

Policy Reviews and Essays

Groundwater Supply in Texas: Private Land Considerations in a Rule-of-Capture State

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Texas is a top water-consuming state in the United States and is increasingly relying on groundwater. Groundwater markets are attracting greater attention as a mechanism for transferring water from rural to urban areas. However, excessive extraction is being exacerbated by the “rule-of-capture” that governs the use of groundwater in Texas combined with widespread subdivision of land. Over-exploitation of common-pool resources is not inevitable. A cooperative approach to groundwater management could reduce the negative economic impacts of water transfers in the area of origin and provide landowner incentives to regulate extraction. Landowner associations, monitored by local groundwater conservation districts, offer an instructive model for sustainably managing groundwater while at the same reallocating water resources from rural to municipal uses.

Keywords cooperative management, groundwater districts, groundwater markets, local control, rule-of-capture, water supply, wildlife cooperatives

Texas is one of the top four water-consuming states in the United States. The state’s population is expected to almost double to 40 million by 2050, and annual water demand is projected to grow from 17 million to 20 million acre-feet (TWDB 2002). Patterns of water use are also changing, with irrigation use likely to shrink from 57% to 43% of total consumption while municipal use is expected to grow from 25% to 35% (TWDB 2001). Such growth in demand and the shift from agriculture to urban

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uses will present serious challenges for water planners, while limited supply and distribution of water could severely hinder economic growth in Texas (Smerdon et al. 1988).

Surface water accounts for about 40% of total consumption, compared to 60% from groundwater aquifers, which underlie about 81% of Texas (TWDB 2002) (Figure 1). Currently, over 80% of extracted groundwater is used for irrigation, but this is expected to decline to less than 60% in the next 50 years while use for municipal purposes is expected to increase to over 30%. There is likely to be increasing reliance on groundwater because surface water supplies are limited (Frye and Curtis 1990; Chang and Griffin 1992). Yet most aquifers in Texas suffer from limited recharge due to low precipitation or excessive pumping. The Edwards Aquifer, which recharges rapidly when precipitation is adequate, has received special attention because it is the primary water source for San Antonio and supplies the Comal and San Marcos springs that provide habitat for eight threatened or endangered species (Grubb 1997).

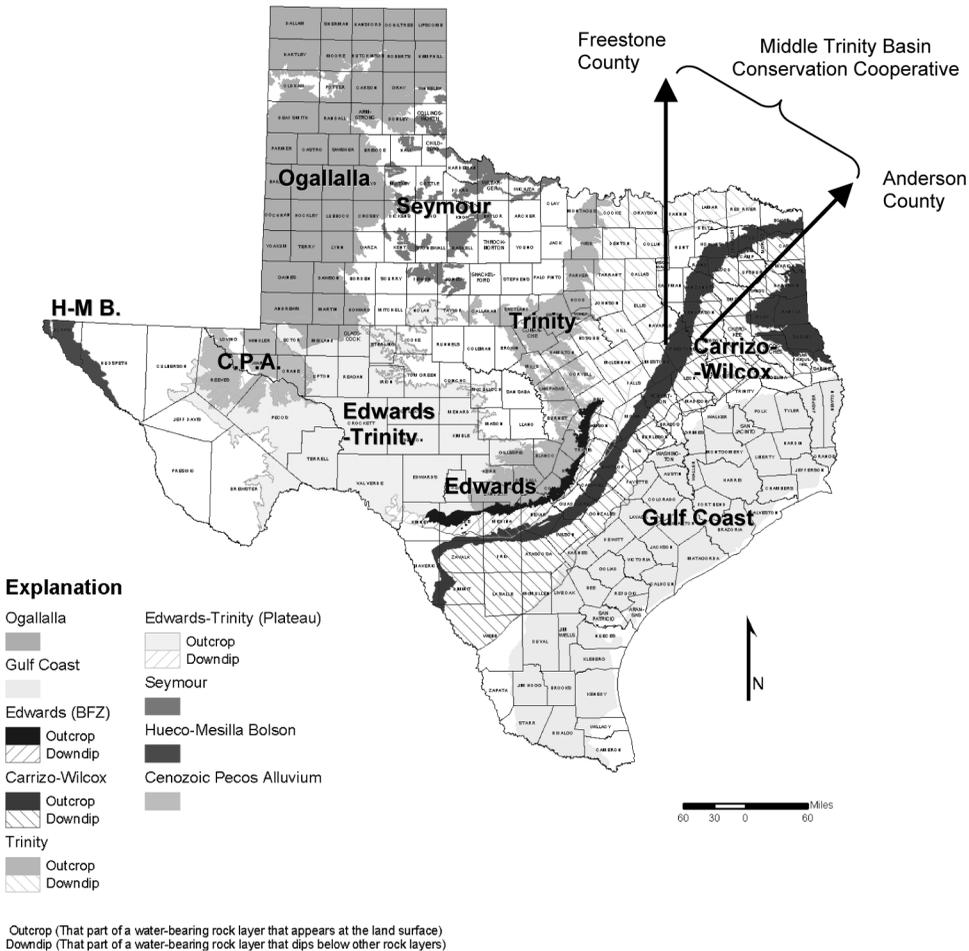


FIGURE 1 Major aquifers of Texas and location of Middle Trinity Basin Conservation Cooperative. From TWDB (2002).

Rapid population growth, particularly along the Interstate Highway 35 corridor, has accelerated land subdivision and urbanization especially to the west and south of Austin and San Antonio (Wilkins et al. 2000). As a result, the Governor's Task Force (2000) identified land fragmentation and limited water supply as the two most serious natural resource issues facing Texas today.

The purpose of our article is to discuss an innovative option for promoting sustainable groundwater extraction in Texas. Our main arguments are: (1) Groundwater districts are the logical institutional entity for coordinating groundwater extraction plans because they can facilitate cooperation among landowners; and (2) landowner associations may enhance the cooperative management of common-pool resources, such as groundwater. We first review the legal status of groundwater in Texas. Next we consider the implications of its status for policy aimed at ensuring the sustainable use of groundwater. Finally, we explore the role of landowner associations for creating positive landowner incentives to extract groundwater sustainably. In addition to implications for groundwater policy in Texas, our observations may have relevance for the management of other unregulated common-pool resources on private land elsewhere.

Legal Status of Texas Groundwater

Texas groundwater is one of the few natural resources in the United States that is not regulated by a central agency (Todd 1992). Groundwater law is based on the English common law doctrine of "absolute ownership" (Kaiser 1986), which allows landowners to extract unlimited amounts of groundwater from beneath their property, as long as they do not waste it. Because 95% of land in Texas is privately owned and only owners of land above an aquifer have the right to extract water from it, Texas groundwater is technically a common-pool resource with restricted access. Communal or common-pool resources are those whose attributes hinder the right of exclusive individual use (Hardin 1968). Lack of exclusivity together with the increasing lift costs as groundwater levels drop often lead to the "rule-of-capture," that is, incentives for individuals to "capture" groundwater quickly to minimize pumping costs (Anderson and Leal 1991). Such incentives often lead to unsustainable and socially inequitable use of common-pool resources.

In 1949 the Texas Legislature initiated the creation of groundwater conservation districts (groundwater districts), which are aligned along county boundaries and encompass one or more counties, in an attempt to conserve groundwater, protect water quality, and prevent land subsidence (Urban 1992). However, the law allowing unrestricted use of groundwater together with funding shortfalls have restricted the activities of these entities to data gathering, promoting water conservation initiatives, and preventing egregious wastage, instead of regulating groundwater extraction rates (Johnson 1982; Kaiser 1986).

One exception occurs in the Edwards Aquifer. In response to a lawsuit brought by the Sierra Club and the consequent federal ruling that the Texas Water Commission develop a plan to maintain threatened or endangered species habitat by ensuring adequate spring flow, the Texas legislature passed Senate Bill 1477 in May 1993. This resulted in the creation of the Edwards Aquifer Authority (EAA) (Voteller 1998) and in pumping limits of 450,000 acre-feet per year from the aquifer (Kaiser and Phillips 1998). Unlike other water conservation districts, the EAA was ordered to use its powers to regulate groundwater withdrawal in the seven counties overlying the aquifer's recharge and storage areas.

In partial response to concerns over growing water consumption, the Texas legislature passed Senate Bill 1 in 1997 that mandated regional water supply planning. Regional planning requires cooperation between cities, local water districts, counties, and other water institutions. As a result, the 1997 mandate led to a “bottom-up” development of the 2002 State Water Plan, which incorporates 16 regional water plans and various policy recommendations for water use (TWDB 2002). Each regional planning area encompasses either an entire hydrologic unit (e.g., Edwards Aquifer Authority) or one or more counties, and each of the existing 79 groundwater districts falls within one or more of these regional planning areas.

Policy Considerations

Some authors have suggested that using rights-based market mechanisms for distributing groundwater is preferable to centralized regulatory control (Gisser 1983; Griffin and Boadu 1992; Todd 1992; Kaiser and Phillips 1998). Water marketing has become common in parts of the western United States (Michelson 1994) and was recommended in the 1990 and 2002 Texas State Water Plans, while groundwater rights have been or are being purchased to ensure water supplies for Houston, San Antonio, Amarillo, and El Paso. Water markets could resolve conflicts over water extraction from the Edwards Aquifer because they provide incentives for municipal and industrial consumers to reduce waste when pumping rates are restricted (Schaible et al. 1999). However, sustainable marketing of groundwater depends on the establishment of safe yields that avoid negative ecological, economic and social impacts (Kaiser and Skillern 2001). In addition, sustainable extraction rates could be enhanced by economic incentives that encourage rural landowners to maintain open spaces that maximize aquifer recharge and to reallocate groundwater they extract.

In contemplating policy alternatives to centralized regulation and absolute privatization, neither of which ensure the efficient allocation and sustainable use of common-pool resources, it is necessary to recognize that overexploitation of such resources is not inevitable (Ostrom 1990). They can be used sustainably when there is an autonomous local controlling body (Ostrom 2001). Stable common-pool resource institutions occur when communities with access to these resources have the right to organize, and there exist well-defined community and resource boundaries, appropriation rules, effective monitoring mechanisms, graduated sanctions, and collective-choice and conflict-resolution arrangements (Ostrom 1990). In Texas, the first two characteristics are in place because of the rights to free association, well-defined property boundaries, and clearly delineated aquifers. The other requirements for sustainable common-pool resource use are addressed next.

Due to demand-supply disparities, transferable pumping permits are being promoted as a mechanism for allowing landowners to sell water to third parties willing to pay for their pumping rights. To implement such a rights-based approach for groundwater, Provencher and Burt (1994) proposed a model in which landowners are allocated marketable permits by water managers who are responsible for protecting safe minimum aquifer levels and for monitoring extraction. In this model, allocation of permits would be based on the aquifer's productivity, with permitted wells being spaced according to the aquifer's heterogeneity. To accommodate personal needs, existing domestic wells could be exempted from use permits, provided pumping does not exceed 25,000 gallons per day (gpd) (Kaiser and Phillips 1998). During water deficits, landowners would have to proportionately reduce pumping to a level where total extraction is within the safe yield limit. Such a permit system was

established in the Edwards Aquifer in 1997 for landowners extracting over 25,000 gpd, when the EAA purchased irrigation rights from 40 farmers to supply water to San Antonio (Kaiser and Phillips 1998). This resulted in water savings of about 20,000 acre-feet at a cost of \$3 million provided by 30 contributing cities, counties, and water companies.

However, to accurately assess the net benefits of market-based groundwater extraction permitting systems, external environmental and third party impacts must also be considered. Such "external costs" include the loss of available water to the area of origin. This can be accounted for by taxing water transfers and returning the proceeds to the area of origin (McEntire 1989), or by assigning a portion of agricultural water for use in the area of origin (Zilberman et al. 1994).

In addition, implementation of such a permit system in areas where land above aquifers is privately owned and landowners have unrestricted right of access to groundwater will likely meet less landowner resistance and incur less regulatory costs if the incentives for participating landowners are clearly addressed. This may be especially true in states, such as Texas, where landowners have strong property rights orientations (Jackson-Smith et al. 2003), the unrestricted right of access to groundwater beneath private land is a long-standing tradition, and rural landowners continue to have significant political influence. Although periodic government oversight may be necessary, self-enforcement of market-based systems is usually effective when monitoring is conducted by a local entity in which landowners are represented and have a vested interest (EAA 1998). In addition, because political and aquifer boundaries seldom coincide, coordinated planning among local institutions is also necessary for regional planning initiatives to succeed (Smerdon et al. 1988; Charney and Woodard 1990; Somma 1997). An approach that has been successfully applied in California and Nebraska is the establishment of aquifer-wide, regional, or subbasin districts to coordinate planning and management of groundwater resources based on safe yield criteria (Blomquist 1992; Kaiser and Skillern 2001).

In addressing the necessary criteria for developing an effective groundwater market in Texas, designing management units around aquifer boundaries is a critical first step. The establishment of the EAA to control extraction from the Edwards Aquifer demonstrates that such extraction can be managed at the local level through groundwater districts. These entities are authorized, at least in principle, to prevent overuse of aquifers, and can monitor the level of aquifers to ensure that they are not drawn down below a predetermined safe minimum level. Moreover, because the representatives of groundwater districts are attuned to local concerns, they can facilitate cooperation among landowners. They are thus the logical entity for developing coordinated groundwater extraction plans in collaboration with landowners.

A local approach to groundwater management was reinforced in the Central Carrizo-Wilcox Aquifer when House Bill 1784 of 2001 ratified three multicounty groundwater districts overlying the aquifer, and created a council to provide aquifer-wide management guidance and ensure coordination among the groundwater districts. Similar local control over aquifer resources was recommended in Vermont and northern New York (King and Harris 1990).

To achieve sustainable extraction, the maximum level of extraction permissible to ensure sustained yield of the aquifer must be determined. The Texas Water Development Board provides groundwater models for most major aquifers and new studies are ongoing (TWDB 2001). Once the sustainable yield for a given area is established, the associated groundwater district could inform landowners about the safe minimum level of the aquifer and about the amount of water being withdrawn

from the aquifer. The groundwater district, headed by an elected board of local representatives, could also assign transferable withdrawal permits for the allocation of surplus aquifer water based on criteria that are mutually agreed upon participating landowners, and could regulate pumping to ensure safe minimum levels (Fipps 2002).

Role of Landowner Associations

As noted previously, common-pool resources are more likely to be used sustainably when those with right of access to them make cooperative arrangements with respect to monitoring mechanisms, sanctions for noncompliance with use agreements, and conflict-resolution arrangements (Ostrom 1990). Landowner associations (cooperatives) are generally established to reduce individuals' costs through joint management of various resources, to facilitate marketing of valuable resources when individual landowners own inadequate amounts of the resource to enter into purchase agreements with prospective buyers, or individual transaction costs are too high.

An instructive example of natural resource landowner associations in Texas aimed at enhancing the value and management of a common-pool resource is the establishment of multilandowner wildlife cooperatives. Generally, creation of these associations involves the development of a wildlife management plan that includes voluntary compliance with Texas Parks and Wildlife recommendations for wildlife habitat management and deer harvest rates. More than 100 wildlife associations have been established across Texas, representing more than 3500 landowners and in excess of 1.4 million acres. In addition to having become popular for managing wildlife on smaller land holdings, such associations may hold promise for managing other common-pool resources, including groundwater.

Locally controlled landowner management associations are likely to become increasingly attractive as rural land subdivision continues. Because they create both economic incentives and responsibilities for landowners, such associations can reduce the impacts of land subdivision on common-pool resources that are subject to the "rule-of-capture." If appropriate hydrogeologic models are combined with a transferable permit system and development of a private cooperative, landowners within a groundwater district could pool or "unitize" their acreage to provide a sustainable supply of water, much like oil and gas production in Texas (Libecap and Smith 1999; Provencher 1993).

Moreover, to maximize local buy-in, cooperating landowners could, with the approval of the elected groundwater district representatives, develop pumping rules based on safe minimum levels of the aquifer. In this way, monitoring and enforcement of pumping rules would come from within the landowner group through the groundwater district. The proceeds from the sale of the surplus groundwater could be distributed to each participating landowner based on landowners' permitted extraction volume or their acreage overlying the aquifer. Groundwater cooperatives could also facilitate coordinated land use planning and create economic incentives to maintain open space for aquifer recharge, which would reduce habitat fragmentation and protect other ecosystem services.

Why would landowners cooperate in exercising their groundwater extraction rights? Most individual landowners are unlikely to produce sufficient groundwater to enter into individual marketing agreements or to derive sufficient income to cover the cost of pipelines. By marketing their groundwater rights through an association,

participating landowners could increase and diversify their income stream, thereby reducing their economic risk. In addition, this would also reduce landowner incentives to sell land to offset declining income.

Such incentives are exemplified by the Middle Trinity Basin Conservation Cooperative, a 100,000-acre association of about 25 landowners in Freestone and Anderson counties. Its members are cooperatively managing their land to improve white-tailed deer and waterfowl habitat with the intent of enhancing fee-based hunting opportunities, and they are investigating groundwater-marketing opportunities to augment income from wildlife. Using existing aquifer recharge estimates and assuming a well field of 10 wells spaced 0.5 miles apart, the sustainable groundwater yield from this association could exceed 30,000 acre-ft per year, which would provide a gross annual revenue of approximately \$7.5 million (Kaiser 2000 personal communications).

Conclusion

For nearly 100 years, the “rule-of-capture” has survived attempts to regulate groundwater use in Texas. Under this rule, the combination of the need for efficient water supply to urban areas and accelerating rural land subdivision creates challenges that beg for a unified approach to land and water conservation. Coordinated marketing of groundwater by rural landowners could provide an important economic incentive to maintain open space that benefits aquifer recharge as well as wildlife habitat. By coordinating the shared interest of landowners to benefit from groundwater, locally controlled associations could facilitate the distribution of groundwater to locations of greatest need. Because groundwater districts are already authorized to prevent overuse of aquifers and can be operated by landowner representatives, they are the logical institutional entity for coordinating groundwater extraction plans developed by landowner associations, for monitoring extraction rates, and for implementing sanctions against non-compliant landowners. Under this scenario, government oversight and enforcement would be limited to ensuring that groundwater districts adhere to safe use levels for the aquifer.

Potential case studies of groundwater marketing associations, such as the Middle Trinity Basin Conservation Cooperative, are arising but they are in their infancy. A detailed study of a wider spectrum of landowner associations in Texas is needed to understand the advantages and limitations of such associations for ensuring the sustainable supply of groundwater and for developing water markets through transfers of groundwater from rural to urban areas. Such a study would also provide important lessons for the cooperative management of other commonpool resources both in Texas and elsewhere.

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