Session 21.3

Agricultural Water Use and the 1980 Groundwater Management Act: Institutional Change and Water Conservation in South-Central Arizona, USA. ***Haley Paul***, Arizona State Univeristy & University of Arizona Cooperative Extension-Maricopa County, Phoenix, AZ.

Presented by

Haley Paul
Arizona State Univeristy & University of Arizona Cooperative Extension-Maricopa County, Phoenix, AZ
haleyepaul@gmail.com

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Abstract

Present day human societies face many challenges in effectively managing resources that exhibit characteristics of "common-pool resources" (CPR), of which groundwater is a critical example. CPRs consist of natural or man-made resource systems from which it is difficult to exclude resources users, and where one person's use impacts another's. Scholars also incorporate CPRs into the broader study of social-ecological systems (SESs), placing emphasis on the role of proper and improper institutions in pushing SESs towards sustainability or collapse. Institutions are the rules-in-use that shape human action. The seminal 1980 Groundwater Management Act (GMA) in Arizona, USA is an institution designed to curb groundwater overdraft through a combination of conservation strategies, augmentation and supply development, and reduction in agricultural water use through strict prohibition of its expansion in designated areas. Today, with urbanization pressures and the halting of agricultural expansion, agriculture uses less water on the whole than in 1980. However, in spite of the conservation and efficiency regulations imposed on agriculture by the GMA, on a per-acre basis, agriculture's water consumption is stable. Employing an analytical framework used to evaluate the contribution of institutions to the maintenance of SESs, I examine: a) the original institutional design and process of institutional change within the GMA, b) how institutional change affects resource users' response to signals of water scarcity, and c) how to increase water conservation on farms. Results from the institutional analysis indicate there was insufficient time to incorporate farmers' existing knowledge about water efficiency into the Act. Thus, after 1980, farmers lobbied for adjustments to the regulations of the GMA in order to increase their water use flexibility. To elicit recommendations on how to increase water conservation and irrigation efficiency on farms, I collected primary data through interviews with farmers and water policy experts in south-central Arizona. Suggestions from interviewees include: the need for a greater understanding of the temporary nature of central Arizona agriculture in providing incentives to boost water conservation (e.g. renting land instead of owning land), the promotion of currently available incentives to invest in water conservation, and increased farmer education about water-saving practices. From these results, a “Quick

Reference" publication has been developed in conjunction with the University of Arizona Cooperative Extension. This guide will be a one-stop reference for Arizona farmers to locate and identify the best financial incentives for their operation in order to invest in water conservation and irrigation efficiency measures on the farm.

Introduction

Effectively managing water resources given limited supplies and increasing populations is a challenge all over the world. Properly designing policies, regulations, and rules— collectively known as institutions (Ostrom 2005)—in a manner compatible with the human and environmental factors relevant to a specific area is critical if long-term sustainability of livelihoods is to be achieved. Examining the institutions governing groundwater in the Southwestern United States offers a glimpse into the challenge of achieving successful, long-term management of water resources in an arid environment with high population growth. "The allocation, use, and protection of water resources are among the West's most important political and public policy issues" (Blomquist et al. 2004). Surface water and groundwater alike quench the West's growing thirst. To narrow the scope of this study, I focus on groundwater.

One specific challenge arises when water resources, such as groundwater, exhibit characteristics of common-pool resources (CPRs). Common-pool resources consist of natural or man-made resource systems from which it is difficult to exclude resources users (Ostrom 1990). With CPR systems, one person's use of a resource unit impacts another's use by making that resource unit unavailable to others (Ostrom 1990). Groundwater basins are an example of CPR systems, and the focus of this study. Scholars also incorporate CPRs into the broader study of social-ecological systems (SESs). "All humanly used resources are embedded in complex, social-ecological systems" (Ostrom 2009, p. 419). Thus, SESs are ecological systems that are closely linked to and impacted by a social system (Anderies et al. 2004). Scholars emphasize the impact that proper and improper institutions, in combination with various physical and socioeconomic variables, can have in affecting the long-term performance of SESs (Ostrom 2009; Shivakoti and Ostrom 2002). Institutions are the formal and informal rules-in-use that guide and shape human action (Adger et al. 2003; Lam 1998).

Prior to the passage of the pivotal 1980 Groundwater Management Act, groundwater in Arizona was governed by the doctrine of reasonable use, whereby a landowner had the right to pump as much groundwater from underneath his or her property as could be put to use (Schlager 1995). This institutional arrangement worked well for nearly a century, but with urban population growth and the steady consumption of groundwater by the industrial and agricultural sectors in the south-central part of the state, negative environmental and economic impacts emerged (Connall 1982). Arizona experienced rampant groundwater overdraft throughout the populous south-central part of the state during the middle part of the 20th century. Overdraft occurs when the amount of groundwater removed from a basin exceeds the amount of water being restored; this is also referred to as exceeding safe yield or groundwater mining (Blomquist 1992). In the year 1977, for example, Arizona citizens consumed roughly 2.5 million acre-feet more groundwater than was replenished (Arizona Groundwater Management Study Commission 1980).

To fix the problems associated with groundwater overdraft, such as subsidence, land fissuring, and aquifer compaction (Bouwer 1977), as well as to maintain federal funding for the Bureau of Reclamation project called the Central Arizona Project (CAP), the state of Arizona passed the Groundwater Management Act (GMA) in 1980. The GMA intended to curb groundwater overdraft through a combination of conservation strategies, augmentation and supply development, and reduction in agricultural water use through strict prohibition of its expansion in designated areas called Active Management Areas (AMAs) (Arizona Department of Water Resources [ADWR] 2004). The Arizona Department of Water Resources (ADWR) is the state agency charged with implementing and enforcing the GMA. Groundwater is now regulated and monitored by the Arizona Department of Water Resources (ADWR) within Active Management Areas (AMAs), the regions where groundwater overdraft is most severe (ADWR 2004).

Agricultural, municipal, and industrial uses make up the three water-consuming sectors in the state of Arizona (Figure 1) (ADWR 2010). Together, the three sectors utilize the state‟ s available surface and groundwater supplies. Groundwater is a particularly important type of water resource in the desert because if managed properly, it can "remain plentiful in an area for some years after a drought has taken it toll on water supplies at the surface" (Blomquist et al. 2004, p. 23).

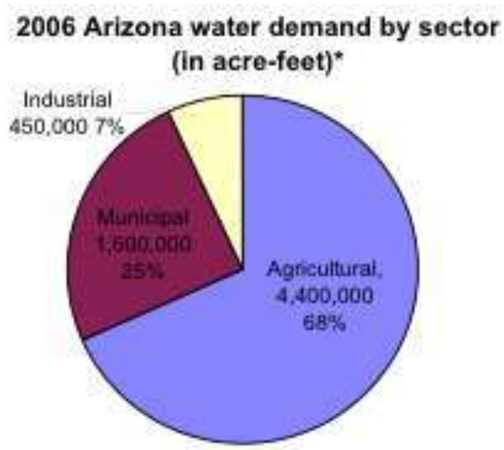

Figure 1. Statewide water use by sector (ADWR 2010).

Despite the development of the 1980 Groundwater Management Act to manage groundwater use, Arizona still faces challenges in ensuring the long-term viability of its groundwater resource base. Most scholars and practitioners agree that the AMAs are not on track to reach safe-yield (Megdal et al. 2008). And today, groundwater still remains a vital part of Arizona‟ s water budget. As of 2006, the state of Arizona used roughly 2.7 million acre-feet of groundwater, 2.8 million acre-feet of Colorado River water, 1.1 million acre-feet of other in-state river surface water (e.g. the Salt, Verde, and Gila Rivers), and 0.22 million acre-feet of effluent (ADWR 2010). Total water use by the state of Arizona equals 6.84 million acre-feet (ADWR 2010). Figure 1 shows the statewide percentage of water used by each sector as of 2006. Even with the gains made in the utilization of surface water (mainly from the Colorado River), groundwater continues to play a critical role in meeting Arizona‟ s total water demand.

One way to examine the impact of an institution such as the GMA on the long-term performance of an SES (south-central Arizona groundwater basins) is through the lens of the Institutional Analysis and Development (IAD) framework (Ostrom 2005). Employed as a way to develop structure across different case studies concerning human-environment interactions (Shivakoti and Ostrom 2002), I use the IAD framework to highlight how a specific groundwater management policy—the Groundwater Management Act of 1980 in Arizona, USA—was originally designed to reduce groundwater overdraft.

Today, with urbanization pressures and the halting of agricultural expansion, agriculture uses less water on the whole than in 1980. However, in spite of the conservation and efficiency regulations imposed on agriculture by the GMA, on a per-acre basis, agriculture's water consumption is stable (Needham and Wilson 2005). Based on the analysis of variables included in the GMA indicated by Ostrom (2009) to be important for the sustainability of SESs, I argue that by not accounting for variables specifically pertaining to the “Users” (Figure 2) in the development of the GMA, the users (farmers), regulated by the provisions of the GMA, perceived a mismatch between costs incurred and benefits gained under the new regulations. In other words, the new regulations attempted to reduce the amount of water farmers could use over time. Because the overall benefit of reducing overdraft was not readily or quickly experienced by farmers, they lobbied for and won amendments to the GMA after its 1980 passage that achieved greater flexibility in how they could use groundwater.

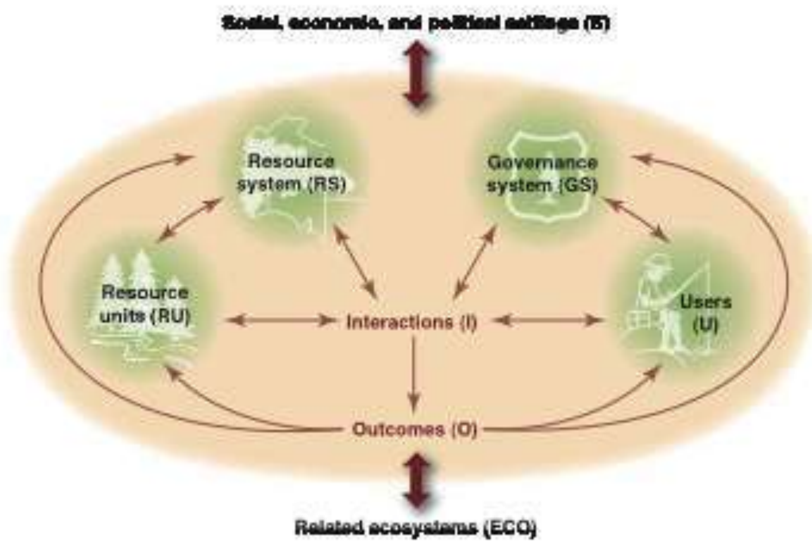

Figure 2. Core subsystems of Social-Ecological Systems (Ostrom 2009, p. 420).

The amendments gained by farmers increased their water use flexibility in the short-term. This flexibility can also be viewed as increased short-term robustness to shocks such as climate extremes (e.g. high temperature, low rainfall) and market fluctuations (e.g. ability to plant a more water intensive crop if the agricultural market demands it). Nevertheless, the amendments generate a trade-off: farmers gain flexibility in their water use, but do not change the amount of water they use per-acre, even though one of the original intents of the Act was to increase water conservation by the sector (Needham and Wilson 2005).

Results

Not long after the law passed, farmers opted to change it because they felt that the GMA constricted their flexibility to use water. Scholars studying other social-ecological systems around the world have noted that when users and other stakeholders are given a strong voice and real responsibility, users of natural resources, such as irrigation farmers, may enhance the economic and ecological performance of the SES (Shivakoti and Ostrom 2002). Some experts interviewed for this study suggested that the lawmakers who constructed the initial GMA rules knew little of the on-the-ground nuances related to farming, especially in the desert. “[The GMA] was written by people that ... didn‟ t really understand what was going on down on the farm" (Water-agriculture expert #5, personal communication, March 4, 2010). A farmer adds:

> There are a lot of assumptions that government people make that have low or no reality. You [can] talk hypothetically [about] the amount of water the plant need[s] but when you actually deliver that water in a production situation it is a lot different because the plant can‟ t take up all the water you send to it. (Farmer #6, personal communication, February 26, 2010)

Without a close examination of the various factors influencing agricultural water use included in the initial development of the GMA, the result was a mismatch between costs and benefits—at least as perceived by the agricultural resource users of south-central Arizona. Farmers were no longer permitted to expand their farms‟ irrigated acreage. They were expected to become more efficient with their water use, and with that efficiency, experience reductions in the water allotted to their farms. The resource once extracted as a private property right was suddenly defined as the communal property of the state of Arizona to be divvied up based on a farmers‟ historic use. A water expert suggests the stark reality farmers suddenly faced:

> I think it was shock at first for farmers that on June 11, 1980 you could use as much water and irrigate any land that you wanted. Then June 12, 1980 comes in and its like, "I can only irrigate this much, and how much water do I have to use? Who is going to tell me what to do?" (Water-agriculture expert #8, personal communication, March 10, 2010) This mismatch meant an adjustment to certain provisions in the original Act to provide

farmers the necessary flexibility to respond to changes in climate and the agricultural market. Anderies et al. (2004) highlight that institutions associated with successful SESs often provide a "rough proportionality between the benefits a resource user obtains and his or her contributions to the public infrastructure" (p. 12). An institution that does so is considered fair in most social systems (Issac et al. 1999). When institutions are constructed and considered fair, they reduce the chance that resource users will try to challenge, avoid, or disrupt the policies of the public infrastructure providers (Anderies et al. 2004). To the agricultural sector of south-central Arizona, the GMA did not appear fair:

> [It was] an upheaval in the agriculture industry because we developed our water ourselves. The wells that we drilled we owned. We bought and paid for them, and took the risks when we drilled them. Sometimes you get dust, sometimes you get water. And here were some people ... suggesting that we were going to lose control of those wells and the water that came from them, and that the water belonged to the state of Arizona instead of to me and my peers. It was brutal. (Farmer #1, personal communication, February 3, 2010)

According to Ostrom (1990), "Participants prefer a set of rules that will give them the most advantageous outcome. Although all will prefer a new institution that [enables] them to coordinate ... activities, ... a fundamental disagreement [may] arise among participants regarding which institution to choose" (p. 42).

Although farmers need water use flexibility, it is also noteworthy that if farmers implemented greater water conservation techniques, they may be better prepared in times of scarcity, because they need less water to achieve the same satisfactory outcome on their farm. Thus, if farmers are prepared to use water as efficiently as possible, their adaptive capacity to water scarcity shocks may increase. Water-conserving technologies allow farmers to save money when water is not scarce by using whatever water is available as efficiently as possible. However, if water does become scarce, on-farm efficiency technologies enable farmers to adapt to the scarcity conditions, when they might not have been able to do so otherwise.

Unlike previous work in the literature that discusses the "weakening" of the GMA through the amendments won by agriculture as well as the municipalities (Hirt et al. 2008), I explore the process of institutional change to illustrate the legitimate concern held by farmers that the original provisions of the GMA did not provide sufficient year-to-year flexibility for water application in their agricultural operations. One result of these gains in inter-annual robustness to certain shocks is that farmers are blocked from receiving signals of water scarcity that may serve to motivate on-farm water conservation. Thus, farmers are not induced to implement water-conserving strategies to the extent originally predicted with the establishment of the GMA. With the institutional arrangements inhibiting the flow of information to farmers signaling impending or actual scarcity, farmers have less incentive to implement water conservation strategies on the farm. And given the importance of proper incentives in determining the success of an SES (Ostrom and Shivakoti 2002), it is important to know what farmers and water and agriculture experts think could be done to boost water conservation on farms in south-central Arizona.

Promoting Agricultural Water Conservation

Agricultural water conservation not only benefits the groundwater basins, it can also increase the capacity a farmer has to adapt in scarcity situations. Increasing per-acre water conservation in agriculture remains an elusive yet important component in managing Arizona‟ s groundwater resources sustainably, and one that can be implemented at the farm-level. Defined as the reduction of water use through enhanced efficiency (Gleick 2002), conservation is critical to the future of Arizona as both groundwater and surface water supplies are predicted to become scarcer through long-term drought and increased urbanization (McKinnon 2009a; McKinnon 2009b).

General, repeating themes from the primary data interviews included the sentiment that more state-level statutory negotiations and institutional amendments to curb agricultural water use are not going to be effective at achieving increased water conservation, mainly because the previously discussed institutional battles have left both the ADWR and farmers politically exhausted. Similarly, both experts and farmers suggested that achieving greater agricultural water conservation is likely to come from economic incentives that farmers choose to implement on their farms, not from increased regulation. Lastly, it was often expressed that farmers want to be as efficient with their water use as economically possible because water is an input cost and anything that reduces costs is appealing to farmers as business operators. To develop strategies to conserve water, efforts to tap into this social norm should be increased.

The recommendations for increasing water conservation on farms in central Arizona include:

1. Recognition by the Natural Resources Conservation Service (NRCS)—a USDA-sponsored organization that "works with landowners through conservation planning and assistance designed to benefit the soil, water, air, plants, and animals that result in productive lands and healthy ecosystems" (Natural Resources Conservation Service [NRCS], 2010a)—of the temporary nature of farming in central Arizona, a rapidly urbanizing area. By recognizing that farmers move around the area and farm different plots of land depending on their specific situation, the NRCS could adjust their requirement necessitating proof of land tenure to receive funding for water conservation improvements. This would allow more farmers who are leasing land the opportunity to participate in NRCS grants and other opportunities (Farmer #5, personal communication, February, 16, 2010).

2 Many farmers now lease the land they farm from developers who are not yet ready to develop. Leases tend to be temporary in nature, with some only season-to-season. With such short time horizons and uncertainty about the duration that one will be farming, investment in water savings technologies decreases. With greater access to incentives— state tax credits or federal matching funds, for example—to install efficient irrigation systems (such as sprinkler, drip, level basin), a farmer could recoup his or her investment faster and be more likely to invest in water savings technologies on the farm (Farmer #2, personal communication, February 10, 2010; Farmer #5, personal communication, February, 16, 2010; Water-agriculture expert #1, personal communication, January 28, 2010).

3 An increased presence of the USDA‟ s Environmental Quality Incentives Program (EQIP) in Arizona. EQIP provides a "voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help eligible participants install or implement structural and management practices on eligible agricultural land" (NRCS, 2010b) (Water-agriculture expert #1, personal communication, January 28, 2010).

4 Promote the leasing (instead of the ownership) of portable irrigation systems, such as sprinklers and drip. By leasing portable water-savings technologies, farmers who do not want to purchase a permanent physical structure, because they are unsure of the duration that they will be farming on a specific plot of land have another way of accessing efficient irrigation technologies (Farmer #5, personal communication, February, 16, 2010).

5 Continue to provide state tax credit opportunities for water conservation. "The tax credits really helped pay for all of our drip irrigation upgrades because it is a dollar for dollar off of your taxes. We wouldn‟ t have done it otherwise" (Farmer #2, personal communication, February 10, 2010).

6. The ADWR sponsors a Water Management Assistance Program and has other funds to help the agricultural sector implement on-farm water efficiency technologies (ADWR, 1999b). Continue to promote and make farmers aware of the assistance that is available to them. "[It is] funded every year and only a handful of people take advantage of it" (Water-agriculture expert #8, personal communication, March 10, 2010).

1 Increased farmer education. Farmers who have been irrigating a certain way their whole life may just continue to operate in that manner because they are accustomed to certain methods of irrigating. Through increased education, farmers can see how efficient practices are implemented on the farm and how they save water (Water-agriculture expert #8, personal communication, March 10, 2010).

2 Although there would be implications on the economics of farming, raising the price of water would induce significant water savings on farms because if something is more

expensive, people tend to use less (Water-agriculture expert #4, personal communication, March 4, 2010; Water-agriculture expert #5, personal communication, March 4, 2010; Water-agriculture expert #6, personal communication, March 5, 2010).

Quick Reference Guide for Farmers in Arizona

Because of these suggestions, I am working with faculty at the University of Arizona Cooperative Extension in Maricopa County to develop a publication that farmers can access to help them make decisions on which financial incentives (specific to increasing irrigation efficiency and water conservation) would be the best fit for their individual operation. Included in the document will be a table outlining the name and descriptions of the assistance programs, eligibility, what type of assistance it is (grant, cost-share, contract, etc.), and where the farmer can go to find more information or apply. This publication will serve as outreach to Arizona agriculturalists, making their lives better by limiting the amount of time they have to spend looking for available incentives in the realm of irrigation and water conservation. This aligns with the goals of Western SARE (the outreach arm of the United States Department of Agriculture) and Arizona Cooperative Extension to serve farmers and make agriculture more sustainable throughout the western United States.

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Author contact information:
Haley Paul, M.S. School of Sustainability | Arizona State University *Current position*: Program

Coordinator, Senior University of Arizona Cooperative Extension, Maricopa County 4341 E. Broadway Road Phoenix, AZ 85040
(480) 371-4778
hepaul@cals.arizona.edu haleyepaul@gmail.com
For additional information see:
http://www.linkedin.com/in/haleyepaul