Water Marketing in Texas: Opportunities for Reform

by

Ronald C. Griffin and Fred O. Boadu

Originally published in NATURAL RESOURCES JOURNAL
32 NAT. RESOURCES J. 265 (1992)

RONALD C. GRIFFIN*
FRED O. BOADU*

Water Marketing in Texas: Opportunities for Reform

ABSTRACT

Surface water marketing, as it is conducted in Texas, is assessed to identify areas of success as well as those meriting improvement. Overall, surface water markets have assisted the State in responding to changing conditions, but policy revisions are needed to repair the deficiencies of existing institutions. Concerning the extension of market policy to groundwater management, it is argued that the absolute ownership doctrine employed for Texas groundwater should be removed in favor of a market-oriented groundwater code derived from surface water law and experience. Recommendations for modifying both surface water and groundwater law are offered.

The research on which this paper is based was financed in part by the Texas Agricultural Experiment Station (TA-30152) and the Department of Interior (United States Geological Survey Award Number 14-08-0001-G1725).

I. INTRODUCTION

Although it may seem distasteful, perhaps even alarming, to the uninitiated, there is a strong ideology indicating that water is better managed as an economic commodity than as either a political issue or an administrative object.[1] On the other hand, it seems inadvisable to employ the purist notion of a "free" market, due to special circumstances relating to water.[2] These special circumstances imply that an unfettered market structure cannot be relied upon to advance social objectives in many cases. As a result, some administrative control and structure must be placed upon water marketing if such marketing is to serve society broadly.

Buying and selling surface water rights has long been possible in Texas, at least in theory, although the practice is confined to the last 20 years.

*The authors are associate professor and assistant professor with the Department of Agricultural Economics, Texas A&M University, College Station, TX 77843.

1. There is extensive literature on water marketing in the United States. For economic perspectives on water marketing, see T. Anderson, Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment (1983). Also, see various articles in 29 Nat. Res. J. (2)(1989).

2. Some economists disagree that these are sufficient grounds for limiting market influence. *See*, for example, T. Tregarthen, *Water in Colorado: Fear and Loathing of the Marketplace* in Anderson, *supra* note 1.

There are reasons to believe that the role of surface water marketing is increasing in the state, and there is a strong need for a thorough inspection of the impact of this institution. Somewhat contrarily, the market mechanism has a limited role in the case of Texas groundwater due to a differing legal foundation. Texas faces an important issue pertaining to the potential for harnessing market forces to address groundwater scarcity. Although the present legal doctrines of other western states differ, sometimes markedly, from those employed in Texas, market-supporting revisions to water law are being broadly considered by many states. Texas' experience may offer information useful to states engaged in such deliberations.

In this paper we examine how well water marketing is serving the state and identifies areas of success as well as that meriting improvement. Policy remedies are identified for current market deficiencies, and the potential for extending market principles to groundwater is investigated. Some of the presented evidence offers insights for the modification of water law in other western states. The rest of the paper is organized as follows: Section II contains the legal background, economic concepts, and quasi-empirical results which stand behind surface water marketing in the State of Texas. The ideas, concepts, and principles outlined in Section II are used in Section III to discuss the extension of the market mechanism to groundwater. Because groundwater management is particularly problematic for the Edwards Aquifer, which serves the San Antonio region, extra attention is focused here. The implications of our recommendations for the conjunctive management of surface water and groundwater are briefly considered in Section IV. Conclusions are presented in Section V.

II. SURFACE WATER MARKETS IN TEXAS

Law and Economics

Through a long, evolutionary process over which various legal alternatives were tried, Texas has come to rely on the prior appropriation doctrine for the allocation of surface water.[3] The noteworthy elements of this law are that all water users must possess a permit to divert water from a surface water source, there is a seniority associated with this permit relative to permits held by other water users in the basin, and this permit is transferable (that is, it can be sold). Water permits are, in effect,

3. For an historical review, *see* C. Chang and R. Griffin, *Water Marketing as a Reallocative Institution in Texas*, Water Resources Res., (1992) (forthcoming). In Texas the waters of the ordinary flow and underflow of the rivers and natural streams, stormwater, floodwater, and rainwater are the property of the state, to be held in trust for the use and benefit of all the people. *See* Tex. Water Code Ann. § 11.021(a) (Vernon Supp. 1986). This state water is subject to appropriation. Tex. Water Code Ann. § 11.001 (Vernon Supp. 1986).

property rights to a commodity.[4] In theory, this property right is limited by the seniority system which protects more senior rights from interference by junior rights.

There are two caveats to this general portrayal of Texas surface water law. First, Texas law prioritizes the water uses of different sectors as a means of settling allocation disputes in general and as a means of guaranteeing, in particular, that municipal and domestic water will always be available. In theory, interests pursuing municipal or domestic water supplies possess eminent domain authority to take water from other sectors.[5] This is a clear exception to the "first in time, first in right" rule of prior appropriations. Water appropriations that were begun after 1931 can even be taken without compensation.[6] In practice, it has been more viable to develop additional supplies or to find willing water sellers. Second, water law for the lower Rio Grande Valley (RGV) departs from these statements insofar as seniority is concerned. Surface water rights in the RGV are correlative, so that periodic shortage or abundance is equally shared by all right holders.[7]

Many economic theoreticians are unabashed in their support for the appropriative style legal system Texas uses for surface water. They argue that the appropriation doctrine establishes well defined property rights to water in the form of permits, and the transferability of these permits creates a market price for water.[8] The logic employed here holds that price is an information-rich signal about the relative scarcity of water and that this signal urges individuals to do the right things in response to this scarcity level. Because price induces appropriate action by people, ad-

4. A permit is merely a license to become an appropriator of public water on statutory conditions. The appropriative right is a right of private property. *See*, Clark v. Briscoe Irr. Co., 200 S.W. 2d 674 (1947). The appropriative right or a permit may be sold and assigned without invalidating the appropriation. *See* Fairbanks v. Hidalgo County W.I. Dist. No. 2, 261 S.W. 542, 545 (Tex. Civ. App., 1923; *writ dism.*)

5. Under a 1931 law popularly known as the Wagstaff Act, it was established that certain water uses are preferred over others. "It is express public policy of the State of Texas, and for benefit of greatest number of people that, in appropriation of water, appropriation of water for domestic and municipal uses is and remains superior to rights of state to appropriate it for all other purposes." *See* Tex. Water Code Ann. § 11.024(1) (Vernon Supp. 1986). Sections of the Act also granted eminent domain powers to political subdivisions of the State to take water necessary for domestic and municipal uses. *See* Tex. Water Code Ann. § 11.033 (Vernon Supp. 1986).

6. "Any appropriations made after May 17, 1931, for any purpose other than domestic or municipal use is subject to the right of any city or town to make future appropriations of the water for domestic or municipal use without paying for the water." *See* Tex. Water Code Ann. § 11.028. (Vernon Supp. 1986). According to J. Milliman, *Water Law and Private Decision-Making: A Critique*, 2 J. Law and Econ. 41, 50 (1959), "It is difficult to see how such a statute can be justified either on grounds of economic efficiency or on those of equity and protection of investment."

7. *See* Chang and Griffin, *supra* note 3.

8. According to Anderson, "Restrictions on transferability [of water permits] are restrictions on efficiency." *Supra* note 1, at 4.

ditional regulation is unnecessary.[9] In the absence of this signal, other coercive institutions are needed to motivate appropriate production and consumption decisions, and it can be very difficult to design a policy which accomplishes this.

A prime difficulty with such nonmarket policies is the ability to gather, process, and use information effectively. The information base is constantly shifting as populations, preferences, resource availabilities, and technologies change. Command-and-control policies can establish appropriate water allocations, but, once set, the rigidity of these policies causes them to age rapidly. By emphasizing a continuous, decentralized *process* of reallocation rather than the precise allocations at any one point in time, economists have made an interesting contribution to the management of water scarcity.

Economic support of the appropriation doctrine pertains primarily to water rights as transferable property rights, and secondarily to the seniority system which gives more risk-adverse water users the opportunity to protect their specialized interests by trading for more senior rights.[10] More senior rights possess greater value to users and therefore command higher prices.

While describing Texas water management institutions, it is important to recognize the interface between water markets and Texas water districts. Broadly empowered, regional water districts, usually called river authorities, were created during the 1929-59 period to assist Texas water development efforts.[11] River authorities operate independently and without the benefit of any state funding. As a consequence of the latter feature, the style of these organizations has been to favor internal reallocations of their water rights to more highly valued uses (and more highly paying customers).

There appears to be economic cause to both celebrate and condemn the river authority concept. On the one hand, river authority appreciation for revenue has led them to be responsive to changing private demands. On the other hand, they dominate particular basins to a degree that market competition is impossible. Moreover, market participation by river au-

9. These ideas are based on the well known "invisible hand" arguments. To the extent that price institutions summarize the information in the market, individuals acting on the basis of price signals will act in their best interests and, by so doing, the best interests of society in aggregate. *See* C. Schultze, The Public Use of Private Interest (1977).

10. For a discussion of the economic content of the relationship between the appropriation doctrine and property rights *see* T. Anderson, Water Crisis: Ending the Policy Drought (1983). On the risk-distribution characteristics of the appropriation doctrine, *see* H. Burness and J. Quirk, *Appropriative Water Rights and the Efficient Allocation of Resources*, 69 Am. Econ. Rev. 25 (1979).

11. The creation and operation of regional districts for water purposes is authorized by statute, under authority of the Conservation Amendment to the Texas Constitution. *See* Tex. Water Code Ann. § 50.451(a) (referring to Texas Constitution Article XVI § 59).

thorities has been confined to buying (not selling) water rights and, often, the leasing of water to industries and cities. Monopolistic influence has therefore tended to increase, and there is no evidence suggesting that a reversal of this power will ever occur. To place these observations in perspective, 13 river authorities control 25 percent of the surface water that is consumptively used in Texas, and about 30 percent of the water rights held by these organizations were not developed originally but were purchased as part of acquisitions of other private or public canal companies.[12] Some basins contain no river authorities or only small river authority operations while other basins are dominated by river authorities.

Water as a Commodity: Similarities and Differences

It is important to understand the pros and cons of depicting water as a marketable commodity. An example will suffice. When the owner of an orange sells it to another party, he/she sacrifices the orange in exchange for money, and the buyer sacrifices the buying power of the money in exchange for the orange. No one else is affected by the exchange, so both parties are able to make good *social* decisions in this case. Therefore, social interests are well served by merely establishing property rights to oranges. Such a policy has excellent dynamic properties, because the buyers and sellers will naturally respond to changing scarcity. If unfortunate weather in the form of a freeze reduces the production of oranges, then price is bid up and consumption is reallocated to only the higher valued uses. Political elements need not debate the orange needs of various groups so as to legislate a specific course of action to address the crisis. An administrative agency need not investigate the orange shortage and hire consultants to study opportunities for orange conservation. The government need not construct another orchard; if orchard construction is advantageous, entrepreneurs will respond. Finally, orange management districts appear superfluous.

Such considerations are fundamental to economic logic regarding the merits of market-based policy. As a consequence of the similarity between an orange and a gallon of water, economists are prone to be positive about a market policy for the production and allocation of water. On the other hand, if the buyer intends to consume the orange and throw the rind on the roadside, then other people are affected. Policy needs then become more complicated than the simple assignment of property rights. Market policy may require some augmentation to correct the external effects of the transaction. In this case, the establishment of litter laws

12. *See* J. Harper and R. Griffin, *The Structure and Role of River Authorities in Texas*, 24 Wat. Resources Bull. 1317 (1988).

Table 1. Hypothetical Water Market Effects

	I. Initial Conditions		II. C sells 250af to A	III. C sells 100af to A
Streamflow	1000		1000	1000
Urban Diversion	-500	A	-750	-600
Streamflow (Segment 1)	500		250	400
Urban Diversion	-400	B	Harm	-400
Streamflow (Segment 2)	100			0
A's Return Flow (60%)	+300			+320
B's Return Flow (75%)	+300			+300
Stream Flow (Segment 3)	700			620
Agricultural Diversion	-500	C		-400
Streamflow (Segment 4)	200			220
C's Return Flow (20%)	+100			+80

(which limit property rights in the orange) seems sufficient, but it is conceivable that social interests in external effects are so weighty that markets are not advantageous relative to the institutional alternatives. What external effects might be associated with water rights exchanges? Is water different from oranges in some substantive ways?

Upon close inspection, there are some potential external effects that *can* be associated with surface water right transfers in general or specific circumstances. These include return flow externalities, instream values, and secondary economic effects. Each of these categories is a potential source of market failure, so we will examine each in turn. In effect, each category represents an area where market-based policy may be deficient. The first two can be considered together.

Return Flow Externalities and Instream Benefits

Consider the simple example illustrated in Table 1. City A has a permit to divert 500 acre-feet (af), but it only consumptively uses 40 percent of this water with 60 percent (300 af) reentering the river at some point

downstream as return flow. City B, A's downstream neighbor, possesses a permit to withdraw 400 af, and its return flow of 300 af (75 percent) occurs at the same point as does City A's return flow. Downstream, farmer C can legally divert 500 af and the farmer's return flow is 100 af (20 percent). Column I of Table 1 illustrates the pattern of diversion, return flow, and streamflows that result from this scenario. As a consequence of these combined uses, streamflow has been depleted from 1,000 af to 300 af.

Now suppose that the farmer sells half of the farm's diversion rights (250 af) to City A. City A can now divert 750 af from the river, and this fact is depicted within column II of Table 1. Following A's diversion of this amount, there is only 250 af in the river—an insufficient amount to satisfy City B's permit. A market structure allowing this exchange between A and C would fail because of external effects upon B. Water users within a given basin are dependent upon the arrangement of each other's diversions and return flows. Changes within this arrangement can have third-party effects which are generally termed "return flow externalities."

It is noted in the theoretical literature that a market fix can be achieved by limiting transfers to only the consumptively utilized portion of a water permit and barring transfers which harm third parties.[13] Like other western states, Texas uses this suggestion by informing all potentially affected permit holders of a proposed transfer and providing a hearing regarding the proposal. If deleterious impacts are found, the transfer is not approved by the Texas Water Commission (TWC).[14] This refinement therefore appears to be a sufficient remedy, and detrimental return flow externalities will be largely avoided. It is notable that this procedure does not aid in the encouragement of permit transfers where there are beneficial return flow externalities. It only limits detrimental return flow externalities. Clearly, any process for reallocating water rights, including marketing, faces an informational burden in discovering and accounting for return flow effects. The present system is likely imperfect, but better options have not arisen.

Suppose a best case scenario in which this administrative procedure is followed. To avoid injury to City B the transfer is limited to 100 af of diverted water with an obligation that return flow from this 100 af will still be 20 percent (20 af). In the aftermath of this transaction the situation identified by the final column of Table I is obtained. Overall, it can be positively observed that all permit holders are satisfied and final streamflow is maintained at 300 af so that unrepresented, downstream users are unaffected.

13. *See* L. Hartman and D. Seastone, Water Transfers: Economic Efficiency and Alternative Institutions (1970).

14. *See* Chang and Griffin, *supra* note 3.

An expanded perspective and further inspection reveals, however, that instream flow regimes have been affected. There are four consecutive stream segments of interest beginning with the point of A's diversion and ending at the point of C's return flow. Contrasted to the pretransfer scenario, streamflows have changed along all four segments. For the first three, streamflows have been reduced. Streamflow for the fourth segment has been enhanced. In general, the reduced streamflow can be damaging to streamflow users along segments 1-3, and streamflow users along segment 4 can be benefited. Instream values relating to recreation, aquatic and wildlife habitat, general aesthetics, estuary inflows, and the assimilation of pollution are attracting increased attention, both within economic theory and water law.[15]

The most noteworthy point is that instream flow effects constitute yet another form of external effect, and unless instream users participate in market activities in a unique manner, economic efficiency may not be served by a water market.[16] An interesting alternative is to employ agency-defined economic incentives to subsidize downstream transfers of water rights and to tax upstream transfers of water rights as a means of accounting for instream flow values that might otherwise be undervalued.[17] Such a policy would be relatively simple to apply given that administrative approval of transfers is already required, and it would also avoid the demand revelation problem caused by the public good character of many instream uses.[18] There are several regulatory alternatives for addressing instream water demands, but the prospective interface between these

15. For an excellent discussion of the many important issues associated instream water uses, *see* L. MacDonnell, T. Rice, and S. Shupe, Instream Flow Protection in the West (1989).

16. By definition, instream users do not divert water so their interests in the water resource are on somewhat incompatible terms with the interests of diverters. Not only is there competition for limited water, but diverters and instream users care about different dimensions of the water resource. Diverters care about diverted and consumed quantities; instream users care about flow quantities and lake levels. The dimensioning problem confuses simultaneous market participation by both user groups. Diverters need to hold permits to divert water. Instream users are unaffected by diversion activities as long as the diversions occur downstream from the location of their interests. Therefore, instream users do not have to buy diversion permits to enhance instream benefits; they can just as effectively enhance instream flows by subsidizing the reallocation of diversion permits to diverters downstream. As a second important issue, there is often a high degree of nonrivalry and nonexclusivity associated with instream uses. These are the two technical conditions necessary to define a public good. To illustrate: during a period of low river flow along a certain segment, additional flow could benefit many individuals and, if congestion is not a problem, the amount of extra benefit received by one individual will be largely independent of the benefits experienced by others. This is nonrivalry. If instream users can enjoy these benefits without cost because there is no effective means of excluding them (nonexclusivity), then we confront the classic free rider (or demand revelation) problem associated with public goods. Markets cannot produce or allocate public goods efficiently because of these two conditions. *See* R. Boadway, Public Sector Economics (1979).

17. *See* R. Griffin and Shih-Hsun Hsu, *The Potential for Water Market Efficiency When Instream Flows Have Value*, Am. J. Agric. Econ. (1992) (in review).

18. See the explanation of note 16.

institutions and water market institutions is problematic. This is as it must be, for at issue is the matter of allocating water between instream and diversionary water uses.

Secondary Economic Effects

The third area of possible market failure pertains to secondary effects and so-called "area-of-origin" concerns. Market reallocations are dominated by agricultural-to-urban transfers which often infers that there are distinct exporting regions (areas-of-origin) and importing regions (areas-of-receipt). From the perspective of the area-of-origin, the transferred water represents a lost resource base, and this is a major concern throughout the West.[19] Economists sometimes tend to dismiss this perspective as protectionism and as a barrier to the achievement of economic efficiency.[20] It is professed that negative secondary effects for the area-of-origin are balanced by the positive secondary effects for the area-of-receipt in a full employment economy. This argument is available only when the accounting stance remains broad enough to encompass both regions. Local business interests and their political representatives cannot be so generous. Recent literature is mindful of the importance of water resources to local development and welfare opportunities.[21] For the economist whose concerns extend beyond the limited norms of economic efficiency embodied in potential Pareto optimality or Pareto optimality, there are potentially crucial distribution matters involved in water market advocacy, and these concerns represent another potential market failure.

19. To deal with secondary effects and "area-of-origin" concerns, a 1913 Texas law states that "no person may take or divert any of the water of the ordinary flow, underflow, or storm flow of any stream, watercourse, or watershed in this State into any other natural stream, watercourse, or watershed to the prejudice of any person or property situated within the watershed from which the water is proposed to be taken or diverted." *See* Tex. Water Code Ann. § 11.085 (Vernon Supp. 1986). The Texas Supreme Court has held that prejudice is to be determined by weighing the detriments to the basin of origin against the benefits of the diversion. *See* City of San Antonio v. Water Comm'n, 407 S. W. 2d 752, 759 (TEX. 1966). Passed in 1965, the Water Resources Administration and Development Act authorized the development of a state water plan and explicitly prohibited "any plan which contemplates or results in the removal from the basin of origin of any surface water . . . required to supply the reasonably foreseeable future water supply requirements for the ensuing fifty-year period within the basin of origin, except on a temporary interim basis." *See* Acts 59th LEG., p. 587 ch. 297, 583-604 § 3(b). C. Johnson and L. Knippa have referred to this provision as a "fifty-year lock-up" and have argued for its removal. *See Transbasin Diversion of Water* 43 Tex. L. Rev. 1035 1965. For a good discussion of area-of-origin problems in Western states, *see* L. MacDonnell, C. Howe, J. Corbridge Jr. and W. Ahrens, Guidelines For Developing Area-of-Origin Compensation (1985).

20. *See supra* note 1 and references therein.

21. For example, *see* studies by F. Brown and H. Ingram, Water and Poverty in the Southwest (1987); H. Ingram and C. Oggins, Water, The Community and Markets in the West (1990); Also, *see* K. Weber, *Effects of Water Transfers on Rural Areas: A Response to Shupe, Weatherford, and Checchio*, 30 Nat. Res. J. 13 (1990).

The problem of secondary effects is an inherently normative topic, and the science of economics seems ill suited for prescribing a cure when no illness is believed to be present.[22] It should be recognized that all allocative institutions, not just markets, must confront this issue. For example, the management of the Lower Colorado River Authority (LCRA) continues to struggle over the potential reallocation of its extensive water right holdings. While the vast majority of this water has been committed historically to a productive rice industry, upstream, Austin-based interests are seeking water for urban use and the maintenance of stable lake levels during the summer. If revised LCRA policies result in a substantive reallocation and a consequent reduction in rice production, the rural rice-producing region will clearly suffer.

Texas Water Marketing: Activity and Benefits

Based upon both formal and informal observations, it appears that Texas has had a positive experience with surface water marketing. The only concrete Texas evidence emanates from water market operations in the RGV where seniority is absent, so a measure of the value of seniority cannot be established. Purchase and lease prices of RGV water rights can be obtained and contrasted to use values. During the 20 years since a final determination of water rights in the RGV, some 150+ transfers have occurred.[23] Ninety-nine percent of these transfers are from agricultural to nonagricultural use. Transfers from agriculture to municipalities have amounted to nearly 75,000 acre-feet.[24] Forty-five percent of current urban holdings of water rights were possessed by agriculture twenty years ago. Water rights have traded at prices ranging roughly from $450 to $600 per acre-foot, and water can be leased for one season at $15-$18 per acre-foot[25] There are no river authorities operating in the RGV. The many water districts of the RGV participate in rental markets as both lessors and lessees, but they do not sell water rights. Sales have been from private individuals and firms.[26]

22. Although economics is a normative science, in its predominately neoclassical form there is little room for considering secondary effects. Because any identified secondary effect is thought to be offset by an equal and opposite effect elsewhere, it is generally held that the issue is one of income distribution rather than allocative efficiency. Even though they are uniquely postured for the task, most economists are reluctant to make recommendations involving matters of income distribution. *See* J. Hamilton, N. Whittlesey, M. Robison, and J. Ellis, *Economic Effects, Value Added, and Benefits in Regional Project Analysis*, 73 Am. J. Agric. Econ. 334 (1991).

23. A detailed study of the lower Rio Grande water market has been conducted by Chang and Griffin, *supra* note 3. The information presented in this section is condensed from Chang and Griffin.

24. *Id.*

25. *Id.*

26. *Id.*

Chang and Griffin selected some representative 1983-84 transfers to estimate the agricultural value of traded water as well as its new value in municipal use.[27] Consultations with transactors indicated that much of the sold agricultural water would have otherwise been unused by its owners. Agricultural water values can be bounded above, however, by making the generous assumption that irrigation water would have been devoted to cotton production. After including government farm program payments to capture private agricultural values, it was determined that the sacrificed value of sold water compounded over a fifty-year period ranged from $300 to $2,300 per acre-foot depending upon expected cotton prices and dryland cotton yields. This contrasts with municipal benefits that range from $6,500 to $21,000 per acre-foot depending upon future rises in municipal utility rates.[28] Municipal benefits were computed as the added consumer surplus provided by the water purchase after accounting for projected rate increases and population growth over a fifty-year planning period.

These findings indicate that the net value of these transfers can be rather large. Assuming that the average transfer produced $10,000 of net benefits per acre-foot, there is a sizable aggregate value for the 75,000 af transferred from agricultural to municipal use during the past twenty years. The extension of these results to the rest of Texas or other states is ill advised for several reasons. The return flow externality and secondary economic effects issues are largely absent in this region. Return flows are negligible because of proximity to the Gulf of Mexico. Water transfers are generally local, and the secondary economic effects problem is rather moot. Moreover, instream flow values are relatively unaffected by marketing in the RGV.[29] Finally, this is a region of very high population growth which causes unusually high municipal benefits.

These results provide some testimony, albeit a likely best case scenario, regarding the potential merits of market-based policy. In the absence of transferable water rights, what would have transpired during the two decades since adjudication in the RGV? After all, marketing operations have nearly doubled municipal water supply during this period. We submit that there would have been a substantial amount of political haranguing, calls for legislative action, formation of special interests groups, and

27. *Id.*

28. *Id.*

29. Rio Grande flows are slight except for releases from upstream reservoirs. As a consequence of this fact, water administrators view the lowermost reservoir as the diversion point for all downstream diversions. Because reservoir releases travel across essentially the same stretch (diverters are concentrated close to the Gulf), it is felt that transfers are inconsequential for either return flows or instream flows.

excruciating interdisciplinary studies of the water problems of the Rio Grande Valley basin. Instead, reallocation in the RGV has occurred steadily and without fanfare.

Needed Refinements in Surface Water Marketing Institutions

Overall, there are some compelling reasons to believe that surface water marketing is serving the state well. If this is to continue into the future, additional legal and administrative refinements will be required to meet changing goals and socioeconomic settings as well as accounting for the different physical circumstances of other areas. The needed refinements in surface water marketing institutions relate to three principal concerns: return flow externalities, instream flow values, and secondary economic effects.

Return Flow Externalities

Return flow externalities are, for the moment, sufficiently accounted for in Texas water law. It was stated earlier that Texas third parties are protected from detrimental return flow externalities which might result from water right transfers. Water law or, more accurately, administrative procedure is adequate in this way. It is interesting to observe that while third parties are receiving protection from the harms of water transfers, they are not protected from return flow changes which occur when a water user changes a water use practice. For example, a farmer may freely alter irrigation technology to a more efficient system, allowing an increase in irrigated acreage with no increase in water diversions. A likely side effect of such a decision will be an increase in the consumptive use of water and a decrease in return flow. Similarly, cities have urged residents to engage in conservation measures, many of which increase the ratio of consumed water to diverted water, with negative consequences for return flows.[30] Water reuse programs, such as tailwater recovery by farmers and golf course irrigation with effluent by cities, are clearer examples of

30. The conservation measures initiated by cities in Texas are partly in response to the initiative taken by the 69th Texas Legislature in redefining water conservation in the Water Code to include both the development of water resources and those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for current and future consumptive and non-consumptive uses. Act of May 23, 1985, ch. 133, § 1.09, 1985 Tex. Sess. Law Serv. 630, 635 (Vernon) (Codified as Tex. Water Code Ann. § 1134 (Vernon Supp. 1986)). The legislation became effective upon the passage in November 1985 of the constitutional amendments which were proposed by Tex. H.R.J. 6, 69th Leg., 1985 Tex. Sess. Law Serv., A-100 (Vernon Supp. 1986).

technology adoption which harm third parties through reduced return flow.[31]

Legal reform for accomplishing a more complete treatment of return flow interrelationships must involve a more accurate conceptualization of the ways in which people use and benefit from water. At this juncture in the history of evolving water scarcity it is important to recognize that the individuals responses to changing scarcity can alter diversion and/or consumption quantities. Both impacts are important to other users. It follows then that there are properly two sticks to be emphasized in the property rights bundle having to do with water. To date, water law of the western states has emphasized one stick, to wit, allowed diversion quantity, with various regulatory bandaids being applied in attempts to repair the inadequacies of this narrow notion. A preferred approach may be to distinguish two property rights in water: a right to divert a fixed amount of water and a right to consume a fixed quantity of water. Not only could water marketing be extended to trade in both types of rights (thereby internalizing the return flow externality), but such a system of water rights would also erect appropriate incentives for individuals modifying their practices of water use.

Instream Benefits

At least one author has argued for a rearrangement of sectoral water priorities to rank instream flow needs highly and thereby authorize the TWC to grant instream flow appropriative permits, deny other permit applications on the basis of possible instream flow related damage, and condition diversion permits so that environmental damages are lessened.[32] This approach is close to what is needed, but it (1) is overly regulatory, (2) fails to effectively harness the Texas surface water market, and (3) fails to recognize its impact upon water reallocations that will be needed in the future. The sectoral priorities have never been an effectual basis for allocating water and consequently have never found much application. Quite simply, it cannot be maintained that a particular type of water use is more beneficial than another in all circumstances. But Johnston is correct in noting the need for allowing appropriative permits to be held

31. Water reuse projects are on the increase in Texas. For an excellent discussion of the legal-institutional questions raised by these projects, *see* F. Booth, *Ownership of Developed Water: A Property Right Threatened*. 17 St. Marys L. J. 1185 (1986). Also, *see* S. Peel, *Acquisition of Municipal Water Rights in Texas: A Conceptual and Operational Analysis*. 17 Tex. Tech. L. Rev. 811 (1986).

32. *See* the discussion by J. Johnston, *Environmental Significance of Instream Flows*, 17 St. Marys L. J. 1297 (1986).

for instream uses. Instream users, user groups, and representative agencies (such as water districts, river authorities, and the Texas Department of Parks and Wildlife) should be allowed to apply for permits of unappropriated waters and *purchase water rights* from currently licensed water diverters.

A good argument can even be constructed for a *one-time* reapportionment of water from current diversionary uses to instream use as a means of redressing past policy deficiencies which tipped the scales against instream uses. Whether public trust or some other concept is employed to accomplish this realignment is not as important as the need to assure water users that the heavy hand of government will be reluctant to again perform the service. After a one-time exercise of reapportionment, changes in instream water demand can be accommodated through market activities or incentive-based policies such as the tax/subsidy scheme suggested previously.[33] Once instream uses have achieved equal standing and protection, further threat of intervention can only undermine decentralized policies and encourage unproductive expropriative effort and defensive action. It has long been acknowledged that property rights to water require a large degree of tenure certainty if water markets are to operate effectively.[34]

If market policy is expanded to incorporate instream flow users or user groups, the TWC practice of notifying other water users regarding proposed transfers and conducting hearings to assess third-party impacts should include notification of those permit-holding parties dependent upon instream flows. In the absence of such changes, the default approach could be the burdensome exercise of the public trust doctrine in courtrooms on an individual, case-by-case basis. Experience indicates that this is an onerous, time-consuming, and costly alternative.

Secondary Economic Effects

The issue of reform for acknowledging secondary effects is still more perplexing. If it is determined that deleterious secondary effects are cause for moderating so-called reallocations to "highest and best use," then it may be possible to devise schemes for compensating areas-of-origin.[35] Exporting regions could obtain the legal authority to levy taxes upon water exports and devote the resulting receipts into economic development

33. *See* Griffin and Hsu, *supra* note 17.

34. On this point, both the courts and economists are in agreement. For an excellent discussion of these principles by economists, see S. V. Ciriacy-Wantrup, *Concepts Used as Economic Criteria for a System of Water Rights*, 32 Land Econ. 295 (1956); and, Milliman, *supra* note 6. From the perspective of Courts, *see*, generally, Sporhase v. Nebraska, 458 United States 941, 953 (1982).

35. *See* MacDonnell, *supra* note 19.

projects. A similar proposal would be to require that all sales be conducted through an area "Water Marketing Board" with the stipulation that proceeds be allocated by formula among the seller and local interests. If status quo economic relationships between current water users and area businesses and workers are grounds for protection, we must be mindful of the consequences. Perhaps foremost among these is the inertia conveyed to water rights. Far fewer water rights will be reallocated to new uses if it is necessary to compensate the indirect beneficiaries of the old uses.

III. THE POTENTIAL FOR GROUNDWATER MARKETS IN TEXAS

Law and Economics

Groundwater is administered in Texas according to the principle of absolute ownership—a doctrine derived from English common law.[36] Texas landowners may extract groundwater from beneath their land as long as their use is not wasteful.[37] The condition of no waste is a very light burden in the state as interpretation extends only the landowner's practice of use, not in relation to alternative, perhaps more highly valued, uses by other individuals.[38] With respect to water marketing, the land-

36. Groundwater in Texas is defined by the statute relating to underground water conservation districts as water suitable for agricultural, gardening, domestic or stock-raising purposes, percolating below the earths surface. Tex. Water Code Ann. § 52.001 (Vernon, 1986). Texas courts have held that Percolating waters are exclusive property of owner of surface of soil and owner has all rights incident to them that one might have as to any other species of property Texas Co. v. Burkett, 117 Tex. 16, 296 S.W. 273 (1927). The English rule announced in Acton v. Blundell, 12 M.2.W. 324 (1843) was adopted in the case of Houston T.C.R.R. v. East, 98 Tex. 146, 81 S.W. 279 (1904). The rule states that, the person who owns the surface may dig therein, and apply all that is there found to his own purposes at his free will and pleasure; and that if, in the exercise of such right, he intercepts or drains off the water collected from underground springs in his neighbors well, this inconvenience to his neighbor falls within the description of *damnum absque injura*, which cannot become the ground of an action, at 280.

37. The limitation of the English rule is that the owner may not maliciously take water for the sole purpose of injuring his or her neighbor, Cantwell v. Zinser, 208 S.W. 2d 577 (1948, CA) (landowner has no right to intercept and waste percolating waters to detriment of adjoining landowner, or wantonly and willfully waste it. *See* Corpus Christi v. Pleasanton, 154 Tex. 289, 276 S.W. 2d 798 (1955); Pecos County Water Control & Improv. Dist. v. Williams, 271 S.W. 2d 503 (1954, CA) (writ ref in re) (holding landowner owns percolating water under his or her land and can make nonwasteful use of it)). Also, *see* Friendswood Dev. Co. v. Smith-Southwest Industries, Inc., 576 S.W. 2d 21 (1978, Tex.).

38. The "use test" is well established in Texas law and is codified under Tex. Water Code Ann. § 11.205 (Vernon Supp. 1986). Thus, for example, in Corpus Christi v. Pleasanton, 276 S.W. 2d 798, 802 (1955) in which plaintiff charged that water losses due to the means of transportation from place of capture to place of use constituted waste, the Texas Supreme Court interpreted the statute to mean that "the transportation of artesian water by specified means . . . constituted waste and was unlawful only if the water was put to an unlawful use."

owner does not hold title to specific units of water beneath his land.[39] Thus, groundwater marketing is limited to two forms in Texas. The landowner may "reduce groundwater to ownership" by pumping it after which it can be sold and transported. Or the land itself may be sold, after which the new owner may pump water and apply it to a different use, perhaps somewhere else. Texas High Plains cities relying on the Ogallala Aquifer have purchased nearby irrigated farmland to enhance municipal water supply. There is at least one Oklahoma city (Altus) which has acquired Texas land for this use.

Despite occasional use, these market forms are quite limited in their ability to address growing water scarcity. The fundamental issue is that a groundwater user cannot contract with another groundwater user for a reduction in one's pumping so that the other may increase pumping. Economists have argued for the legal reform necessary to use this third, most comprehensive market form, which is active in some states.[40] The basic reform is to adjudicate groundwater rights and assign quantitative permits to users. Before pursuing the point further, there is a logically prior matter. *What third-party impacts would accompany a general groundwater market and are these sufficiently extensive to recommend nonmarket, regulatory policies over marketing?*

The earlier surface water discussion provides considerable insight for obtaining answers to this all-important question. Of the three classifications of surface water external effects, two are clearly relevant to groundwater: return flow externalities and secondary economic effects. A third category, instream values, is irrelevant in the case of groundwater.[41] On the other hand, two new sorts of external effects peculiar to groundwater emerge: inter temporal externalities over the depletion rate of groundwater stocks and the impacts of well drawdown upon neighboring wells. Thus, four possible market failures associated with groundwater marketing need to be addressed: return flow externalities, secondary economic effects, inter temporal externalities, and well drawdown.

39. One commentator has argued that the designation of the English rule as absolute ownership is not exactly accurate. What the landowner has absolute ownership of is the water after he has removed it from the soil and reduced it to possession, *see* A. Walker, *Theories of Ownership and Control of Oil and Gas Companies with Those of Groundwater*, in Proc. Water Law Conference, Univ. of Texas (1956). A contrary view holds that the owner of the surface *does*, with minor exceptions, own the water under it just as he owns the oil and gas. *See* J. Greenhill, (in the same Proceedings). *See* discussion in W. Hutchins, The Texas Law of Water Rights (1961). For a recent discussion of those issues *see* C. Johnson, *The Continuing Voids in Texas Water Law: Are Concepts and Terminology to Blame?* 17 St. Marys L. J. 128 (1986).

40. M. Gisser, *Groundwater: Focusing on the Real Issue*. 91 J. Pol. Econ. 1001 (1983).

41. Groundwater-surface water interactions can cause groundwater reallocations to have relevance for instream flows, but we are addressing pure groundwater scenarios at the present time.

Return Flow Externalities and Secondary Economic Effects

As in the case of surface water, return flow to the aquifer subsequent to groundwater use creates third-party effects that are relevant to market exchanges. Adequate control of return flow external effects is possible by limiting exchanges to the consumptively utilized portion of a groundwater permit. Secondary economic effects are also at issue for groundwater exchanges—again giving rise to the difficult question of whether to protect sectors which are economically linked to water right sellers. With regard to policy needs for managing aquifers serving rural areas, the question of secondary effects can become a crucial issue due to the limited economic alternatives for those people who are economically dependent upon irrigated agriculture.

Intertemporal Externalities

Present groundwater law provides landowners with broad latitude in choosing the rate at which they mine nonrenewable groundwater stocks. It is theoretically well established that profit-maximizing groundwater users do not ignore future interests in groundwater availability. Rather, they logically trade off the value of present use against the opportunity costs of future uses, and vice-versa, with personal discount rates having critical bearing upon this decisionmaking. The lesser the discount rate, the greater the incentive to conserve groundwater supplies for future use.[42] Of course, in highly permeable and transmissive formations such as the Edwards Aquifer, which serves the San Antonio region, the fugitive nature of the groundwater resource implies that individual decisions to conserve water for the future do not prevent others from using it.

It is also well established that the use of discounting in such decision processes constitutes formal dictatorial rule by the present generation when society is conceived as the aggregate of all people, present and future.[43] Therefore, a perception of future people as equal members of society would require that a zero discount rate be employed in assessing the optimal rate of depletion for groundwater. This would have dramatic

42. Using the illustrative example of a purely exhaustible and nonrechargable aquifer, a competitive market system will "mine" the aquifer at a rate which maintains $p_t = p_0 e^{rt}$ across all time periods. Here, p_t is the net value of water (after pumping costs are paid) per unit of water in period t, e is the base natural logarithmic constant, and r is the personal discount rate. Thus, net water value must grow at the rate of interest, and this is controlled by the rate of groundwater withdrawal. Other things being equal, an increase in the discount rate implies that net water value must increase more rapidly over time, and this can only be accomplished through a higher rate of depletion. *See* H. Hotelling, *The Economics of Exhaustible Resources*, 39 J. Pol. Econ. 137 (1931).

43. *See* J. Ferejohn and T. Page, *On the Foundations of Intertemporal Choice*, 60 Am. J. Agric. Econ. 269 (1978).

implications for groundwater use where such use relates to nonrenewable stocks. In particular, application of a zero discount rate may well indicate that no groundwater mining should be undertaken currently.

While technological advance achieved through investment by the present generation is typically advocated as a genuine offset for resource depletion, a balanced appraisal probably culminates by acknowledging that private discount rates are too high for serving a society which perceives future people as its members, even if they are lesser members. Although groundwater marketing is not the lone institution possessing this failure, a complete proposal for revising groundwater law to support water marketing should address this issue clearly.[44] It may be desirable to remove groundwater depletion decisions from market purview by fixing annual groundwater rights through a more socially sensitive process than that offered by the investment-oriented mindset of a particular generation of people, where each person is constrained to individual (rather than collective) action and is powerless to conserve for future peoples without jeopardizing one's own economic position. Once annual groundwater rights are established by nonmarket process, ensuing trade among current and prospective groundwater users would then influence water allocation across alternative uses statically but not dynamically.

Drawdown Externalities

Unless groundwater rights are carefully defined, a groundwater market will involve uncompensated external effects between users due to water table drawdowns. Thinking of groundwater rights as transferable rights to derive net benefits from the groundwater resource, it is clear that pumping lifts are important determinants of these benefits. Many groundwater right transfers would likely result in an altered geographic distribution of groundwater withdrawals, thus altering local patterns of drawdown even when total aquifer extraction is unchanged.[45] These changes may well harm third parties while assisting others. In this same vein, it has been argued that "absolute ownership" is a misnomer for Texas groundwater principles, because the groundwater user is not protected from water table declines brought on by one's neighbor.[46]

Possible legal remedies for this external effect include (i) well spacing regulations or (ii) flexible standards of "reasonableness" involving the

44. All proposable mechanisms for balancing "consume now" versus "conserve for later" issues will be unavoidably attentive to the wishes of those at the table. The absence of future people does not mean that they are unconsidered, however, for they can be represented altruistically.

45. *See* J. Emel, *Groundwater Rights: Definition and Transfer*, 27 Nat. Res. J., 653 (1987).

46. *See* Johnson, *supra* note 39.

degree of permitted injury upon third parties.[47] According to Emel, these corrections are inferior to a third remedy: the establishment of fixed, quantitative criteria concerning the amount of well interference which is permitted in any given area. Under the latter system, a proposed transfer of the consumptively used portion of a groundwater right should be analyzed by the prevailing hydrologic simulation model for the aquifer. If the transfer does not cause the criteria to be exceeded, the transfer is approved.[48]

The Edwards Aquifer

As a more precise backdrop for further discussion, it is useful to survey important features of the critical Edwards Aquifer problem being faced within the area surrounding San Antonio. The aquifer is unique in its very high transmissivity, resulting from its fractured limestone structure. San Antonio is the nation's third largest city that is entirely dependent upon groundwater, all of which comes from the Edwards.[49] San Antonio's wells are among the world's most productive. As a result, residents here and in neighboring communities pay some of the lowest water rates in the state.

The aquifer is recharged at its western outcropping in the Nueces River basin. Groundwater flows out of the basin eastward, serving first as an important source of irrigation water in a semiarid environment. From there water flows through the portion of the formation underlying San Antonio whose original settlement occurred because of springflow (no longer active). Finally, Edwards' groundwater discharges at several springs. The most important of these springs, Comal and San Marcos, yield large discharges which are important to the availability of surface water in the Guadalupe River basin.[50] Even more crucially, these springs are environmentally unique, home to some endangered species existing nowhere else, and the clear, scenic waterways attract large numbers of recreationists and their economy-supporting expenditures.

Annual aquifer recharge averages 635,500 acre-feet but has varied from 43,700 to 2,003,600 acre-feet.[51] Varying recharge is quickly reflected in well water levels and springflows. Maximum annual pumpage for the 1978-88 period has been estimated at 588,000 acre-feet, omitting springflows.[52] Municipal and military use accounts for 288,000 acre-feet of this

47. *See* Emel, *supra* note 45.
48. *Id.*
49. *See* 7 United States Water News, 12, 1 (June 1991).
50. Special Committee on the Edwards Aquifer, Committee Report to the 72nd Legislature, January 8, 1991, pp. 38-9.
51. *Id.*, at 3,25.
52. *Id.*, at 12.

amount but continues to grow, and San Antonio is still developing new wells.[53] Agricultural use is 230,000 acre-feet.[54] The expected negative relationship between springflows and total pumpage has been demonstrated empirically.[55] Even if current rates of pumpage are maintained, a reoccurrence of the drought of record is estimated to dry Comal Springs for a nine-year period.[56] Under the same conditions, the San Marcos spring will continue to flow at a reduced level, though perhaps not year-round.[57]

Political tensions remain high in the region as a result of conflicting concerns over (1) the preservation of irrigated agriculture and the resultant economic relationships in a farming area with few profitable alternatives, (2) San Antonio's thirst for increased municipal and industrial water resources, (3) environmental/recreational water values within some of Texas's most unique attractions, and (4) the role of spring discharges for maintaining surface water supply. Calls for self-restraint in groundwater use and development were firmly rejected by the agricultural community and led to secession of two rural counties from the Edwards Underground Water District in 1989. A downstream river authority possessing springflow-dependent surface water rights filed suit to have the aquifer declared an underground stream, in which case the groundwater body would be administered on the same basis as surface water.[58] In another recently filed suit, the Sierra Club seeks to apply the Endangered Species Act to obtain pumping restrictions adequate for protecting minimal springflow for Comal Springs.[59] On May 7, 1991 San Antonio citizens ratified an initiative to halt the controversial but partially completed Applewhite Reservoir which was to provide the city with its first surface water supplies. The City Water Board responded with a suit seeking to invalidate the vote.

Amidst all this controversy, the stakes get higher as water withdrawals increase and new wells are completed. A newly established aquacultural enterprise west of San Antonio has a well flowing under artesian pressure at 48,000 acre-feet per year.[60] This new demand upon the Edwards has alarmed many users.

These tensions have focused a lot of attention on the region. The general consensus is that legal reform is required and that the resulting institutions

53. *Id.*
54. *Id.*
55. *Id.*, at 19.
56. *Id.*, at 14.
57. *Id.*, at 14.
58. *In re* The Adjudication of Rights To Water in the Edwards Aquifer, No. 89-0381 (22nd JUD. DIST. Tex. filed June 15, 1989).
59. Sierra Club v. Manual Lujan, No. Mo-91-CA061 (W. D. Tex. filed May 17, 1991).
60. *See* Austin American-Statesman, 1 (August 17, 1991).

will serve as a model for similar reform throughout the state. The issue confronting lawmakers is to erect a new system of groundwater law that is well engineered for balancing the varied interests of the Edwards' many suitors.

How Could Groundwater Law Be Usefully Changed?

Before settling upon the appropriations doctrine for the management of surface water, Texas had labored with other legal doctrines and eventually found them unsuited for the conditions and needs of the state.[61] The historical willingness to experiment with alternative water management institutions suggests that the protectionist concept that groundwater legal doctrine is immutable in Texas is fundamentally invalid. It is equally apparent in the face of growing conflict that absolute ownership has become ineffective due to evolving scarcity and the altered demands of the state. Recent legislative experience in urging landowners to form groundwater management districts has not been successful, because the to-be-regulated groundwater users are little interested in creating a potentially oppressive agency and, if created, the district is politically obligated to its members and is therefore reluctant to pursue substantive change. Another option is to develop a new body of regulatory law empowering an agency of government to design and enforce limits upon groundwater pumpage and/or the manner in which groundwater is employed in individual uses.[62] This is the command-and-control path which was eventually taken by Arizona after a long history of unsettling dispute.[63]

With the following exceptions, proposals for groundwater law reform do not borrow from the State's positive experience with surface water markets. An extensive study commissioned by the City of San Antonio and the Edwards Underground Water District highlighted supply enhancement and water conservation policies, but it did at least mention the marketing option. This study did not seriously consider such a policy.[64]

Two years ago the Texas Legislature considered, but did not pass, the Edwards Aquifer Administration Act which would have established marketable groundwater rights for the region.[65] Groundwater rights were

61. *See* Chang and Griffin, *supra* note 3.

62. The idea of setting pumpage limits has attracted considerable attention within the longstanding debate over allocating Edwards Aquifer water. Recently filed legislation proposes to reduce irrigation water consumption by 10% by the year 2000. See SB 1404 § 11.554(8)(c) and companion bill HB 2437 filed March 3, 1991.

63. The Arizona approach is a command-and-control institution, because it is centralized and regulatory rather than decentralized and incentive-oriented. One commentator has suggested that this approach is testimony to how wrong things can go. *See* Gisser, *supra* note 40.

64. *See* report by CH2M HILL Central, Inc., San Antonio Regional Water Resource Study (1986).

65. *See* S.B. 1441,71st Leg. (1989) and companion bill H.B. 2771, 71st Leg. (1989).

proposed to be correlative (no seniorities) and determined according to each well's maximum use over the preceding ten-year period.[66] Although the Bill did not strictly employ the prior appropriation doctrine and included unnecessary language barring speculation, requiring vague conservation activities, and initiating a brief race to drill more wells, it did represent a strong move toward groundwater marketing.

The final report of a special legislative committee completed in 1991 concludes that three policy options are available for the Edwards Aquifer: (1) ". . . declare that groundwater, like surface water, is the property of the state, and to develop laws that regulate and manage groundwater throughout the state"; (2) have the Edwards Aquifer Underground Water Conservation District regulate pumping; and (3) create a new "management entity" to regulate groundwater.[67] Although the first option is sufficiently expansive to permit an interpretation encompassing transferable groundwater rights, this was not envisioned within the report which actually emphasized regulatory action.

A model groundwater doctrine should be adopted for the Edwards Aquifer with the intent that it be progressively revised and implemented for the rest of the state. Basic elements for this new body of law include the adjudication of rights based upon historical use, seniority via the prior appropriation doctrine, metering of future use with established penalties for exceeding permit limitations, transferability by amendment with TWC oversight, and TWC limitations upon cumulative local drawdown effects caused by groundwater transfers. Within the adjudication process, a specific amount of rights should be granted to agencies or groups acting as caretakers of the important springflows produced by the Edwards Aquifer. The variability of annual recharge implies that all permits will not be satisfied each year, and the TWC will have to inform junior appropriators when their permits cannot be fulfilled, as in the surface water system. If secondary economic effects are perceived as legitimate social interests requiring protection, then some form of compensatory arrangement, such as those mentioned previously, can be integrated within water law.

Overall, this proposal acts to create an incentive system for attaining appropriate levels of groundwater use, conservation, and groundwater and surface water development. It borrows from Texas's positive and growing reliance upon surface water marketing and, more importantly, it effectively brings surface water and groundwater laws into confluence.

IV. THE NEED FOR CONJUNCTIVE MANAGEMENT

Numerous scholars of western water problems and policy have reacted negatively to the unfortunate fact that most states employ different bodies

66. *Id.*
67. *Supra* note 50.

of law in administering groundwater and surface water. With the noteworthy exceptions of Colorado and New Mexico, most state laws ignore the hydrological connection of these waters, and nowhere is this more true than in Texas. It has been reported that Texas groundwater law is the main obstacle for achieving needed conjunctive management in the state.[68] Whatever the historical reasons for these disparities, one can safely assume that growing conflict between surface water and groundwater users will bring about better integration between legal doctrines. Otherwise, conflict will persist. It seems advantageous to respond to the problem as soon as possible.

Attention to the pure hydrologic interface between all water users produces important insights regarding institutional deficiencies. Viewed from this perspective, all groundwater withdrawals either reduce surface water outflows or induce compensating groundwater recharge from a surface water supply.[69] As a result of groundwater diffusivity and the distance between groundwater wells and affected watercourses, the effect of groundwater withdrawal upon surface water supply is delayed, and the delay may be measured in days or thousands of years.[70] In the limit, any increase in water supply achieved through groundwater development is temporary. Eventually, all groundwater development is accomplished by equal reductions in surface waters. In the case of the highly mobile waters of the Edwards Aquifer, these effects are rather immediate, and the "rights" of surface water users are obviously subordinated to groundwater users in the process.

This situation can be rectified by establishing groundwater rights in accordance with the proposal outlined above. The establishment of fixed groundwater rights will necessarily establish concrete limits upon the influences all water users can impose on one another. The result will be a clearer understanding of each person's rights thereby fostering responsible coordination rather than conflict. While other paths can be pursued for rectifying the doctrinal clash of present water laws in Texas, it is most natural to employ a single doctrine for managing both major water forms.

V. CONCLUSIONS

Summarizing the major points of this discussion:

- Water is not completely amenable to market allocation, but through careful design of both property rights and market limitations, much

68. *See* O. Templer, *Conjunctive Management of Water Resources in the Context of Texas Water Law*, 16 Wat. Resources Bull. 305 (1980).

69. *See* W. Balleau, *Water Appropriation and Transfer in a General Hydrogeologic System*, 28 Nat. Res. J. 269 (1988). Also, *see* Gisser, *supra* note 40.

70. *Id.*

can be achieved by relying upon market incentives. Price is the embodiment of available information on the scarcity of water and is an effective tool for motivating *appropriate* levels of individual action in response to this scarcity.

- Recognition of water-related interdependencies aids in the successful design and administration of a water market.
- Market activity in the Rio Grande Valley has had a substantially positive influence upon the region, but some special characteristics of this region imply that full extension to the rest of the state is impractical in the absence of some controls. This region is unique because of the general absence of external effects relating to return flows, instream flows, and secondary economic effects.
- Surface water marketing should be conducted in an institutional framework which causes the market to react to return flow externalities, instream flow values, and if the protection of current economic relationships is socially desirable, secondary economic effects. As a result, water market participation must be controlled so as to observe and account for these important third party impacts.
- As in the case of surface water, Texas can benefit from legal reform to enable groundwater marketing if drawdown interrelationships, groundwater exhaustability, and secondary effects (if sanctioned) can be formally confronted. Opportunities for achieving these conditions are available and have been identified.
- Policy tools are available for limiting market deficiencies in the case of the several possible external effects for both surface water and groundwater forms. As a consequence, water marketing can serve the state much more broadly than it is currently.