Mexican Revolution has had two implications of primary interest for our discussions. First, the development of irrigated lands was to be a tool in the implementation of land reform. In virtually all water reclamation projects constructed by the CNA (or its predecessors), large parts of the newly developed irrigation lands were used for the formation of farm cooperatives (*ejidos*) populated with previously landless farmers.²⁷ Indeed, the 'national' character of the CNA, in contrast to the BuRec's regional character, may largely be explained by this linking of irrigation development to a national program for land reform. Secondly, it can be argued that concern by the framers of Mexico's constitution for the importance of available water supplies in efforts to redistribute land lead to their nationalization of all water resources; i.e., water resources are, by the constitution, the property of the state. The elimination of private property rights in water is consistent with a concern that this vital resource would not be monopolized by the wealthy '*latifundistas*,' thereby thwarting the goals of land reform.²⁸

With property rights to water vested with the federal government, the CNA, as a federal entity, can technically be viewed as owning both water facilities and water rights. Unlike the case with its counterpart in the United States, the CNA's authority in this regard is not limited by states' control of water rights. Similar to the restrictions facing the BuRec, however, the CNA's ability to price water at amounts which exceed costs is questionable. The CNA has a legislative mandate to collect all (or in some cases, a proportion of) O&M costs. Limits on the recuperation of

27. See E. Venezian & W. Gamble, *The Agricultural Development of Mexico* (1969) (providing a comprehensive overview of agricultural development in Mexico).

28. *Id.*

capital costs are also set out by law. Strictly speaking, it would seem that Mexican law is mute on the issue as to whether or not the CNA could impose charges for water which exceed legislative limits on cost recuperation. As in the case of the BuRec, water costs in CNA projects are fixed in nature. For any one farmer, he may not vary the quantity of water which he uses, thereby varying his water costs.

Historically, cooperatives (*ejidos*), including those in Mexico's irrigation districts, had available to them special facilities for the acquisition of credit, extension/educational services, and marketing facilities. The government's paternalistic interest in the development of the *ejido* system is of interest for our discussions given the long history of subsidies afforded the system. Subsidies for water costs ultimately extended to *all* farmers in irrigation districts. Thus, with few exceptions, CNA farmers have never been required to repay capital costs associated with water reclamation projects; moreover, for long periods of time O&M costs were heavily subsidized by the government.

There is an obvious contrast between goals sought by federal water reclamation projects under the auspices of Mexico's CNA and those of the BuRec in the United States. CNA projects have been essentially single purpose in nature, serving basically to promote agricultural production from irrigation within a context which emphasized the goals of land reform. On the other hand, since the 1930s BuRec projects were intended to be multiple purpose in nature, serving not only the needs of irrigated agriculture but those of urban centers and society at large.

Aside from possible implications related to cost allocation, this difference can have important implications for our upcoming discussions of alternative decentralized, market mechanisms as they might be used to affect water prices and therefore incentives for efficient water use. With its evolved tradition of concern with multiple purpose uses of water, mechanisms by which competing demands for water are transmitted through water prices may be easily accommodated within existing procedures used by the BuRec in its efforts to deal with the water needs of its diverse clients. Such may not be the case with an agency like the CNA whose client-agency ties have been limited to agriculture.

Mexico's CNA faces changes in public mandates and priorities which reflect changing conditions paralleling those in the United States. As in the United States, the best locations for new, large scaled water reclamation developments have been taken and there are few if any opportunities for new developments of any substantial scale. The demands for fiscal austerity and growing environmental concerns have resulted in dramatic declines in monies available for the subsidization of water reclamation activities and more stringent requirements for improved water management practices. Indeed, the 'end of an era' of federal interest in the financing of expanded irrigation noted by Stoevener and Kraynick in the United States may apply with equal force in Mexico.

In response to pressures for the elimination of subsidies to farmers in CNA districts, the CNA is in the process of implementing an institutional change which is of central importance for the theme of this paper. User Associations are being formed within each irrigation district. The Associations will have responsibilities which parallel those in irrigation units: water users will have the responsibility for financing and implementing O&M activities. Costs for required O&M activities, as well as contributions to the CNA's O&M costs for reservoirs and major distribution canals, are determined by the Associations and collected from individual water users. It would seem to be the case that the charters which establish the Associations provide them with a great deal of latitude in terms of permissible activities approved by Association members. One sees in these new Associations at least the outline of a possible entity which could play the role of central manager in the centralized paradigm for efficient water pricing and allocation. This possibility is expanded upon in later sections.

WATER COSTS IN IRRIGATION: INCENTIVES FOR EFFICIENT WATER USE?

We now turn our attention to the issue of major interest in this paper: water pricing as a means for providing incentives for efficient water use in irrigation. In this section we consider the extent to which water costs paid by irrigators in BuRec and CNA projects might serve this purpose. In subsections A and B we consider capital and O&M costs, respectively. In subsection C we focus on the questions: what is the proximity of water costs paid by irrigators to the scarcity value of water; and what might we conclude in terms of the possibilities of the BuRec and/or the CNA raising water costs to the end of improving water use efficiency?

A. Capital Costs in BuRec and CNA Irrigation Districts

As noted above, the bulk of United States water reclamation projects are viewed as multiple-purpose projects. Thus, strictly for the purposes of cost allocation, project costs are spread among private and public beneficiaries of the project.²⁹ For the purpose of determining repayment of allocated costs, farmers pay their ability to pay, power users, municipalities and industry will typically pay the full amount of their allocated costs, and all costs allocated to the public as a beneficiary are

29. Costs are typically allocated to each beneficiary on the basis of 'separable' and 'joint' costs. Separable costs assigned to a beneficiary are the savings in project costs which would result from eliminating from the project those project features which exclusively serve the beneficiary. Joint costs are all costs which remain after the calculation of separable costs for all beneficiaries. Joint costs are allocated to beneficiaries in proportion to each beneficiary's net benefits and/or relative use of the project. See *Economic and Environmental Principles*, *supra* note 26, at §9; Bureau of Reclamation, U.S. Dep't of the Interior Ser. 110, Water and Power Instructions ch. 4 (1980).

absorbed by the federal government. For 49 BuRec projects studied by Burness et al., the percent of total construction costs which was allocated to irrigation ranged between 18 percent to 100 percent, and averaged 70 percent. The percent of costs allocated to farmers which were in fact to be paid by farmers ranged from nine percent to 100 percent, and averaged 31 percent.³⁰ Notwithstanding the fact that BuRec farmers pay less than the full amount of capital costs allocated to them, their current outstanding payment obligations total some \$5 billion, involving an average annual payment of \$43/ha. (\$1990), or about two percent of average gross farm income.³¹ With average water use of 6.8 acre feet per hectare on BuRec farms,³² this implies capital cost payments of \$6.32/acre foot.

As described above, reclamation projects in Mexico are typically single purpose in character. Potential public beneficiaries of CNA projects, such as recreation, wildlife enhancement, the environment, et cetera, are not considered for the purpose of cost allocation. Nor is it the case that municipal/industrial users are allocated any substantive proportion of costs. Thus, the costs of CNA projects would generally be allocated solely to the irrigation sector. Allocations notwithstanding, there is little if any history of capital cost recuperation from farmers in CNA projects. It then follows that CNA farmers do not have an existing capital cost obligation as do farmers in BuRec projects.

As an aside, we note that there has been little in the way of new authorizations for large reclamation projects in either the United States or Mexico. Over the last two decades, however, one finds in both countries ongoing investment programs for the rehabilitation of existing projects. The ability to pay principle would not seem to guide cost sharing arrangements for such programs in the United States. While there are no hard and fast rules for determining cost sharing for rehabilitation projects in BuRec districts, it would appear that on average farmers contribute some 50 percent of these costs. In terms of rehabilitation programs in Mexico, the CNA is seemingly breaking with past capital cost recovery policies. It is making efforts to institute a limited form of cost recuperation for these costs, particularly in the Northern and Northwestern Regions. There presently exists no agencywide criteria for the recuperation of capital costs for rehabilitation program, however. Ad hoc negotiations are conducted in each Region. In those districts where capital cost recuperation has been suc-

30. Burness et al., *supra* note 11, at 820, tbl. 3. In many instances, costs allocated to irrigation in excess of farmer's ability to pay are charged to 'excess power revenues.' Excess power revenues are net power revenues which may become available after the 50 years over which the hydropower unit has completed paying the costs allocated to hydroelectric power. *See id.* at 816-17.

31. 1987 Summary Statistics, *supra* note 3, at 5, 7, and 25. Outstanding and pending payment contracts amount to \$5 billion; a 25 year, interest-free, remaining pay-out period is assumed. Gross crop value is \$2,300/ha.

32. Bureau of Reclamation, U.S. Dep't of the Interior, 1988 Summary Statistics 66 (1988). In converting acres to hectares measurement, acres are multiplied by 2.5.

cessfully negotiated, the arrangements will typically involve a contribution of 20–30 percent of costs by water users, 20–30 percent by the state government, with the balance absorbed by the CNA.

B. O&M Costs in BuRec and CNA Irrigation Districts

It is generally the case that annual O&M expenditures in BuRec projects are at levels required to fully maintain irrigation facilities, and, setting aside issues concerning the allocation of O&M costs among beneficiaries of BuRec projects,³³ farmers pay the full amount of O&M costs which are allocated to them. With the BuRec on average delivering some 24.8 million acre feet of water to farms for the irrigation of 3.66 million hectares,³⁴ water use on BuRec farms averages 6.8 acre feet per hectare with O&M costs of approximately \$13 per acre foot (\$1990).³⁵

For the last decade or so annual O&M expenditures in CNA districts have been substantively less than levels required to adequately maintain all irrigation facilities. The difference between full O&M expenditures, those required to adequately maintain irrigation facilities, and actual expenditures is referred to as deferred maintenance. The result of continuous deferred maintenance in the CNA's irrigation districts has been an irrigation system which is in extraordinarily poor repair. The CNA's multi-million dollar rehabilitation and modernization program to which reference was made above is an effort to catch up on past deferred maintenance.

Moreover, until very recently, CNA farmers paid but a small (15–25 percent) proportion of these less-than-adequate O&M expenditures. Over the last year or two, the CNA has made notable progress in increasing the level of O&M expenditures in many irrigation districts, as well as increasing the proportion of O&M costs which are paid by water users. For 1990–91, the CNA's planned O&M expenditures are \$89 million (United States dollars),³⁶ which is 66 percent of estimated full O&M

33. As an example of this issue, for 14 projects in the BuRec's Pick-Sloan Missouri River Basin Project, while irrigation was allocated 68.8 percent of the project's O&M costs, irrigators paid but 7 percent of those costs in 1979; nonreimbursable, public uses of the projects were allocated 8.2 percent of O&M costs, but were charged 63.8 percent of O&M costs incurred in 1979. It must be recognized that the Pick-Sloan Project is not typical of BuRec projects, however. The development of irrigation in this project, with 269,805 completed irrigation acres developed in 1979, has fallen well short of preproject plans for the development of 1.33 million irrigation acres. See D. Franklin & R. Hageman, *Cost Sharing with Irrigated Agriculture: Promise vs. Performance*, 20 Water Resources Res. 1047 (1984).

34. U.S. Dep't of Commerce, *supra* note 4, at 66–74.

35. *Id.* Nineteen eighty-eight values are adjusted to \$1,990 at 4 percent per year. The adjusted average O&M costs are \$88 per hectare or \$12.94 per acre-foot if divided by average water use of 6.8 acre-feet per hectare.

36. Comision Nacional del Agua, *Grado de Autosuficiencia de los Distritos de Riego en 1991* (1991). The annual expenditure is calculated by adding the expected O&M payments by farmers to federal budgeted expenditures for O&M. Pesos are converted to dollars at a rate of 3,000 pesos equaling U.S. \$1. See *id.* cols. 6 & 10.

expenditures (United States \$134 million).³⁷ Water users are expected to pay 52 percent of these planned expenditures.

Using the 1990 pattern of water use in CNA districts as being representative of an average year, we may then say that on average the CNA delivers some 23 million acre feet of water to farmers for the irrigation of 2.81 million hectares.³⁸ Water use averages 8.2 acre feet per hectare, and, during 1990–91, farmers will pay O&M costs of \$2 per acre foot.³⁹

C. Water Costs as Incentives for Efficiency: Conclusions

The stated goals of this section are to respond to the questions: (i) what is the proximity of water costs paid by irrigators to the scarcity value of water;⁴⁰ and (ii) what might we conclude in terms of the possibilities of the BuRec and/or the CNA raising water costs for the purpose of improving water use efficiency? We consider each question in turn.

(i) What is the proximity of water costs paid by irrigators to the scarcity value of water?

While, as was pointed out in the first section, the scarcity value of water is determined by myriad factors and can vary widely under different conditions, the following observations may be useful in setting out the possible range for water's scarcity value in BuRec and CNA irrigation districts. A recent study by the CNA provides estimates for the *average* value of water as measured by net farm income in irrigation districts located in northwest Mexico. These values range from \$30 to \$60 per acre foot.⁴¹ To some extent, this range is consistent with estimates for the marginal value of water in northern irrigation districts found in earlier works: \$30–\$45/acre foot in the Comarca Lagunera district⁴²; and \$40–\$65/acre foot in dis-

37. *Id.* col. 1. We note that included in the CNA's calculation of O&M costs is an item called 'Irrigacion y Drenaje' (I&D). I&D costs are costs incurred by the CNA for extension and educational services to farmers. I&D costs account for some 18 percent of current O&M expenditures of the CNA, and 11 percent of 'full' O&M costs. Farmers in BuRec districts also benefit from extension and educational programs, but such programs are not provided by the BuRec; they are provided by the U.S. Department of Agriculture. BuRec farmers do not directly pay for these programs.

38. Comision Nacional del Agua, Gerencia de Distritos de Productividad, Resultados de Produccion y Productividad: Ano Agricola 1990 (no date available).

39. O&M costs are \$46.3 million for the delivery of 23 million acre feet of water. This cost constitutes 52 percent of CNA's planned O&M expenditure of \$89 million.

40. The argument that water use in irrigated farms can generally be made more efficient is made in a number of works. E.g. J. McGuckin et al., *Optimal Control of Irrigation Scheduling Using a Random Time Frame*, 69 Amer. J. Ag. Econ. 123 (1987); O. Burt & M. Stauber, *Economic Analysis of Irrigations in a Subhumid Climate*, 53 Am. J. Agric. Econ. 33 (1971); N. Dudley et al., *Optimal Intraseasonal Irrigation Water Allocation*, 7 Water Resources Res. 770 (1971). The source of such inefficiencies typically derives from the use of water applications based upon the principle of maximum plant growth.

41. Comision Nacional del Agua, Gerencia Regional del Noroeste, Estudio Sobre La Recuperacion del Costo de Capital en Irrigacion (1989) (assuming water use of 8 acre feet per hectare).

42. Cummings, *supra* note 2, at 18. Values are inflated to 1990 dollars.

tricts along Mexico's northwest coast.⁴³ Values for water used in irrigation in the western United States would also seem to lie in the range of \$30 to \$60 per acre foot.⁴⁴ Further, \$50 as an average scarcity value of water is consistent with average market values for water rights traded among farmers observed in western states on the order of \$500.⁴⁵ Thus, recognizing that ranges for water scarcity values may be quite broad,⁴⁶ we take \$50/acre foot as a reasonable average for such values for the purposes of our discussions.

Using \$50/acre foot as an estimate for the scarcity value of water, the response to our first question is straightforward. With BuRec farmers paying on average \$6.32/a.f. in capital costs and \$13/a.f. for O&M costs, farmer's water costs are \$19.32/a.f., or about 39 percent of the scarcity value of water. CNA farmers have no capital cost obligations and presently pay but \$2/a.f. in O&M costs. Their water costs are then \$2/a.f., or four percent of the scarcity value of water.

(ii) What might we conclude in terms of the possibilities of the BuRec and/or the CNA raising water costs to the end of improving water use efficiency?

With water costs one-third or less of scarcity values for water, and absent any good reason for believing that such costs (which are fixed in nature) may affect water use efficiency in irrigation, an obvious question then centers on options available to the BuRec and CNA for using prices for improving the efficiency of water use. At least two general alternatives in this regard might be considered. First, they might simply increase water costs charged to farmers by amounts which would approach the scarcity value of water, costs on the order of \$50/a.f. For reasons mentioned above, under present laws this alternative is clearly unfeasible for the BuRec—it manages water facilities, not water per se and has no control over water costs beyond those related to actual annual O&M expenditures. For similar reasons, it would appear that this alternative would be equally unfeasible for the CNA, but this is not totally clear. In either case, a movement in this direction would require legislative changes in both countries.⁴⁷

43. R. Cummings, *Interbasin Water Transfers: A Case Study in Mexico* 55 (1974). Values are inflated to 1990 dollars.

44. See, e.g., R. Cummings et al., *Reductions of Water Allocations to Irrigated Agriculture in the Estancia Basin with Implications for New Mexico* (Dep't of Economics Working Paper No., University of New Mexico, 1977); B. Saliba, *Market Transactions and Pricing of Water Rights in the West*, in *Water Marketing: Opportunities and Challenges of a New Era* 3-1, 3-20 (S. Shupe ed., 1986); B. Saliba et al., *Do Water Market Prices Appropriately Measure Water Values?*, 27 Nat. Res. J. 617 (1987).

45. Five hundred dollars would be the capitalized value of water profits of \$50/year, using a 10 percent discount rate. See Saliba et al., *supra* note 44.

46. See, e.g. Cummings, *Reductions of Water Allocations*, *supra* note 44 (providing examples of such ranges at the extensive margin in New Mexico's Estancia Valley).

47. In the case of the BuRec, such changes are highly unlikely. The sovereignty and rights of individual states as provided in the U.S. Constitution are involved here, and it is improbable that western states would cede parts of these rights to the federal government.

The price-costing alternative has a major weakness in terms of any real expectations for farmers to support its adoption. Scarcity pricing of water represents higher costs to the farmer. Rents to water, or in other words the benefits from increased water use efficiency, accrue to the federal government. While one might think of means by which such rents, or some form of related benefits, could be directly or indirectly returned to farmers in ways which would not affect water use decisions, farmer's resistance to higher costs on their face may be a predictable reaction. These considerations might then lead one to a second alternative which involves rents, or some proportion of rents, accruing directly to farmers: individual or group marketing of water rights. We then focus our attention upon means by which this second alternative might be implemented.

ACHIEVING WATER USE EFFICIENCY WITH MARKET INSTITUTIONS: ALTERNATIVE APPROACHES

Our concern in this section is with institutions akin to the decentralized paradigm for efficient resource allocation. Thus, our focus is on market, or marketlike, institutions in which willing buyers and sellers of water rights exchange those rights. A market price is established which reflects the relative scarcity of water. The extent to which this price accurately measures the scarcity value of water, and results in an efficient allocation of water, will typically depend upon the extent to which the characteristics of the marketlike institution approximate those of the competitive paradigm.⁴⁸

In broader terms, our concern is with mechanisms for transferring usufructuary or property rights to water from one user or group of users to others. Such transfers presumably involve reallocations of water to higher valued—i.e., more efficient—uses. The relevance of this concern in the United States⁴⁹ manifested by the increase in public interest in reallocative mechanisms which has occurred over the last two decades or so. Such interests reflect an evolving decision environment which is receptive to increased reliance on water transfers as a means for resolving water scarcity problems. This is to say that judicial rulings which place growing emphasis on water use efficiency in considerations of interstate water disputes,⁵⁰ the increasing political strength of urban areas, growing water scarcity, and the decline in federal subsidies for water projects have all had the effect of creating a political environment in the United States which is conducive to considerations of water transfers.

48. See Brajer et al., *The Strengths and Weaknesses of Water Markets as They Affect Water Scarcity and Sovereignty Interests in the West*, 29 Nat. Res. J. 489 (1989).

49. Given that there are no private property rights to water, there are no formal precedents for water transfers, particularly within any kind of market context in Mexico.

50. See 29 Nat. Res. J. (Spring 1989) (Special issue: *New Challenges to Western Water Law*).

We will begin our inquiry as to alternative market structures for water transfers by examining the potential strengths and weaknesses of private water markets. Our concern is with market institutions which might be used by the BuRec and the CNA for improving water use efficiency. While private water markets do not currently operate in BuRec or CNA districts,⁵¹ our review of the workings of private markets in the United States serves to set the stage for later discussions. Following our consideration of private water markets, attention is then turned to an examination of water marketing mechanisms used in transactions involving water in BuRec projects, mechanisms wherein public interests in water transfers are represented by the direct participation of a third party.

A. Private Water Markets

In the simplest and most general terms, a private water market is an institution, formal or informal, which facilitate the exchange of water rights among willing buyers and sellers. The major strengths claimed for water markets are, first, under ideal conditions it can be shown that unfettered markets for water will result in an allocation of water rights which is economically efficient, i.e., which will result in water being placed in its highest valued uses.⁵² Secondly, it is argued by some that water markets can eliminate water shortages as well as limit distributional conflicts.⁵³

The private sale of water rights is reasonably common in many western states, in many instances involving the sale of water rights by private individuals, farmers, to municipalities.⁵⁴ In transactions involving one farmer's sale of a perpetual water right to another farmer, prices average about \$500 per acre foot.⁵⁵ Farmer sales of water to municipalities bring much higher prices. A broad sample of water rights prices in west-

51. Water markets in the western U.S. have been characterized as a 'two-tiered' water market, reflecting the fact that in a number of western water basins a large proportion of available surface waters are in federal (BuRec) projects and the 'rules' by which water can be transferred in federal projects are quite different from those which apply to transfers among private individuals with property rights in water. In these regards, see W. Ellis & C. DuMars, *The Two-Tiered Market in Western Water*, 57 Neb. L. Rev. 333 (1978).

52. These 'conditions' include: many buyers and sellers; well defined property rights; perfect mobility, and perfect information—conditions which are virtually nonexistent in western water basins. See Brajer et al., *supra* note 48.

53. T. Anderson, Conflict or Cooperation: The Case for Water Markets, (Montana State University, Political Economy Research Center Working Paper, 1983). See also D. Gardner, *Institutional Impediments to Efficient Water Allocation*, 5 Pol'y Stud. Review 353 (1985).

54. See F. Brown et al., *Water Reallocation, Market Proficiency and Conflicting Social Values*, in *Water and Agriculture in the Western U.S.: Conservation, Reallocation, and Markets* (G. Weatherford ed., 1982); R. Wahl & F. Osterhoudt, *Voluntary Transfers of Water in the West*, in *National Water Summary 1985: Institutional-Management Issues* 113 (Office of Policy Analysis, U.S. Dep't of the Interior ed., 1985).

55. See M. Kelso et al., *Water Supplies and Economic Growth in an Arid Environment* 28-49 (1973); R. Khoshakhlagh et al., *Forecasting Future Market Values of Water Rights in New Mexico* (New Mexico Water Resources Research Institute Report No. 092, 1977).

ern states, primarily involving the sale of agricultural water rights to municipalities, is given in Table 1.⁵⁶

Probably the best example of a functioning water market in the west is seen within the Northern Colorado Water Conservancy District. Each year, the NCWCD divides the amount of project water available to it among the owners of its 310,000 shares. These shares can be bought, sold and/or leased within the district. The price at which these water shares have sold has varied considerably over time, averaging (per acre foot in 1980 dollars) \$99 in 1961; \$504 in 1970, \$2,895 in 1980; \$1,600 in 1983; and \$900 in 1985.⁵⁷ Rapid growth in the area's economy during the 1970s gave rise to rapid increases in the price of water rights in the NCWCD; urban development slowed after 1980 as is reflected in the decline in water prices between the early 1970s and 1985.

There are two important caveats which one must keep in mind in these considerations of private water markets. First, one must understand that the private market transactions for water rights to which reference is made above do not generally take place within a market setting analogous to the paradigm of pure or perfect competition. They may involve one or a few transfers of water rights between monopolistic and/or monopsonistic entities, transfers of water rights within a competitive environment, or any mixture of market conditions between these extremes.⁵⁸ One finds few (probably no more than one or two)⁵⁹ examples in the United States of highly organized, competitive water markets *a la* the competitive paradigm;⁶⁰ there are none in Mexico. The assumed conditions underlying the competitive model which are most often found to be lacking in private water markets are: many sellers and (particularly) buyers; perfect mobility (as it relates to small transactions costs);⁶¹ well-defined property rights;⁶² and, to a lesser extent, perfect information.⁶³ Secondly, to an

56. Saliba et al., *supra* note 44, at 640 tbl. 2.

57. C. Howe et al., *Innovations in Water Management: Lessons from the Colorado-Big Thompson Project and Northern Colorado Water Conservancy District*, in Scarce Water and Institutional Change (K. Frederick ed., 1986). See also, e.g., Wahl & Osterhoudt, *supra* note 54.

58. G. Weatherford & S. Shupe, *Reallocating Water in the Arid West*, in *Water Marketing: Opportunities and Challenges of a New Era*, *supra* note 10, at 1-11.

59. *Id.*

60. See *id.*; Brajer et al., *supra* note 48.

61. See B. Colby, *Transactions Costs and Efficiency in Western Water Allocation* 72 Am. J. Agric. Econ. 1184 (1990) (presenting the argument that transactions costs should be higher than present levels).

62. Risks and uncertainty are associated with property rights to water in many cases. As examples, the quantum of the right, or its seniority, may later be found to be less than represented in a transaction; the terms of the right can be socially or politically altered over time; unanticipated third-party effects may arise resulting in a suit; and in some states it could be the case that the sale of a water right could be taken as *prima facie* evidence of nonbeneficial use, thereby resulting in the revocation of the right. See Weatherford & Shupe, *supra* note 57; K. Frederick, *Introduction in Scarce Water and Institutional Change*, *supra* note 56, at 9.

63. Brajer et al., *supra* note 48.

TABLE 1. Representative Prices for Sales of Perpetual Water Rights, 1984–1987 (1986 dollars per acre-foot)

	ARIZONA	COLORADO	NEVADA	NEW MEXICO	UTAH
1984	\$ 560	\$ 1,460	\$ 1,570	\$ 1,460	\$ 430
1985	\$ 920	\$ 1,080	\$ 1,450	\$ 1,250	\$ 350
1986	\$ 1,430	—	—	\$ 1,210	—
1987	\$ 1,000	—	\$ 1,750	\$ 1,110	—

extent that is determined by state laws, water rights transactions must be approved by the state. This will typically involve an application for a transfer submitted to the office of the state engineer who examines the proposed transfer for any adverse effects on third parties. In some states, the transfer is publicized and any interested party can challenge the transfer at hearings conducted by the state engineer. Thus, the ideal conditions to which reference was made above are seldom found in United States water markets, and such markets should be viewed as involving marketlike exchanges of water rights. However imperfect these markets, one might reasonably expect efficiency gains from these marketlike transfers.

Asserted weaknesses of the private market for water rights focus primarily on *equity* considerations.⁶⁴ As one example in this regard, in most western states municipalities are exempt from the payment of property taxes imposed by counties. It is then argued that the market acquisition of rural water rights by municipalities can have the effect of deteriorating the tax base of rural county governments.⁶⁵ As an example, a common practice (particularly in Colorado and Arizona) for water rights to be obtained by a municipality is its purchase of farmland which has water rights associated with it. This means for acquiring water rights removes lands on the county government's tax rolls, with the potential result of eroding its ability to maintain social infrastructure. Secondly, a great deal of opposition to the idea of allowing water rights to be transferred via markets derives from the wide range of potential externalities

64. As they exist in the U.S., a potential weakness of private water markets, more directly related to efficiency matters, may derive from the lack of congruity between actual markets and the competitive paradigm. Thus, it might be argued that the market paradigm's efficiency benefits may not be imputed to transactions which take place in much-less-than-perfect markets.

65. J. Ross, *Valuation of Water Rights for Acquisition, Condemnation, and Taxation Purposes in Water Marketing: Opportunities and Challenges of a New Era*, *supra* note 10 at ch. 3; see also S. Nunn, *The Political Economy of Institutional Change: A Distribution Criterion for Acceptance of Groundwater Rules*, 25 Nat. Res. J. 867 (1985); S. Shupe et al., *Western Water Rights: The Era of Reallocation*, 29 Nat. Res. J. 413 (1989); A. Charney & G. Woodard, *Socioeconomic Impacts of Water Farming on Rural Areas of Origin in Arizona*, 72 Am. J. Agric. Econ. 1193 (1990).

associated with the transfer of water rights, particularly in cases where the transfer results in a change in the location of use. Typical external effects relevant in these regards include effects on: fish and wildlife habitat; the protection of aquatic life; recreation; aesthetic beauty; navigation; water quality; access to public waters; and minimum instream flows.⁶⁶

While some argue that such externalities might be taken into consideration in water markets via the careful construction of water rights and market institutions,⁶⁷ equity considerations lead many to question the efficacy of water markets notwithstanding efficiency benefits which might derive from their use. Brown and Ingram argue that unfettered water markets will threaten both environmental quality and the rights of nonurban constituencies by ignoring the noneconomic values of water,⁶⁸ Mumme and Ingram see water markets as "nothing less than a program for the redistribution of control over western water . . . toward those parties most able to purchase scarce water rights,"⁶⁹ and a number of scholars are particularly concerned with water markets as a source for increasing social conflicts.⁷⁰

Indeed, there is growing evidence that water law in western states is becoming increasingly influenced by considerations related to equity or, more generally, to the idea that water has a communal value. The idea here is that water is so essential to western society that any transfer of water rights must be subject to close scrutiny by representatives of the general public for assessments of the potential impacts of the transfer on traditional cultural patterns of communities.⁷¹ A number of western states have institutionalized public interest provisions regarding water rights transfers in their water codes or, in the case of California, their state constitutions.⁷² The court's acceptance of what has become known as the public trust doctrine as it relates to the public's interests in water rights transfers is seen in the 1985 *Shokal v. Dunn* decision.⁷³ In this case the court accepted an extraordinarily broad view of the potential components of public interests; set out the provision that duty to protect the public interest "is related to the larger doctrine of the public trust";⁷⁴ and established

66. C. Wilkinson, *Public Interest Constraints on Water Transfers in Water Marketing: Opportunities and Challenges in a New Era*, *supra* note 10, at 2-14.

67. Anderson, *supra* note 53.

68. F. Brown & H. Ingram, *Water and Poverty in the Southwest* 15 (1986).

69. S. Mumme & H. Ingram, *Community Values in Southwest Water Management*, 5 *Pol'y Stud. Rev.* 377.

70. See, e.g., J. Folk-Williams et al., *Western Water Flows to the Cities* (1985); T. DeYoung & H. Jenkins-Smith, *Uncertainty in the Western Water Market: An Assessment of Policies and Potentials*, in *Water Marketing: Opportunities and Challenges of a New Era*, *supra* note 10, at 5-60.

71. Mumme & Ingram, *supra* note 69.

72. "The general welfare requires . . . that the waste or unreasonable use . . . of water be prevented, and that the conservation of such water is to be exercised . . . in the interest of the people and the public welfare . . ." Cal. Const., art. X, §2.

73. 707 P.2d 441 (Idaho 1985).

74. *Id.* at 447 n.2.

that the burden of proof is upon the applicant for a water market transfer to demonstrate that "the [proposed transfer] is either in the local public interest or that there are factors that outweigh the local public interest in favor of the [transfer]."75

In short, the contemporary debate in the United States concerning greater reliance on water markets as a means for resolving growing water scarcity is centered on trade-tradeoffs between efficiency and equity.

B. Water Transfers of Water in BuRec Projects: 'Brokered' Transactions and 'Water Banking'

Looking next to water resources under the auspices of the BuRec, federal law provides that in federal projects "the right to use the water . . . shall be appurtenant to the land irrigated . . .,"76 a provision that at one time was interpreted as disallowing transfers of water beyond the boundaries of a irrigation district. In more recent legislation, the Congress has authorized the delivery of project water to urban areas in the vicinity of irrigation projects, and in 1920 authorized the Secretary of the Interior to contract for water "for purposes other than irrigation."77

Over the last two-plus decades, the more limited interpretation of the appurtenance requirement has been relaxed considerably, and a large number of water transfers within irrigation districts as well as between irrigation districts and municipal/industrial users have been allowed by the BuRec (with the concurrence of appropriate state bodies, and after determination that external effects are minimal).78 The extent to which such transactions have been marketlike, in the sense of farmers surrendering water rights in response to prices determined within something of a market context, varies from case to case. In what follows, we provide examples of water rights transfers involving the BuRec which are, and are not, marketlike.

One example of BuRec sponsored water transfers in the nonmarketlike category is seen in the BuRec's Casper-Alcova irrigation district located in Northern Wyoming. The city of Casper, Wyoming, was facing severe water shortages due to rapid urban growth. Under an agreement which was effectively brokered by the BuRec, the city is financing the rehabilitation and lining of parts79 of the Casper-Alcova district's 59-mile long major distribution canal and its 190-mile-long lateral systems. The

75. *Id.* at 450.

76. Reclamation Act of 1902, ch. 1093, §8 in part, 32 Stat. 390 (codified as amended and supplemented at 43 U.S.C. §372 (1976)).

77. Wahl, *Voluntary Transfers of Federally Supplied Water*, in *Water Marketing: Opportunities and Challenges of a New Era*, *supra* note 10, at 4-4 to 4-5.

78. *Id.* at 4-5 to 4-7.

79. Environmental concerns arose concerning the possible adverse effects of the canal lining program on wetlands. To assure that wetlands were protected, four of the larger seepage areas were maintained. See Wahl & Osterhoudt, *supra* note 54, at 116.

effect of this capital investment will be to reduce canal seepage, thereby yielding the city 7,000 acre-feet of water per year without reducing the quantity of water available for irrigation uses.

A second example which is much grander in scale is seen in the cooperative transfer planned by the BuRec and the California Department of Water Resources involving the Imperial Irrigation District (IID), which diverts some three million acre feet of water each year through the BuRec's All-American Canal, and the Metropolitan Water District of Southern California (MWD). The IID has 1,627 miles of main canals and laterals used to irrigate some 450,000 acres of land. The MWD is concerned with finding a source for municipal water supplies to replace water allocated to but previously unused by the state of Arizona which the state of Arizona will now begin using. A study by the California Department of Water Resources demonstrated that as much as 437,000 acre feet of water could be saved in the IID by investments for: canal lining, spill-interceptor canals, tailwater recovery systems, system automation, more regulatory reservoirs, and a more flexible system of deliveries.⁸⁰ Water so conserved would cost from \$8-\$115 per acre foot. The BuRec, the MWD, and the IID are in the process of negotiating the MWD's financing of these investments to the end of making water conserved by the process available to them for municipal uses.

Looking next to water transfers involving BuRec projects which approximate market transactions, a particularly interesting example is seen in the BuRec's role as a water bank during the 1976-77 drought in California.⁸¹ The fourth driest year in California in over 100 years was 1976, and 1977 was the driest year on record. Statewide precipitation was 65 percent of normal in 1976 and 45 percent of normal in 1977. On April 7, 1977, the United States Congress enacted Public Law 96-18 which authorized the operation of federal water banks during California's drought. The BuRec, as an agent of the Secretary of the Interior, was authorized to assist willing buyers and sellers of water rights to transfer water in federal (BuRec) projects and other sources. Priorities among purchasers were

80. See *id.* We should note that ownership of water 'saved' by this program is challenged by Mexico. Noting that seepage from the Canal recharges aquifers which extend into Mexico, Mexico claims that the U.S. cannot line the Canal without consulting them under a 1973 International Border and Water Commission Minute Agreement. See D. Hayes, *The All-American Canal Lining Project: A Catalyst for Rational and Comprehensive Groundwater Management on the United States-Mexican Border?*, Transboundary Resources Report (International Transboundary Resources Center, University of New Mexico, School of Law, Albuquerque, N.M.), Spring 1991, at 1.

81. One sees an expansion in the role of water banking in recent legislation adopted in the State of New Mexico. Conservancy districts are now allowed to 'bank' unused water in storage reservoirs, and such 'banked' water is considered to be a beneficial use of the water. Under the 'prior appropriation' doctrine, rights to water which is not put to beneficial use may be revoked by the state. This new provision whereby banked water is considered to be a beneficial use then protects the water rights of the conservancy districts during periods where less-than-full use is being made of their water supplies.

established: preservation of orchards and other perennial crops, irrigation of support crops for dairy and beef-cattle herds and other breeding stock, and irrigation of other crops. Public Law 96-18 also made funds available for interest-free loans to irrigation purchasers of water with a repayment period not to exceed five years.

A Congressionally imposed caveat for such transactions was that no undue benefit or profit should accrue to water sellers. Thus, the BuRec was directed to establish water prices that would recover all expenditures in acquiring the water, and which would reimburse sellers for any lost income from their transfer of water to other users. The price at which water was exchanged in the water bank was then the opportunity cost of water to irrigators. Lease prices for water arranged at the water bank ranged from \$55-\$142 per acre foot, and averaged \$61 per acre foot.⁸² Bearing in mind that this average price included conveyance and pumping costs required to get water to the purchaser, the proximity of this average lease value (\$61) to our earlier estimate for an average scarcity value of water (\$50) is remarkable. The bank purchased some 46,438 acre feet of water from the California State Water Project and the BuRec's Central Valley Project, and sold 42,544 acre feet (the difference represented return-flow and conveyance losses). The operation of this water bank in California is credited with substantively easing the hardships suffered by California farmers and cities during the drought.

The BuRec has since played the banker's role in a number of other transfers. One example is seen in the transfer of water between the Emery Water Conservancy District and the Utah Power and Light Company in central Utah.⁸³ Following their assessment of environmental effects which could attend such a transfer, the BuRec facilitated a reduction in irrigated acres in the Conservancy District which freed 6,000 acre feet of water which was then transferred to the UPLC. Both private parties and the federal government benefited from the transfer. Farmers were directly compensated for the transferred water (in unreported amounts). The UPLC was required to pay the farmers remaining debts to the federal government for costs allocated to the Conservancy District for capital cost recovery, but at M&I rates rather than at rates established for farmers. This resulted in a net increase in the total capital cost repayment obligation to be received by the federal government in the amount of \$3.9 million.

Still another example is seen in the Arvin-Edison Water Storage District (AWSD) in California's San Joaquin Valley. The AWSD operates a water exchange pool wherein each year offers and requests for water exchanges are submitted to the District. Buyers and sellers are brought

82. Wahl & Osterhoudt, *supra* note 54, at 117.

83. *Id.* at 114-15.

together for the purpose of facilitating water exchanges. Some seven to eight percent of the District's water supplies are exchanged each year.

What we see here is increasing reliance on marketlike sales and transfers of water in BuRec projects to the end of improving the efficiency of water use among *all* water users. Water prices provide irrigators with incentives to economize on water use in a number of ways: adopt more water efficient cropping patterns;⁸⁴ collaborate in investment programs for reducing distribution losses of water; and the retirement from irrigation of marginal lands. *Equity* issues—externalities and other public interest concerns—are (must be)⁸⁵ accommodated in such transactions by the BuRec's involvement as a third party in all transactions.

SUMMARY AND CONCLUSIONS

Concern in this paper has focused on water pricing as a means for improving water use efficiency in irrigation. Such improvements may obtain in a number of ways. Examples include: for any crop, adopting water use coefficients which bring into proximity the marginal value product of water and the scarcity value of water; adopting cropping patterns with high returns to water (an issue about which we have said little in this paper); and the reallocation/transfer of water from low to high valued uses.

We have examined a number of alternative ways in which water prices might be used to provide farmers with incentives to collaborate in programs to enhance efficiency, and have noted the importance of national and regional mandates and priorities in assessing them. One alternative involves water prices which capture the full costs of providing water. A water agency such as the BuRec or CNA might positively affect the efficiency of water use by pricing water—increasing water costs—at levels approaching the scarcity value of water. Such a policy would likely require the formulation of mechanisms by which some part of the rents to water captured by the water pricing system, or basinwide benefits which accrue from increased water efficiency, are returned to farmers in ways which leave unaffected the farmer's choice of water use levels. For the institutional contexts of our case studies in the United States and Mexico, the implementation of this alternative would require changes in existing laws which presently limit the allowable costs which can be imposed on clients of the BuRec and CNA.

84. We find no hard evidence of BuRec farmers making substantial adjustments in water use per acre for any given crop.

85. The BuRec's concern with these issues is mandated by federal environmental laws in the U.S.; indeed, it is required that an environmental impact statement be prepared for all permanent water transfer programs.

A second alternative considered was the use of private markets. With reasonably competitive market structures, the scarcity value of water would be established by market-clearing prices. In the context of such markets, the interests of individual farmers are best served by adopting patterns of water use at which the value of water in use approximates market prices for water; otherwise, rights to water are sold in the market place. Under such conditions, water would be reallocated from low to higher valued uses and users and an efficient pattern of water use would obtain. In the United States, a movement in the direction of greater reliance on *private* water markets would require at least three sets of changes. First, congressional repeal of the appurtenance requirements in federal reclamation laws would be required. Second, a legal mechanism for bringing into congruence private markets and the Public Interest Doctrine, as set out in most state laws and/or constitutions, would require development. Third, attention would be required for means by which the structure of water markets might be more closely aligned to the structure of a competitive market.⁸⁶ Absent a change in the Mexican Constitution, it would appear to be the case there can be no market for perpetual water rights in that country inasmuch as individuals do not have property rights in water. Farmers in CNA districts do, however, appear to have something akin to usufructuary rights and possible market transactions involving the lease of these rights might be considered. Provisions for the operation of such markets might be included in the charters which establish the new User Associations which the CNA is in the process of forming.

There is no question as to the efficiency of water use which would result from an allocation of the resource within the context of a market. Questions do arise as to undesirable effects which can attend market transfers of water. There must generally exist some middle ground, however, between living with an existing pattern of water use wherein water use may be grossly inefficient and the paradigm of perfect competition. Such a middle ground is seen in the evolving role of the BuRec as a broker in marketlike water transfers in the western United States. Greater reliance on marketlike allocations of water in Mexico could substantively enhance overall water use efficiency. The CNA, or Water User Associations, would seem to be ideally suited for the broker's role played by the BuRec in the United States.

86. See Brajer et al, *supra* note 48 (offering suggestions in this regard).