Banking on a fantasy or grounded in high-quality data? Assessing the Connection between Hydrology and Policy in Arizona's Groundwater Legislation*

Abstract

Since pumping technology became more available in the last century, groundwater has been used to provide water to growing populations. Many places, including the state of Arizona, soon realized that they were depleting this resource at an alarming rate with severe consequences, e.g. land subsidence and loss of the aquifer's overall storage capacity by compaction, diminished water quality, and increased pumping costs. In 1980, the State of Arizona passed the Groundwater Management Act (GMA) in an attempt to reverse some of the groundwater depletion and in order to secure Arizona's supply of Colorado River water from the U.S. government.

Although many water managers and policy makers view the GMA as progressive and successful, it has some significant hydrologic shortcomings. First, the GMA does not manage groundwater and surface water together, even though they are hydrologically connected. Second, it may have created a situation that makes Arizona more vulnerable to climate change. Third, some of the current policies, like water banking, allow localized groundwater pumping in some locations but recharge surface water in other sub-basins in an attempt to balance water withdrawal. In this paper, I attempt to determine how important water science is in making water policies in the state. I do this in two ways; first I survey the hydrologic literature to get an impression of the important aspects to consider when making hydrologically-sound policies and see if the current policies in Arizona incorporate these considerations. Then, I present data collected from interviews with informants who have implemented the policies of the GMA in an attempt to determine how important science is to them compared to other aspects in making water policies and what their perceptions are on the success and failure of the GMA. Although water policy makers generally cite scientific considerations as being important in making policy, there are several other aspects that receive at least as much consideration in how water policy is made in the state, despite the known consequences in the long-run of scientifically unsound practices.

Water, Development, and the Desert: Intentions and Unintended Consequences

Globally, groundwater depletion is occurring at a staggering rate: Konikow and Kendy estimate that withdrawals total between 750-800 square kilometers per year**(Konikow and Kendy 2005, 317). Arid and semiarid regions, as well as densely populated parts of the humid tropics and temperate zone, are especially vulnerable to the impacts of climate change, in addition to facing the problem of absolute water scarcity (Vorosmarty et al. 2000, 285 and 287). Standish-Lee *et al.*

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* The reader should note that the title of this paper is actually the title of a thesis by the same name. This shorter paper for the STS Graduate Student conference will, however, establish the theoretically framework for the thesis.

** This is, depending on which end of the range you use, 628 million acre-feet (MAF) of water per year that is used (based on 775 km^3/yr). For a point of reference, the whole Colorado River allocation for consumptive use totals 16.5 MAF (Christensen et al. 2004, 352).

also cite the importance of effectively managing water quantity and quality in arid regions, especially since drought conditions, which demonstrably effect water quantity during a particular time period, may further diminish water quality (Standish-Lee et al. 2006). Many arid and semi-arid regions throughout the world are some of the fastest growing populations in the world, and the arid Western U.S. is no exception. According to an unpublished paper produced by ASU's Global Institute of Sustainability, the population of Arizona's three most populous counties, Pima, Maricopa, and Pinal, has rapidly grown from 1.4 million in 1970 to 5 million in 2006, and growth is still occurring (Holway *et al*. 2006, 2). The Arizona Department of Economic Security estimates that by 2055, the population of these counties will be over 11.1 million (Holway *et al*. 2006, 2-3). As populations in arid regions grow, their demand for water for water also grows. Up through 1982 in Arizona, over sixty percent of the state's total water supply was provided with groundwater, which resulted a 2.2 million-acre-feet (MAF) overdraft annually (Connall 1982, 314). These massive amounts of groundwater were pumped in order to supply residents, municipalities, industries, and agriculture with water. Using groundwater, however, does not come without problems. Within decades of extensive pumping, many people throughout the state fell victim to the well-documented consequences of increased pumping costs from lowered water tables and subsidence and fissuring causing property damage (Konikow and Kendy 2005, 317). Officials in the state knew of these problems for sometime even before the Carter administration established the so-called "hit list" that effectively brought an end to the era of large-scale water projects in the Western U.S (August and Gammage 2007, 19), adding extra pressure to the state to deal with its groundwater problems. With the closing of the era of large-scale reclamation projects, and global groundwater depletion, legislation like the Groundwater Management Act (GMA) has been recommended for other areas looking to evaluate alternatives to groundwater (Jacobs and Holway 2004, 52).

With virtually no prospect of a new water project to bring in water to the state's growing population, Arizona was under intense pressure politically to manage its groundwater overdraft, and in 1980, then-governor Bruce Babbitt signed the Groundwater Management Act (GMA) into law (August and Gammage 2007, 19; Connall 1982, 313; Jacobs and Holway 2004, 52). The GMA is generally recognized as being one of the most comprehensive groundwater management tools of its time and set forth an assured water supply (AWS) program requiring that water users prove the availability of a 100-year supply (Jacobs and Holway 2004, 52; Pearce 2007, 29). The GMA also created Active Management Areas (AMAs) in an attempt to manage the worst areas of groundwater overdraft that occurred in the most densely populated areas of the state. In AMAs the goal was to achieve safe yield, or a long-term balance between water withdrawals and natural and artificial recharge, by 2025 (A.R.S. § 45-561.12). The law established a timeline for how the objectives of the GMA would be accomplished, which included decadal installments of management reports describing the progress towards the goals set forth by the GMA. In addition to managing overdraft, the GMA also attempted to provide a means to efficiently allocate groundwater that would still be used and to augment the state's groundwater supply through water supply development. Additionally, the GMA also established the state agency responsible for executing the mandates of the GMA (Jacobs and Holway 2004, 53-56).

A necessary component of meeting the goals set forth by the GMA are the state's recharge programs (Megdal 2007, 188). The concept of water recharge programs has been around for some time, but it was not until the GMA was amended in 1986 that the door to artificial recharge opened[***] This strategy of using surface water, usually Colorado River water, or effluent to recharge groundwater is known as conjunctive management and is practiced in many arid states in the Western U.S (Blomquist et al. 2004, 12).

Although it is generally hailed as being a progressive strategy for managing water, the GMA's implementation in Arizona has several major shortcomings, with perhaps the most notable being that recharge and withdrawal are allowed to occur in separate sub-basins. At this time, there is also not a sufficient recovery system to deliver the recharged water to water users (Blomquist *et al.* 2004, 143). Furthermore, the GMA only manages groundwater, while the state's surface water is managed by another unrelated set of laws (Jacobs and Holway 2004, 64).

While the GMA's original goal of achieving safe yield seems to be a good one, another of its goals seems to have become more important: facilitation of development. The state of Arizona's population has grown by 280% since the GMA was passed (Jacobs and Holway 2004, 53). Presumably, without a "renewable" source of water, in this case Colorado River water delivered via the Central Arizona Project, Arizona would not have been able to accommodate the growth that has occurred. In essence, it appears that by passing the GMA, Arizona further facilitated and subsidized the high rates of growth that the state has experienced.

Additionally, the AWS rules have substantial loopholes that further allow rapid growth and development to take place. AWS rules state that a 100-year supply of water must be demonstrated for any construction project, however, construction that is concurrent with the project applying for the AWS certification does not need to be taken into account when calculating the available water (Pearce 2007, 30). Furthermore, developments are allowed to use groundwater if they enroll in one of the recharge programs, either the Arizona Water Banking Authority or the Central Arizona Groundwater Recharge Districts. The water recharged, however, does not legally have to be in the same sub-basin as the water that was extracted. Localized subsidence and compaction of the aquifer can occur as a result of these policies that are not consistent with known hydrologic principles.

Despite some of these known inconsistencies with hydrology, little is currently being done to significantly change the GMA (Pearce 2007, 118), probably in part because of the nonseverance clause, which makes it impossible for the law to be substantially changed from how it currently exists without it being thrown out altogether, but also because of a general lack of political will to change the situation.

[***] Water, like all natural resources, has natural "reservoirs", or areas where it is stored, and fluxes, or mechanisms of transfer. These fluxes move water from one reservoir to another, and in the case of water, this process is known as the hydrologic cycle. Recharge, or the infiltration of water, usually through precipitation, through the ground, acts to balance part of the water budget since groundwater flows to areas where it is discharged into other reservoirs, typically streams. Recharge programs in the state of Arizona work in two ways, either through taking surface water and allowing it to infiltrate into an aquifer or by providing surface water to users who would normally use groundwater.

Is there a Problem with Water in Arizona?

Although the preceding issues could be problematic, at this time whether or not they constitute an actual "problem" dire enough for water managers and state politicians to immediately address is unclear. Another issue concerning water that has been brought up recently is climate change. Arizona has the lowest priority on the Colorado, meaning that if there is a drought that impacts the Colorado River's flow, CAP allocations will be cut before any other states' (Pearce 2007, 33). Specifically, when water elevation levels at Lake Mead fall below 343 m, CAP deliveries are reduced from 1.4 MAF to 1.2 MAF. If the Lake Mead water levels fall below 330 m, then deliveries to CAP and many other states will be reduced proportionally to maintain necessary power generation (Christensen et al. 2004, 345). This effectively makes Arizona even more vulnerable to climate change, especially since there are so many people who have migrated to the state.

Several efforts have been made to try to address various "issues" that have been identified, including reports about different topics produced by various institutions (Arizona Water Institute, Governor's Water Management Commission, etc.). Because of Arizona's vulnerability and the large amount of uncertainty relating to issues of climate change and development in the state and its impacts on water availability, the SPARC (Science Policy Assessment and Research on Climate) group at Arizona State University held a workshop in November of 2006. The workshop participants were invited to come to the campus and discuss their thoughts on a white paper that our group produced ranking the water stressors in Central Arizona. Although workshop participants generally thought that Central Arizona had enough water for the next 25 years, there was still a sense that ensuring the water supply was much less certain after that. Participants also generally cited a lack of urgency among water policy makers in dealing with future water problems (SPARC 2007). So perhaps then the best answer to the question "is there a problem with the water supply in Arizona?" is that for now, there is enough water. Perhaps later there will be problems with supplying water, but the time frame and the circumstances involved with that problem seem uncertain at this time. The next section of this paper will provide some insight as to why this recognized potential problem is not currently being prioritized by water managers.

Setting the (Water) Agenda

How do politicians, or in this case, water managers, select agendas? How come even though experts on the subject of water and Central Arizona agree that there are some future problems, they are not being sufficiently addressed? Being trained in the sciences, my initial reaction was that water managers did not understand the full ramifications of their choice to leave the current legal system in place—one that has separate laws for surface water and groundwater in the state and large loopholes that still allow nearly half a million-acre-feet of water to be overdrafted every year. It soon became apparent that looking at the issue of water in Central Arizona would be insufficient just from a science standpoint, because there must be a reason or a set of reasons for the current situation. Clearly if nothing is changing with water despite the known issues, then this is probably an instance where something political cannot be resolved by technical means alone. In one of my preliminary presentations on this work, someone suggested that I look into

Kingdon's *Agendas, Alternatives, and Public Policies*. It is only after establishing a greater political framework that I came to better understand Arizona's current water dilemma.

Kingdon establishes that in order for an agenda to be set, a generally recognized problem has to exist among politicians. Only once something has been "problematized" does it get prioritized since there are many issues vying for attention, and decision makers only have so much time and energy they can devote to policy making. Once it becomes prioritized, alternatives to the current policy are considered, an action is taken, and the issue is considered "dealt with". Kingdon cites that there must be some kind of mechanism or event, usually a disaster or crisis, that makes people notice what is happening so that the problem gets pushed to the front of the agenda (Kingdon 2003, 90-95).

Arizona's history of confronting water issues illustrates this point well. In the case of Arizona's water, decision makers and scientists generally recognized that there were substantial problems with using large quantities of groundwater, especially in an arid region where recharge is low. Other laws besides the GMA had been passed in an attempt to manage the overdraft, but failed (Connall 1982, 314). In this case, the mechanism that changed failure to relative success in water policies, or the "focusing event", occurred when the Carter administration put political pressure on Western states by denying funding to more reclamation projects, like the CAP to deliver the state's Colorado River allocation, unless the state would pass a law that would more effectively manage the overdraft than the previous pieces of legislation.

Now that the political pressure has been alleviated and a relatively steady state has been reached (steady states are much less threatening to policy makers than fluctuations, according to Kingdon (2003, 91-92), there is no longer a sufficient reason or proper incentive for water issues to get bumped to the forefront of the state's political agenda. In order for this to happen, there must be some kind of triggering event.

What's It Going to Take?

The next question then is what is it going to be the focusing event for water issues to get prioritized in the state's agenda? At this point, without any real data, I can only speculate, but right now I suspect that there will have to be a situation where some people are not actually able to get water when the go to turn on their tap, as suggested to me by a credible informant who has worked for the state's water projects for many years. Without my input, the informant stated that there would have to be some near-catastrophic event where people were unable to get water before any of the current laws were changed (this probably has to do largely with the fact that the GMA nonseverance clause).

I also have two other hypotheses that I am hoping to confirm during my data collection:

(1.) There are some points of consensus among hydrologists and water managers about particular issues, like water recharge and water extraction should occur within the same sub-basin, but consensus gets lost when litigation gets involved in the political process.

(2.) Science does not really have an important role in setting the state's political agenda, at least when water is the issue, even though interviewed officials will probably say it does. Personally, I am still shocked that this is the case, but usually, science is left out of the equation.

My thesis will attempt to see if when questioned, what kinds of issues water managers and hydrologists employed by the state view as problems, and then will ask them what would have to occur for these problems to be addressed. I am looking to see if they mention the importance of hydrology on their own, or if I have to ask them about how important science is compared with other variables in making water policy.

References

August, Jack L., Jr. and Grady Gammage, Jr. Shaped by water: an Arizona historical perspective, in *Arizona Water Policy: Managing Innovations in an Urbanizing, Arid Region*, ed. Bonnie G. Colby and Katharine L. Jacobs, 10-25. Washington, D.C.: Resources for the Future.

Blomquist, William, Edella Schlager, and Tanya Heikkila. *Common Waters, Diverging Streams: Linking Institutions and Water Management in Arizona, California and Colorado*. Washington, D.C.: Resources for the Future.

Christensen, Niklas S., Andrew W. Wood, Nathalie Voisin, Dennis P. Lettenmaier, and Richard N. Palmer. 2004. The effects of climate change on the hydrology and water resources of the Colorado River Basin. Climatic Change 62: 337-363.

Connall, Desmond D. 1982. A history of the Arizona Groundwater Management Act. Arizona State Law Journal 2: 313-343.

Holway, James M. ("Jim"), Peter Newell, and Terri Sue Rossi. 2006. Water and growth: future water supplies for Central Arizona. Arizona State University http://sustainability.asu.edu/gios/waterworkshop.htm.

Jacobs, Katharine L. and James M. Holway. 2004. Managing for sustainability in an arid climate: lessons learned from 20 years of groundwater management in Arizona, USA. Hydrogeology Journal 12: 52-65.

Kingdon, John W. 2003. *Agendas, Alternatives, and Public Policies*. New York: Addison-Wesley Educational Publishers.

Konikow, Leonard F. and Eloise Kendy. 2005. Groundwater depletion: a global problem. Hydrogeology Journal 13: 317-320.

Megdal, Sharon B. Arizona's recharge and recovery programs, in *Arizona Water Policy: Managing Innovations in an Urbanizing, Arid Region*, ed. Bonnie G. Colby and Katharine L. Jacobs, 188-203. Washington, D.C.: Resources for the Future.

Pearce, Michael J. Balancing competing interests: the history of state and federal water laws, in *Arizona Water Policy: Managing Innovations in an Urbanizing, Arid Region*, ed. Bonnie G. Colby and Katharine L. Jacobs, 26-44. Washington, D.C.: Resources for the Future.

SPARC. 2007. Multiple stressors on Central Arizona water resources: a report of the Water Stressors Workshop. Arizona State University. http://www.cspo.org/working/AZ_Water_resources.htm

Standish-Lee, P., E. Loboschefsky, and K. Lecina. 2006. Half full or half empty? Either way it's time to plan. Journal of the American Water Works Association 98: 76

Vorosmarty, Charles J., Pamela Green, Joseph Salisbury, and Richard B. Lammers. 2004. Global Water Resources: Vulnerability from Climate Change and Population Growth. Washington, D.C.: Resources for the Future.