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Discussion: Water Scarcity–Future Uses and Implications for Policy

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The three articles presented at this invited session examine the evolution of water policy planning and the implementation of regulatory tools to achieve water conservation objectives. Two articles focus on Texas water issues and the third focuses on the Georgia planning experience. Each article clearly illustrates the value of sharing advances in hydrologic and economic modeling with local community stakeholder groups to facilitate the credible development of regional water management plans. Moreover, each article hints that stronger regulatory tools may be needed to achieve long-run policy objectives.

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The three articles demonstrate that most water policy issues confronting planners result from current or future scarcity concerns attributable to: 1) growing residential, commercial, industrial, agricultural, recreational, and environmental demands; 2) the inherent uncertainty of surface water supply; and 3) declining aquifer stocks. Given the rapid population growth in the southern United States in combination with increasing industrial and agricultural demands, it is becoming clear that under existing management institutions and allocation rules, regional water supplies may be insufficient to satisfy all competing demands for residential use, waste treatment, hydropower, recreation, irrigation, wildlife protection, navigation, and industry and ensure an adequate supply for future development. The articles presented by Johnson et al. (2011), Mullen (2011) and Rister et al. (2011), each address important water management issues and emerging policy solutions confronting water management policymakers in two southern states in a variety of economic and hydrologic settings. Collectively, the three articles address the evolution of water policies and regulations developed to encourage sustainable water use, protect water quality, and allocate increasingly scarce water supplies to their greatest economic value now and into the future for Texas and Georgia.

Johnson et al. focus on groundwater conservation policy issues and present a comprehensive literature review of 50 years of research that quantify the determinants of groundwater extraction in the Texas High Plains (THP). Their literature review reveals that under historic economic incentives and management institutions, the necessary forces existed to create a regional economy based heavily on the agricultural mining of a near-exhaustible groundwater resource. This development strategy resulted in the agricultural mining of the Southern Ogallala Aquifer, and groundwater reserves are now approximately 50% of their 1940 storage level (Ogallala Commons, 2004). In contrast to the Johnson et al. article, Rister et al. focus on surface flow water management issues and broaden the policy question to consider both quantity and quality issues associated with surface water management along the

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Rio Grande River, a water resource collectively managed by Texas and Mexico. Similar to Johnson et al.'s economic landscape, agricultural water use in the Rio Grande has historically been the dominant form of water use, but unlike the THP, rapid nonagricultural economic growth coupled with dramatic population growth has resulted in a new set of demands that now heavily compete with agriculture for scarce water supplies. The third article by Mullen (2011) is set in Georgia and has a broader scope than either of the two Texas articles in that it focuses on the statewide evolution and implementation of Georgia water policy in both urban and rural areas. Mullen also addresses the need for conjunctive surface and groundwater management plans in noting that surface and groundwater quality and quantity issues are often interrelated and the development of credible water management policy often precludes developing a surface water management policy in isolation from a corresponding groundwater management policy, and vice versa.

Despite the significant difference in the three geographic settings, there is significant commonality in the planning approach taken by both states. Both states clearly recognize that successful water planning must be decentralized, have clientele buy-in, be based on the best science available, and that the geographic extent of a regional plan must be sufficiently large to accommodate all substate political/administrative boundaries that overlay well-defined hydrologic boundaries. Both states also recognize that a well-designed planning process explicitly acknowledges the importance of water resources to all citizens, including future generations, and the relationships/tradeoffs between economic prosperity and environmental quality. As noted by Mullen (2011), a good management plan must have a strong scientific foundation and be flexible enough to accommodate new scientific and policy insights as well as changing social, economic, cultural, and environmental factors. Clearly, both states recognize that a water management plan is essentially a flexible framework that allows for more planning to occur in the future. Texas Senate Bill 1 (SB 1) requires that each water management plan must be updated every five years, and the Georgia Comprehensive Statewide Water Management Plan (CSWMP) includes a provision that each adopted Regional Water Plan is subject to review and modification by the Water Planning Council and the Georgia Environmental Protection Division.

Why Water Policy?

Before further discussing the content of the three presented articles, it is appropriate to briefly focus on the need for water policy planning. Introductory welfare economics teaches us that private markets are perfectly efficient and cannot benefit from government/regulatory intervention when "certain conditions" are met. When the appropriate conditions are satisfied, the private market provides the optimal quantity of a good or resource at the socially efficient price. Given this knowledge, why has water resource planning become such a crucial issue to public policymakers in many states? The answer is that the necessary "certain conditions" are not satisfied for an efficient private market. Private markets are perfectly efficient only if there are no public goods, no externalities, no monopoly buyers or sellers, no increasing returns to scale, no information problems, no transactions costs, no taxes, no common property, and no other "distortions" that come between the costs paid by buyers and the benefits received by sellers. These conditions are usually not all satisfied when dealing with water resources and thus efficient private water markets generally have not evolved. Instead of economically efficient market forces determining quantity and price, water is generally allocated through somewhat inflexible institutional doctrines such as the appropriations doctrine, riparian doctrine, and the Texas right of capture.

These doctrines have generally resulted in poorly defined property rights for water resources. Following Randall (1987), a well-defined property right is characterized by four attributes. First, property rights must be exclusive to ensure that all benefits and costs of using the commodity directly accrue to the owner. Second, property rights must be completely specified to provide accurate information about the rights that accompany ownership, the restrictions on those rights, and the penalty for their violation. This specification is intended to resolve potential conflicts among owners and between owners and nonowners. Third, property rights must be transferable to allow resources to move to their highest valued use. Fourth, property rights must be enforceable and actually enforced. The best specification of rights is meaningless if violations do not have consequences for the violator. Together these four properties allow producers and consumers to evaluate precisely their potential gain in using a resource.

In theory, a competitive private market will lead to an efficient allocation of a commodity, but the public good nature of water resources has generally prevented the efficient allocation of water by traditional market mechanisms. Most in-stream water uses are nonrival (nonconsumptive, classic examples are environmental and recreational use), whereas out-of-stream diversion use tends to be rival (consumptive, with irrigation being an example). The nonrivalry of many water uses makes it difficult to associate full benefits with the cost of water allocated to nonrival uses and water tends to be underallocated to nonrival uses. The inability to exclude leads to "free riding" and common property issues that encourage individuals to pay less than the true value of water resource to them, possibly even nothing, believing others will compensate for their underpayment. Collectively and individually, nonrivalry and nonexclusivity of water resources are two reasons market prices cannot be used as accurate indicators of the water's marginal benefit and cost in alternative uses to determine efficient market allocations.

The public good characteristics of water resources nature is not the sole factor preventing an efficient market allocation of water between alternative uses. In a pure market system, all benefits and costs from resource employment accrue to the users of that resource and are reflected in the value (price) of the resource. The nature of water use, however, causes technical interdependencies, a form of externality, among water users, especially irrigators using surface water. Downstream users are often dependent on return flows from upstream water users. Unless these relationships are accounted for in the market allocation decision, changes in one water user's pattern of use may force changes in another's use. Given, the lack of well-defined property rights, in combination with uncertain future surface supplies and groundwater storage levels resulting from stochastic precipitation patterns, and the need to conserve water supplies for future generations, states are increasingly turning to regulatory agreements to modify existing water allocation institutions to achieve economically efficient outcomes.

Current Policy Tools

Johnson et al. note that before the passage of SB 1 in 1997, Texas groundwater conservation districts (GCD) primarily used education, well-spacing enforcement, and groundwater level monitoring to encourage voluntary groundwater conservation. The passage of SB 1 and Senate Bill 2 (SB 2) collectively signal the initial steps in the transition of Texas groundwater management from the rule of capture, which is a private property doctrine of land (not water) providing groundwater access through land ownership to a regulatory system that authorizes GCD to monitor and regulate the volume of groundwater extracted. In 2005, the Texas Legislature passed House Bill 1763, which requires groundwater conservation districts to set groundwater conservation goals, designated as desired future conditions (DFC). However, Johnson et al. report the DFC currently being considered by GCD in the THP frequently may not restrict anticipated baseline groundwater use (use under current economic incentives) because many areas of the THP are likely to incur economic depletion before storage levels drop below the DFC even with increases in irrigation efficiency. This finding is unsettling if the policy purpose of groundwater conservation is to transform the regional economy from an economy based heavily on the agricultural mining of a near-exhaustible resource to a less water-dependent economy. It might be necessary to broaden the water management discussion to identify an alternative set of regional economic activities that are less water-intensive. Once the appropriate alternative economic future is identified, water policy research could then focus on identifying and implementing water conservation policies that effectively transition the economy from heavy irrigation dependence to a regional economy consistent with a much smaller water endowment. Ongoing integrated policy modeling efforts that are linking economic models to hydrologic models to control for spatial heterogeneity in land use practices and aquifer characteristics need to be broadened to facilitate the economic transition and provide policymakers with a tool to identify areas in the THP in which groundwater conservation reserves can be most cost-effectively located.

The water management situation along the Rio Grande River is much different than in the THP. Instead of optimally managing an exhaustible groundwater stock by imposing withdrawal restrictions or extraction taxes on groundwater use, both demand management and supply augmentation tools are being used to manage the surface water supplies of the Rio Grande River. Rister et al. (2011) note that poorly specified property rights and/or outdated multistate/multination legal agreements governing the use of Rio Grande water supplies slowly became economically inefficient over time. Today, the Rio Grande surface water supplies are managed under the authority of the SB 1 and SB 2 legislation in combination with legal adjudications of the overappropriated river system. One consequence of the adjudication process was the development of several categories of water rights and a water right priority system to allocate water in periods of shortage. In lieu of a market allocation system, when supplies are short, the priority system allocates water first to domestic residential use, then industrial use, and finally to agricultural use. The priority system is designed to allocate water to its highest uses in a period of shortage.

Agricultural demand management policies in the lower Rio Grande have generally been unsuccessful because the irrigation districts own the use of the water, which creates a strong disincentive for individual farmers to replace their low-efficiency furrow irrigation systems with more efficient irrigation technology to conserve scarce water supplies. Marginal cost pricing is an ineffective demand management policy because the irrigation districts own/control most of the water rights, and the districts prefer economies of size with respect to delivery; thus, delivery rates are based on delivery volume established by the irrigation district and not volumetric use by the producer.

Lower Rio Grande supply management policies are designed to cost-effectively mitigate supply risks caused by drought and the pressures imposed by increasing economic and population growth. The menu of available supply enhancement strategies consist of infrastructure rehabilitation, construction of desalination plants as a source of potable water, improved irrigation scheduling, improved irrigation canal delivery systems to reduce seepage losses, and tailwater reuse. In summary, water ownership, water quantity and quality, environmental issues, and economic institutions are the primary issues affecting the appropriate use of Rio Grande water. The efficient allocation and augmentation of the Rio Grande water supply will require additional research on the marginal value of water in each alternative water use and cooperation among stakeholders.

Contrasting with the almost exclusive focus on agricultural water management tools presented in the two Texas articles, Mullen (2011) discusses the value of five residential water management tools in addition to agricultural management tools. Residential water management is a critical issue in the Atlanta metropolitan area because the area draws water supplies from Lake Lanier, a reservoir on the Chattahoochee River north of Atlanta, although the lake was originally developed for hydropower generation and not water supply. As expressed by Mullen, the legal uncertainty of the state's water supply coupled with increasing water demand pressures and drought led the Georgia Association of County Commissioners to call for a statewide comprehensive water plan in 1999.

Although the Georgia legislative language is slightly different than the language contained in Texas' water planning legislation, the spirit and scope of Georgia's Comprehensive Statewide Water Planning Act of 2004 is similar to the language contained in Texas SB 1 and SB 2. The Georgia Act established a broad set of guiding principles to direct the design of the water management plan and established a water council to coordinate the planning process. The guiding principles explicitly acknowledge the importance of water resources to all of Georgia's citizens, including future generations, the connection between economic prosperity and environmental quality, and the need for periodic revision of a plan. Moreover, the 2004 Act requires the developed management plans to have a strong scientific foundation and be flexible enough to accommodate new scientific and policy insights as well as changing social, economic, cultural, and environmental factors. In 2008, Georgia adopted the Comprehensive Statewide Water Management Plan (CSWMP). Similar to Texas' Groundwater Management Areas, the Regional Water Planning Councils established by the CSWMP are demarcated by county political boundaries, but the counties are aggregated to correspond to well-defined hydrologic boundaries. Each 25-member regional water planning council ideally represents the full spectrum of stakeholders. Mullen (2011) reports that each of the 14 regional water planning councils is now developing their water management plan.

A list of the most frequently proposed residential water management tools consist of: 1) metering multitenant builds to decouple monthly rent from water use cost; 2) promoting marginal cost pricing (increasing block rates); 3) improving residential billing practices to make consumers aware of the relationship between the quantity of water used and their monthly water bill; 4) encouraging the residential adoption of high-efficiency plumping; and 5) using outdoor water restrictions that shift the time of day when water can be applied to landscapes and/or encourage the adoption of less water-dependent landscapes. Decoupling tenant rent from the water use bill removes the fixed-cost appearance of water use and allows price signals to affect tenant water use levels. Marginal cost pricing as a demand management tool can have both intended good consequences and unintended bad consequences. An increasing block rate structure is likely to induce household conservation, but water utilities may realize a less stable revenue stream because when consumers reduce consumption, they reduce high-cost uses first and affect a utilities' ability to incur monthly expenses for infrastructure improvements. Except in the case of a perfectly inelastic demand, improved billing practices that clearly illustrate the relationship between water use and cost will induce conservation behavior. Implementing either high-efficiency plumbing and/or imposing outdoor use restrictions are two additional ways to reduce per-capita water consumption levels.

Mullen (2011) also notes that for the purpose of decreasing agricultural water use, many regional water planning councils have recommended that all new irrigation systems have an efficiency of at least 80%. However, when agricultural water use does not carry a volumetric charge, as is the case in Georgia, the cost of applied irrigation water is simply the energy cost associated with delivering the water from its source to the field. Thus, an increase in irrigation efficiency reduces the energy cost of applying sufficient water to irrigate a crop to a specific level of its full net irrigation requirement. This effectively reduces the marginal cost of applying the last unit of consumptively used water and could increase per-acre water application rates if the crop was previously irrigated to less than full net irrigation requirement.

In summary, both Texas and Georgia are in the midst of complex water planning processes. Both states clearly recognize that the development of a credible water management plan requires a broad array of academic skills. Valid planning models, at a minimum, need to use expertise from the disciplines of hydrology, economics, agronomy, and agricultural engineering. Moreover, this scientific knowledge needs to be clearly explained to the various stakeholders and planning bodies so that the tradeoff impacts of alternative water allocations are clearly understood by all participants. Additional research that focuses on estimating the marginal value of water in alternative uses would greatly improve the economic efficiency of water allocated to alternative uses in all proposed water management plans.

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