February 1992

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Great Plains Research 2(1) 1992, pp. 27-50

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Abstract. *Scientists generally consider all water as merely passing through, but in different phases of, the endless hydrologic cycle. In contrast, the law divides water in the hydrologic cycle into several different classes based on real or supposed physical differences between classes. Legal classes of water are treated separately, usually without consideration of the many interconnections existing between phases of the cycle, and different rules of law have developed concerning the ownership and use of each legal class. Texas courts, like those of other Great Plains jurisdictions, have applied this fragmented classification system, recognizing diverse public and private rights to each class of water. Under such a system, it is obvious that human interference with water in one phase of the cycle can have significant impacts on existing water rights in other phases, a situation especially evident in water-short West Texas, a part of the semi-arid southern Great Plains. Application of this legal system to hydrologic realities has, as one scholar aptly noted, resulted in "a lawyer's paradise and a logician's nightmare."*

In few regions is social and economic well-being more closely tied to a particular resource than in arid and semiarid West Texas, a part of the southern Great Plains. Its water supply is meager, variable, and often dwindling. The institutional framework for allocating existing water supplies, and issues of water law and water rights, are vitally important to any consideration of the development and management of water resources. These legal institutions can serve as absolute constraints on efficient management and utilization of water resources, as well as the land to which the water is applied. Scientists and the law have very different views of water moving through the endless hydrologic cycle. Texas water law divides this water into several unrelated classes, usually without consideration of the numerous interconnections that may exist between the phases of the cycle. Many problems can arise from the application of different rules of law to each class of water, sometimes resulting in adverse impacts not only to competing users from the same source, but to those holding rights to water in other phases of the hydrologic cycle. Perhaps nowhere are these impacts more evident and the source of more controversy than in water-short West Texas, broadly defined here as that part of the state lying west of San Antonio.

This paper discusses the contrasting scientific and legal views of the hydrologic cycle from the author's perspective as a geographer-lawyer. A brief overview of Texas' fragmented water law system is followed by examples of the resultant institutional constraints that hinder more efficient and coordinated management of the state's water resources. The obstacles that impede desirable reforms, made all the more difficult by the large number of well-established private rights to water in some phases of the hydrologic cycle, are also discussed.

Water Law and Hydrology

Though water is a common substance in nature, it is an unusual commodity in law. The hydrologic cycle explains the movement of water, and law has developed to control its use and allocation in each part of the cycle. Often water law depends on the form in which the water is found. Many water resource conflicts stem from water's mobility, and any interference with its natural movement may result in depriving others of water they have long been accustomed to receiving (Matthews 1984; Water Law 1981).

Most hydrologists and other natural scientists recognize the unity of the hydrologic cycle, and generally view all water as merely passing through its different phases (Chorley and More 1969). While they do distinguish between the phases (atmospheric moisture, surface water, soil water, and groundwater) for purposes of classification and study, they do not separate and assign water in each phase to permanent classes that do not exist in nature. They recognize the interrelatedness of the various phases of the cycle (Piper and Thomas 1958; Templer 1973).

I. Atmospheric Moisture.

II. Water on the Surface of the Earth.

1) Diffused surface water.
2) Surface water in watercourses.
   a) Water flowing in well-defined channels.
   b) Water flowing in lakes, ponds, or marshes, but part of a stream system.
3) Surface water in lakes or ponds without connection to a stream system.
4) Spring water.
5) Waste water.

III. Water Under the Surface of the Earth.

1) Groundwater.
   a) Water flowing in definite underground streams.
   b) Percolating groundwater.

Source: Templer 1973.

Figure 1. Legal Classifications of Water.

Historically, the courts in dealing with water law and attendant water rights have largely ignored the operation of the hydrologic cycle (Dolson 1966; Matthews 1984; Templer 1973). The law divides water in the hydrologic cycle into several different classes, based on real or supposed differences in each class. A considerable body of law has developed for several legal classes and subclasses of water (Fig. 1), these having been most often the subject of legal controversy. Each legal class of water is usually treated separately, without recognition of the interrelationships existing within the cycle, and different rules of law have arisen concerning ownership and use of the various classes. The point at which water is diverted from its natural state and brought under human control determines the appropriate legal classification (Piper and Thomas 1958).

Criticism has frequently been leveled at the legal classification system because of its apparent failure to recognize widespread interconnections between the various phases, and that human interference with water in one phase of the cycle can significantly affect opportunities for use, control, and management at other points (Chorley and More 1969). Hydrologist H. E. Thomas (1955) perceptively described the legal classifications of water as "a lawyer's paradise and a logician's nightmare." He also argued that the hydrologic cycle provides a logical basis for distinction of private rights inherent in land ownership as opposed to public rights subject to appropriation. The movement of water is chiefly vertical in the precipitation and soil moisture phases. Horizontal movement is typical of the groundwater and surface water phases, when water is apt to cross property lines and political boundaries, as is does with atmospheric moisture prior to precipitation and surface flow (Thomas 1951).

The compartmentalized legal classification of water developed under the common law. In common law, court decisions are based on precedent when there is no express statutory provision concerning water rights. The courts attempt to find similar situations in past cases and apply the rule of law developed there to the new set of circumstances. Most water law precedents were established when scientific knowledge of the operation of the hydrologic cycle was much less detailed than today. Some rules, such as those of English common law, were developed in physical environments quite different from those where they are currently being or have recently been applied (Piper and Thomas 1958; Templer 1973). This reliance on prior precedent has made it difficult for the courts to recognize and apply current scientific knowledge (Barnes 1956; Guyton 1974). The process tends to perpetuate erroneous or perhaps outmoded hydrologic notions, which can now contribute to inefficiency in water resource management (Thomas 1955). According to Goldfarb (1984, p. xix), "Scientists are often amazed that good science does not always prevail in court . . . [and] much water law is based on obsolete science."

However illogical the compartmentalized legal classification system may be, the courts of most states have divided water moving in the hydrologic cycle into the same legal classes.

The failure of the law to take into account the unity of water in the various phases of the hydrologic cycle is blamed on the tendency of the courts to simplify and compartmentalize legal problems as they arise (Piper and Thomas 1958). Dolson (1966) suggested that most lawsuits involving water are between claimants to the same legal class. Thus, legal classifications developed in the same way with different rules of law for each class. In addition, society has developed the ability to affect and alter significantly the movement of different classes of water at different times. For example, surface water control technology has been in use for centuries, the ability to withdraw large amounts of underground water has occurred only in this century, and cloud seeding for precipitation enhancement remains in its infancy.

Texas Water Law and the Hydrologic Cycle

Texas water law, like that of most other jurisdictions, has been fragmented into a number of discrete and often unrelated divisions. Among the categories of water most often the subject of controversy, and for which the largest bodies of law have developed, in Texas are atmospheric moisture, diffused surface water, surface water in streams, and groundwater. Texas case law and statutes relating to water in streams are exceedingly complex and voluminous, while the law pertaining to groundwater, though well established, is considerably less extensive. In contrast, the law relating to diffused surface water and to atmospheric moisture is relatively sparse. The brief overview of Texas water law that follows in essence traces the course of water moving in the hydrologic cycle from sky to ground to the subsurface.

Atmospheric Moisture

There are many unanswered questions concerning rights to atmospheric moisture in Texas. No Texas cases or statutes deal with public rights in atmospheric moisture. A few states (such as New Mexico) claim sovereign rights to clouds or atmospheric moisture in their jurisdictions, but Texas does not (Templer 1981b). However, Texas courts have perhaps gone farther than those of any other state in attempting to find private rights in atmospheric moisture. In the only case involving precipitation modification to reach Texas' appellate courts, *Southwest Weather Research, Inc.* v. *Duncan* (1958), cloud seeders were temporarily enjoined from engaging in hail suppression operations over plaintiffs' lands, when it was claimed that precipitation was being reduced. The opinion has been interpreted as suggesting that landowners in Texas have a natural right to the precipitation that would fall on their land. In commenting on a landowner's rights to atmospheric moisture, the court said:

> We believe that under our system of government, the landowner is entitled to such precipitation as Nature deigns bestow. We believe that the landowner is entitled therefore and thereby to such rainfall as may come from clouds over his own property that Nature, in her caprice, may provide (319 SW2d 940, Tex. Civ. App.).

This case involved arguments and judicial language with a basis in water law. Its language seems to indicate that the owners of the land surface below the clouds have an actual property claim to this atmospheric moisture, a claim somewhat analogous to that of a riparian landowner to water from a stream (Davis 1968). However, it should be noted that in the mid-1970s on the Texas High Plains another hail suppression dispute, again involving the issue of reduced precipitation, reached a different result; but that case has no appellate history (Templer 1981b).

In 1958, when the *Southwest Weather Research* case was decided, Texas had no legislation allowing the state to manage or control weather modification activities. In 1967, in response to more widespread cloud seeding, a Weather Modification Act (*Texas Water Code* 1988, Chapter 18), was passed, placing such activities under control of a state agency, now the Texas Water Commission. At present, a license and permit are required for each weather modification operation, except those of state and federal agencies for research and experimental purposes; unlicensed activities are prohibited. Subsequent amendments to the Act allow public hearings in affected areas, and public elections may be held where a permit is requested for hail suppression, which is still the most controversial of weather modification operations. Nevertheless, for all its increasingly complex provisions, the Act does not mention, nor has it settled, the question of public and private rights to atmospheric moisture in Texas (Templer 1981b).

Diffused Surface Water

Once precipitation has fallen and collected as sheetflow on the land surface, it becomes part of another legal classification, diffused surface water. Diffused surface water is drainage over the face of a tract of land before it is concentrated into a stream course. Texas law defines a stream course as having a bed, banks, a current of water, and a permanent source of supply, and though it need not be perennial, it must flow regularly enough so that a running stream is maintained for considerable periods of time. Diffused surface water remains as such until it reaches a watercourse, sinks into the ground, or is evaporated. An essential characteristic of diffused surface water is that flows are relatively shortlived (Bouldin 1955; Ownership... 1968). Of special significance to the Texas High Plains, the water which accumulates in the thousands of small, ephemeral playa lake basins on the Llano Estacado is also considered to be diffused surface water (Templer 1976, 1990).

In Texas, the right of landowners to intercept and use diffused surface water on their land is superior to that of adjacent landowners down slope and to any owner of surface water rights on streams into which the runoff might eventually flow (Bouldin 1955; Hutchins 1961). The rule in Texas regarding diffused surface water is similar to that of most other jurisdictions (Hutchins 1971; Matthews 1984; Ownership.. 1968).

A Texas statute (*Texas Water Code* 1988, Sect. 11.142) provides that diffused surface water can be impounded by the landowner on his own property without securing a permit from the state, so long as the reservoir does not exceed 200 acre-feet (approximately 246,700 m^3) in storage capacity. This provision includes most small impoundments commonly called "stock tanks" or "farm ponds." Many Texas counties have from several hundred to several thousand such small reservoirs. There is an important limitation on the use of stored diffused surface water. Since 1953, it may be used only for domestic and livestock purposes, and a permit from the Texas Water Commission is required if the reservoir exceeds the storage limits, if the dam is on a stream, or if the water is to be put to other uses (Templer 1976).

Surface Water in Streams

Surface water upon reaching a stream course is subject to still other types of water rights. Texas is a dual-doctrine state, recognizing both the riparian doctrine, a complex blend of Hispanic civil and English common law principles, and the prior appropriation doctrine for allocating surface water rights (Templer 1978b, 1981a). Only limited riparian rights pertain to most early Hispanic and pre-1840 land grants by the Republic of Texas. More comprehensive riparian rights attach to lands granted by the Republic and state between 1840, when the English common law was adopted, and the Appropriation Acts of 1889 and 1895, including the right to divert streamflow for irrigation and other largely consumptive purposes (Templer 1976, 1978b). Since the Appropriation Acts, most surface water in Texas has been owned by the state and "held in trust for the benefit of the people." A statutory procedure has existed through which individuals can procure water rights from the state. Procurement was first accomplished through a very informal procedure called "certified filing." Landowners merely had to file a sworn statement describing their water diversion with the county clerk. Since 1913, a more strictly administered procedure involves making application to a state agency, now the Texas Water Commission, for a permit to appropriate water.

With both doctrines recognized in Texas, numerous riparian and appropriative water rights existed side-by-side on most streams (Templer 1978b). The two doctrines are, of course, dissimilar in almost every respect. For example, the riparian owner is entitled to a reasonable, but ill-defined, quantity of water, while the appropriator is entitled to a specific maximum quantity; the riparian owner generally cannot store water for future use, while the appropriator is usually permitted to do so. Needless to say, state water agencies and water users experienced great difficulty in coordinating the diverse private and public water rights emanating from these diametrically different doctrines (Trelease 1954). Only a virtually complete water rights adjudication, begun in 1969 to merge all unrecorded surface water rights into the permit system, gives some promise of a final resolution of this complex management issue (Booth 1968; Caroom and Elliott 1981; Templer 1981a, 1985b).

Groundwater

Surface water that percolates underground becomes part of yet another legal classification, groundwater. Texas law subdivides groundwater into two classes: water flowing in well-defined underground streams, and percolating groundwater (Hutchins 1961). The law is well settled about the ownership of percolating groundwater in Texas (Templer 1978a, 1983a, 1989a, 1989b). In the 1904 case *Houston & T.C. Ry. Co.* v. *East,* (98 Tex 146, 81SW 279), the Texas Supreme Court firmly established the strict common law or "English" rule. Generally, under this rule the overlying landowner can pump and use the water beneath his land regardless of the impact in depriving adjacent or more distant users of underground or related surface water of their accustomed supply (Templer 1983a, 1989b). The *East* opinion, based on humid-land legal principles derived from an English and an Ohio case, deemed it impossible to administer legal rules for percolating groundwater because its "existence, origin, movement and course [are] so secret, occult, and concealed." Thus, the court concluded, "the owner of the land is the absolute owner of the soil and percolating water, which is part of and not different from the soil."

Since the *East* case, a few court decisions have established that landowners can sell their groundwater rights, that underground water can be used either on the land from which it is pumped or elsewhere, that liability can be imposed where negligent pumping causes land surface subsidence (normally a problem only along the Gulf Coast), and that there is a firm presumption that all groundwater is percolating unless there is conclusive proof that it flows in a well-defined underground stream (Templer 1989b). For over eight decades, the rule has not been modified to any significant degree, even though it has been replaced in most states that formerly accepted it, and the legal basis for the original decision has been the subject of much criticism.

In the first half of this century, there were many demands for some form of groundwater regulation to prevent aquifer depletion and waste. However, not until 1949 was a statute passed providing for the voluntary establishment of local undergroundwater conservation districts (UWCDs) (*Texas Water Code* 1988, Chapter 52). In addition to this general law, groundwater districts may also be formed by special legislation, though the powers given these special districts may differ considerably from those of general law districts. Prior to 1985, only 12 UWCDs had been created, but following the passage of comprehensive water legislation in that year, the pace of UWCD formation has accelerated. The 1985 legislation authorized the state to designate areas with "critical groundwater problems" and to push for creation of UWCDs in those areas, so that now Texas has over 30 UWCDs. Most of the new UWCDs are only one county in area, and practically all were formed by special legislation, because formation under the general law is a cumbersome and time-consuming procedure (Templer 1989b).

Local UWCDs thus exercise about the only control over landowner rights to groundwater (Templer 1983a, 1989b). General law districts, and some special law districts, have rather broad statutory powers to make and enforce rules for conserving, preserving, protecting, recharging, and preventing waste of groundwater. Regulatory powers include well spacing, water proration, and conservation. Nevertheless, the most significant conservation rules almost all UWCDs enforce pertain to well-spacing and control of off-farm waste of groundwater or tailwater (Templer 1989a, 1989b). Texas courts and the legislature have always been very wary of infringing on these recognized, and largely unregulated, private rights to underground water.

Constraints on Water Resource Management

The foregoing discussion has shown that Texas water rights law is extremely fragmented, a veritable hodgepodge of contrasting and often competing public and private rights, all of which make any efforts at more unified and efficient administration and management of water resources difficult, if not impossible. This overview has provided a basis for understanding many of the water management problems stemming from the legal classifications of water, problems which have been experienced in varying degrees by most other states. The following examples have been chosen to illustrate the present and prospective impact of water use from one legal class on existing water rights and opportunities for water use in other phases of the hydrologic cycle, and the legal obstacles to the conjunctive management of interconnected water resources.

Diffused Surface Water Use and Streamflow

Though there are differing opinions as to the effect of interception of diffused surface water by small private stock tanks, farms ponds and related conservation land treatment practices on downstream water use and water rights (Templer 1973, 1976), it is reasonably well documented that they can have a very adverse impact. The impact of such small reservoirs is a function of their relative size and number and the amount of runoff, which in turn is a function of climate and land surface conditions. The exemption of small reservoirs from the permit requirement applies statewide, irrespective of wide variations in rainfall, runoff, and other hydrologic factors. Because farm ponds and stock tanks can be built at will by landowners, and are even encouraged by some federal agencies, their number is increasing. Most are quite small, having an average storage capacity of only 6.5 acre-feet (approximately 8000 m^3), but they intercept the runoff from a watershed averaging 136 acres (approximately 55 hectares) (Templer 1973). Also, most are shallow and much of the water they store evaporates or is lost to seepage or percolation underground. Because the collection of runoff in the playa lake basins of the Texas High Plains does not involve construction of a dam and the water does not normally flow to a stream course, they are not relevant to this discussion.

A study by the Texas Society of Professional Engineers (1974), illustrating the effect on downstream water rights in a general way, concluded that such small impoundments result in major water losses in Texas. That study reported the average aggregate storage capacity of farm ponds as 51.7 acre-feet per square mile (approximately 246 m^3/ha) of drainage area. The minimum annual runoff in West Texas from the Canadian River watershed southward to the Rio Grande is considerably less than 50 acre-feet per square mile (238 m^3/ha) of drainage area. Therefore, during a year of low rainfall almost all the runoff entering small private reservoirs would be retained and thereby lost to downstream users.

The Society contended that the quantity of water allowed to be impounded under Sect. 11.142, *Texas Water Code*, is excessively large. A landowner without a permit can impound over 65 million gallons (246 million liters) of water in a single reservoir for domestic and livestock purposes, and can build as many reservoirs as his, or his neighbor's, land will fill. This amount is estimated to be 85 times the amount of water actually needed by a typical family cattle ranching operation. The study recommended that Sect. 11.142, which exempts such small reservoirs, be revised and amended so that no reservoir on private property with larger than 10 acre-feet (12,335 m^3) storage capacity would be allowed without a permit from the Texas Water Commission, but no legislative action has been taken.

A study of the drought years of the early 1950s provides corroboration of this impact. Lowry (1958) calculated that the effective drainage areas of the watershed behind farm ponds in several areas of Central and West Texas was reduced by as much as 80%, and that runoff to streams was reduced accordingly. Thus, concerns of downstream water users that their state-permitted surface water rights could be seriously impaired as small reservoirs in upstream watersheds increased in number and size appear to be well founded. Under present Texas law, they still have no legal recourse to protect their existing water rights (Templer 1976, 1983b), one legacy of Texas' compartmentalized water rights system.

Conjunctive Management and the San Antonio Region

The legal division of water rights in the various phases of the hydrologic cycle and the conjunctive management of water resources are closely interrelated. Conjunctive management, as used here, simply refers to the situation where water in two or more phases of the hydrologic cycle are managed together as an integrated resource. It is generally agreed, considering the substantial interconnections between the phases of the hydrologic cycle, that conjunctive management is a desirable objective, especially where it can be demonstrated that unregulated water use in one phase has appreciable effects on established water rights and opportunities for water use in other phases. It is thought that larger amounts of water can be made available for more efficient use through integrated management considering the needs of the various users holding valid water rights, the nature and location of available water resources, and how existing uses can be managed to conserve water and reduce waste (Templer 1976, 1980).

Well-established interconnections are most evident for groundwater and surface water in streams, these two phases usually being the only ones considered in discussions of conjunctive use and management. However, as shown above, diffused surface water, and to a lesser extent atmospheric moisture, are other important hydrologic phases that may someday be more fully integrated with the other two, though conjunctive management involving them is rarely attempted (Templer 1976, 1980). The report of the National Water Commission (1973, p. 234) urged the states to regulate both surface and groundwater through conjunctive management, specifically that ". . . states in which groundwater is an important source of supply commence conjunctive management of surface water (including imported water) and groundwater through public management agencies." Nevertheless, despite its purported advantages, conjunctive management of water resources is practiced in only a few states, for reasons which will become evident.

The unique Edwards Limestone aquifer of the San Antonio region in South Central Texas is unquestionably the state's most complex and controversial groundwater problem area. The aquifer, a narrow five to 30 miles (8-48 km) in width, extends for over 200 miles (322 km) along the Balcones Fault Zone from near the Rio Grande to beyond Austin. It is recharged primarily by spring-fed streams rising on the Edwards Plateau, especially the West Nueces, Nueces, Frio, Sabinal, Medina and San Antonio Rivers. Over 70% of the recharge entering the aquifer originates west of San Antonio in neighboring Medina, Uvalde, and Kinney Counties (Templer 1973, 1989b). Once streamflow and precipitation percolate into the Edwards, the water moves rapidly through large solution channels and cracks in the limestone in an east and then northeast direction to the adjacent San Antonio and Guadalupe River basins, resulting in a massive natural interbasin transfer of groundwater from west to east. The aquifer's water is confined under artesian pressure and its natural discharge feeds some of the largest springs in Texas, which in turn provide much of the baseflow of the San Antonio and Guadalupe Rivers, as well as the ecologically important freshwater inflow to their coastal estuary (Templer 1973, 1983a, 1989b).

The Edwards aquifer provides all the public water supply for 17 cities and towns with populations totalling over 1.3 million, including the total municipal water supply for San Antonio. The aquifer is also heavily pumped for irrigation, primarily in the western counties that supply most of the recharge, and irrigated acreage has increased significantly in the past three decades. In the 1960s, it was already recognized that irrigation wells in the western counties could potentially intercept most of the subterranean eastward flow, thus greatly reducing the amount of water available to San Antonio and other cities (Welder and Reeves 1964). Another certain result would be reduction of springflow in the San Antonio and Guadalupe River basins that might endanger unique wildlife habitats, adversely affect water quality in both rivers and their estuary, and, most importantly, threaten existing surface water rights on these streams. Though the state has granted surface water rights permits to users along the San Antonio and Guadalupe Rivers, under present law it is powerless to prevent unlimited pumping from interfering with them (Stagner 1988; Templer 1983a, 1989b).

The Edwards Underground Water District, which until recently covered most of the aquifer, was formed in 1959 by special legislation for the purpose of conserving, protecting, and recharging the aquifer, and for the prevention of groundwater waste and pollution. However, the district, unlike all general law and some other special law districts, was not given control over well spacing or groundwater production. Plans to construct several large recharge reservoirs on streams where they crossed the recharge zone failed, because, as a former district manager explained, "Once the [surface] water gets into the Edwards [and becomes groundwater], it's up for grabs by any surface owner" (Templer 1983a, 1989b).

Conjunctive management of the interconnected surface and groundwater would seem ideally suited to the Edwards aquifer region; however, Texas' divergent water rights system makes this impossible (Templer 1973, 1976, 1980, 1989b). What is needed to implement conjunctive management would be some legal mechanism to quantify and/or limit private groundwater rights (Stagner 1988). It has often been suggested that, because of its narrow configuration and rapid recharge and flow characteristics, the Edwards aquifer might be declared a well-defined underground stream. In 1988, the Guadalupe-Blanco River Authority revived interest in this approach, contending that the Texas Water Commission could, under present Texas law, declare the Edwards to be state water because of its stream-like characteristics and its close interconnections with surface water. The aquifer could then be subjected to an adjudication of water rights, similar to the adjudication of surface water rights under the 1967 Water Rights Adjudication Act (Jensen 1988; Stagner 1988; Templer 1989b). In 1989, the Authority filed suit in a state district court seeking such a declaratory judgment and a decision on this issue is still awaited. It should be noted, however, that the presumption that all groundwater is percolating is most difficult to overcome and contention of the presence of a well-defined underground stream has never been sustained by Texas courts (Templer 1983a, 1989b).

A much more comprehensive approach to achieving conjunctive management for the Edwards aquifer is a Regional Water Management (RWM) Plan and related Drought Management Plan, formulated in 1988. The Plan would have given the Edwards UWD broad authority to issue permits for new wells and limit pumpage, and irrigation would have been limited to the maximum number of acres irrigated in any year between 1979 and 1995 (Jensen 1988). Needless to say, irrigators strongly opposed the Plan, and the western counties seceded from the Edwards UWD in early 1989. Legislation introduced to implement the RWM Plan became one of the most controversial and volatile issues facing the Seventy-first Legislature in 1989, and passage eventually failed. Texas farmers apparently perceived the Plan as being an attempt to change Texas groundwater law significantly, and thus it became a statewide, rather than a local or regional, issue. Nevertheless, the Edwards aquifer management problem, which is directly attributable to

Texas' fragmented water law, continues to demand a solution. Eventually, urban interests in this increasingly urbanized state probably will have the political power to prevail over rural opposition in confrontations, such as this, pertaining to the allocation and management of scarce water resources (Templer 1989b).

Obstacles to Institutional Reform

The legal and water management literature contains innumerable recommendations for sweeping change of Texas water law (e.g., Johnson 1982a, 1982b). These recommendations are usually based on exhaustive analyses of existing law and the authors cite appropriate case law and statutory and constitutional provisions to support their arguments. However, political realities dictate that most comprehensive reforms face formidable obstacles to being realized, particularly where largely unregulated private water rights are well established and have a long legal history. One solution to achieving coordinated and more efficient management of water resources in Texas might be for the state to establish an all-inclusive appropriation system for application to water in whatever phase of the hydrologic cycle it might be found, thus effectively bringing the total water resource under unified control. Such a broad appropriation system would be most unusual (Matthews 1984), and the likelihood of establishing such an all-inclusive system in Texas is indeed remote. However, Thomas (1951) argued that until this is done, correlation and management of water rights in all phases of the hydrologic cycle cannot be achieved and problems of water use in one phase impacting water rights in other phases will continue to arise.

When, as here, a dual judicial-legislative water law system has developed and become firmly established, it is even more difficult to find a definitive and immediate solution (Radosevich and Sutton 1972; Templer 1978a; Williams 1972). Omitting consideration of atmospheric moisture and diffused surface water, it is recognized that correlated water use and management in a dual-doctrine and common-law-rule state like Texas would be even harder to achieve (Radosevich and Sutton 1972; Templer 1980). Surface waters, appropriated by the state, can be managed in the general public interest, whereas groundwater is privately owned and is not subject to such control. The absolute ownership rule applied to groundwater provides no basis for correlating rights in an integrated supply (Bagley 1961). Thus, the long-established legal division of water into discrete classes effectively bars conjunctive management of surface and underground water in Texas. The magnitude of recognized groundwater rights prevents extension of appropriation to groundwater, as it was earlier applied to surface water. Over 30 years ago, Hutchins (1958) pointed out that court decisions had already welded the absolute ownership rule into a rule of property that would be most difficult to overturn, yet another legacy of the policy of creating separate rules of law for different classes of water.

Texas courts have generally adopted a hands-off policy in groundwater litigation (Johnson 1982a, 1982b). Attempts to persuade the courts to change Texas groundwater law significantly have been singularly unsuccessful despite recognition that some aspects of the common law rule are harsh and outmoded. It has long been argued that the legal basis for this rule, that percolating groundwater is moving beneath the surface in "a secret, occult, and concealed" fashion, is no longer strictly true. Voluminous data exist on the extent of major and minor aquifers, the quantity of water in storage, recharge and discharge rates, and rates of depletion, and the performance of some aquifers under various rates of pumpage have been modeled (Barnes 1956; Guyton 1974). Still, in a significant 1978 groundwater case, *Friendswood Development Co.* v. *Smith-Southwest Industries, Inc.* (576 SW2d 21), the Texas Supreme Court stated that "Providing policy and regulatory procedures in this field is a legislative function.... [Our] courts are not equipped to regulate groundwater use and subsidence on a suit-by-suit basis."

The state legislature appears little more inclined to bring about significant reform. In the 1985 water legislation, the most comprehensive water law reforms of recent years, the provisions pertaining to groundwater management were described by Kramer (1986) as being "the lengthiest, but perhaps the least meaningful part of the 1985 water package." The political power wielded by the vast number of landowners with private, and largely unregulated, groundwater rights is obvious and constitutes a major obstacle to significant legislative change of the system, as shown by the fate of the proposed RWM Plan for the Edwards aquifer region.

Waddle (1974) identified the overriding issue in disputes such as this as being one of *who* should have control over water resources, which in turn may make largely academic the question of *what*, such as conjunctive management, could most effectively be done to achieve the greatest efficiency in water management. In Texas, there is the general feeling among landowners that if there must be regulation of groundwater, it should be achieved through local agencies (Graf 1982), a view strongly shared by most Texas irrigation farmers (Shelley 1983). The general opposition to control of private individual's water rights (and valuable property rights) at any level is understandable. Few landowners with well-recognized, unregulated water rights of long standing will voluntarily cooperate in a regulatory program (Williams 1972, 1985).

Conclusions

This paper has traced the evolution of Texas water law and has provided examples of some of the more obvious institutional impediments to improving the efficiency of managing Texas water resources, an issue of especially critical importance to arid and semiarid West Texas. The fragmented institutional structure which has developed governing water allocation and rights constitutes a formidable obstacle to achieving comprehensive and integrated water resource management. Thomas' (1955) observation that the legal classification system has resulted in "a lawyer's paradise and a logician's nightmare" is apparently true for Texas. In some areas, such as the adjudication of surface water rights, great progress has been made in the last two decades. In other areas, landowner rights to atmospheric moisture, which are poorly defined, or to diffused surface water might be curtailed or restricted without significantly damaging recognized rights. Conversely, groundwater law, where the absolute ownership doctrine is deeply entrenched, seems destined to continue to change slowly through more politically acceptable special legislation designed to meet very specific local problems, such as those of the unique Edwards aquifer in the San Antonio region. It is apparent that Texas' compartmentalized water law cannot serve as an appropriate model to other states for improving efficiency in managing interconnected water resources. Despite a growing trend away from the application of such unscientific legal distinctions, Texas lags behind other Great Plains and western jurisdictions in extending appropriation or more rigorous control to most legal classes of water.

Despite its shortcomings, Texas water law does represent an established resource management system, and the fact that it is resistant to rapid change, partially due to its adherence to previously established legal rules, can be viewed as promoting predictability and stability of existing rights. Thus, hydrologists, engineers, and other professionals involved in water resource planning and management must take into consideration the constraints of the existing legal structure for allocating water resources and protecting recognized private and public rights if their plans and proposals for more efficient water resource management are to be successfully implemented. Also, they can contribute to change by documenting the impact of water law in diminishing efficient water resource management, as well as by providing supportive data and suggesting solutions for unresolved water law problems.

Water law is not wholly inflexible. Ultimately, the courts can accomplish change by distinguishing fact situations and, in conjunction with legislatures, by gradually changing legal rules in response to societal pressures. As scientific knowledge of hydrology grows, courts and legislatures should be better able to anticipate and avoid prospective conflicts and problems of coordinated water resource use and management, such as the examples discussed here. Where possible, water law and water rights should be viewed in the context of a total integrated resource, emulating the interconnected nature of the hydrologic cycle. Given societies' expanding ability to interfere with and control the movement of water in the hydrologic cycle, recognition of new comprehensive, unregulated private water rights in any phase or the extension of the scope of existing rights should be undertaken with considerable caution.

Duisberg (1963, p. 480) prophetically warned that "care must be taken to avoid entanglement of resources in a maze of legal, political, and private property rights problems from which they cannot be easily extricated for eventual uses of higher value." This continues to be sound advice for Texas courts and the legislature (and for those of other Great Plains jurisdictions) concerned with numerous water management problems, especially, as in weather modification, where the applicable law remains unsettled and is still in the process of development.

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