Reflections Compendium – Through December 2023

Sharon B. Megdal, Ph.D.

A commentary series by University of Arizona Water Resources Research Center Director Sharon B. Megdal, *Reflections* essays are published several times a year through the Weekly Wave and posted on the page https://wrrc.arizona.edu/publications/reflections.

REFLECTIONS
Collected Essays on Water
By Sharon B. Megdal, Ph.D.
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Reflections on World Water Day

by Sharon B. Megdal
03/22/2019

World Water Day is a good day for reflection. Just a few days ago, on March 19, 2019, representatives of the seven states of the Colorado River Basin gathered in Phoenix, Arizona to sign a letter asking Congress to approve implementation of the drought contingency plans detailed in the documents attached to the letter. Immediately thereafter, Bureau of Reclamation Commissioner Brenda Burman announced termination of the Department of Interior's request for further input on how to reduce the water supply risks the Colorado River Basin is facing. The March 19th signing and announcement came less than two months after the Arizona Legislature and Governor approved historic actions requisite to Arizona's participation in the Lower Basin Drought Contingency Plan.

The consensus reached by the Colorado River Basin States is noteworthy, as are the efforts within Arizona to develop an implementation plan to share the burden of reduced water deliveries. Pending congressional action, we are entering a new phase of water management wherein we adapt to the reality of a hydrologically stressed, over-allocated river system. Getting to this point has been difficult, and the work is by no means over, even in the short run. There will be funding requests of the federal government related to the Salton Sea and Central Arizona agricultural pumping capacity. Additional documents to complete Arizona's implementation plan will be finalized and approved. Then the heavy lifting will begin on developing plans for the longer term. The drought contingency plans are an overlay to the interim shortage sharing guidelines approved in 2007. Those regulations are set to expire in 2026. Formal discussions on the successor regulations are set to begin by the end of 2020.

I teach a graduate class on water policy in the Spring semester, for which I give a short mid-term. Some test questions have no right or wrong answer. An example is "Explain why you are optimistic, pessimistic, or neither about resolving the water issues of the region." As I reflect on the status of water management, I wish to give my short response. I am optimistic that we will continue to work together to develop the policies and actions needed for residents in Arizona and the broader region to have access to reliable and safe water. The work will be difficult and will never end, at whatever the geographic scale. Water is Life. And water is scarce in the desert. We must all be responsible, informed water users and stewards. This is my simple but I think important message for World Water Day.

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Reflections on Earth Day 2019

by Sharon B. Megdal
04/22/2019

I was recently in Jordan, which is considered the second most water stressed country in the world. While our region of North America is not considered quite so stressed, the similarities of landscape, climate, and precipitation patterns are striking. In recognition of Earth Day 2019, I share my slightly edited opening remarks from the April 14, 2019 International Workshop held at The Hashemite University, located in Zarqa, Jordan.

It is my great honor to be participating in this workshop on Sustainable Development of Arid Lands - a workshop designed to engage in dialogue to identify pathways for addressing some of the critical natural resource and agricultural challenges faced by those living in semi-arid, arid, or what we might call hyper-arid regions, with another purpose being to foster collaboration between the Prince El Hassan Bin Talal faculty at the Hashemite University and other researchers.

I bring several different perspectives to this workshop. I am Director of the Water Resources Research Center and Professor at the University of Arizona in the USA, I am a water decision-maker as an elected member of the Board of Directors of the large Central Arizona Project water conveyance project, and I also serve as President of the International Arid Lands Consortium, in which Jordan has been involved.

My work focuses on water management and policy for growing, water-scarce regions. I used the word “pathways” above rather than solutions, although I do use the word “solutions” in my writings and presentations. Some of the key water challenges we face can be classified as wicked problems. Wicked problems are those that tend to defy standard solutions - for several reasons, including:

1. Incomplete of contradictory knowledge
2. The number of people and opinions involved
3. The large economic burden
4. The interconnected nature of these problems with other problems

Often these problems cannot be solved, but they can be mitigated. Interdisciplinary collaboration is required for effective change. Managing wicked water problems may require changing the questions, managing uncertainty, and creating resilience.

I have asked audiences, including my graduate class, what are some of the thorny or wicked water (or other) problems of this region. We don't have the time to go into discussion of this here, but perhaps you can think about this and come up with your own list. I have at least a few on my list.

I recently spent two days at a summit on transboundary groundwater, with particular focus on the US-Mexico border but also on other borders, including within our US states with indigenous nations. A theme that carried through was the importance of involving researchers from many disciplines, practitioners, and civil society in working to mitigate these wicked problems. The criticality of building relationships and trust was also a theme of the workshop and something we will talk about here. Finally, I suggest we agree that leadership is a critical factor in identifying and implementing pathways to addressing Earth's wicked water challenges.

[Read the Weekly Wave Article on the International Workshop]

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Reflections on Spring as a Time for Growth

by Sharon B. Megdal
05/15/2019

Spring semester is always interesting due to my in-depth interactions with the students taking my graduate course in Water Policy in Arizona and Semi-arid Regions. Teaching this course provides me with the opportunity to cover some of the hottest water topics. Through my lectures and those by guest experts, along with discussion and in-depth analysis of a paper topic by each of the students, we do a deep water dive in just 15 weeks. What I have always liked about teaching this course is the diversity of students it attracts, with this year being no exception. Students of hydrology, environmental science, water and society, law, and more contributed from their different backgrounds and perspectives. Expert guest lecturers came from the agricultural, municipal, and tribal water using sectors, and from state governments in Arizona and South Australia. Guest speakers from the WRRC spoke about our Transboundary Aquifer Assessment Program along the border with Mexico and the robust stakeholder engagement associated with our collaborative efforts in small rural communities. The class field trip to City of Tucson recharge and wetlands sites, CAP's Twin Peaks Pumping Plant, and lunch hosted by BKW Farms exhibited some Arizona water management successes. We also learned about the water challenges our region faces. More than half of the students in the class attended the WRRC's annual conference where they learned about both the challenges and the local solutions applied across Arizona. And, of course, attention throughout the semester focused on the complex negotiations and implications of the Lower Colorado River Basin Drought Contingency Plan (DCP).

A significant amount of learning – mine included – comes through the students' term papers. Students select a topic with a water policy connection, carry out the research, and complete and present a paper within the 15-week semester. While I offer suggestions, I allow quite a bit of leeway in paper topic selection. As in past years, this year I emphasized the importance of consulting experts as part of the research. Each student was required to consult three or more experts, at least in part because it is not possible to gain understanding of the full water policy context from written materials, whether scholarly articles or reports/materials from government and the web sites. This year's topics included municipal conservation programs, mining and groundwater use, the DCP's impact on Central Arizona agriculture, and more.

Not surprisingly, the students and I feel good when we can look back on a semester of hard work and learning. It is gratifying to me to hear from students' unsolicited comments that the course helped them understand how their work has a role to play – a contribution to make – to addressing water issues.

Also gratifying to me is furthering the advancement of the graduate students I advise. This Spring in particular has been full of reviews and consultations associated with dissertations. As one of my Ph.D. students nears completion of her dissertation, two others are finishing up their first substantial dissertation papers, and another just completed her first year. It is exciting to see their potential contributions toward addressing the wicked water problems we face in arid and semi-arid regions. It is equally exciting to watch former students grow professionally. As just one example, several former students, who are now very talented and successful professionals, were speakers and attendees at the Desert Waters International Conference in early April. The creativity and energy of the next generation of water professionals are needed to address the ever-more-complex water problems of tomorrow. While I do not want to overstate my contribution to their success, I am grateful for the opportunity to stimulate their appreciation of the importance of context and robust policy dialogue.

Spring is a time to see plants flower and grow and to reflect on the growth that we nurture through education.

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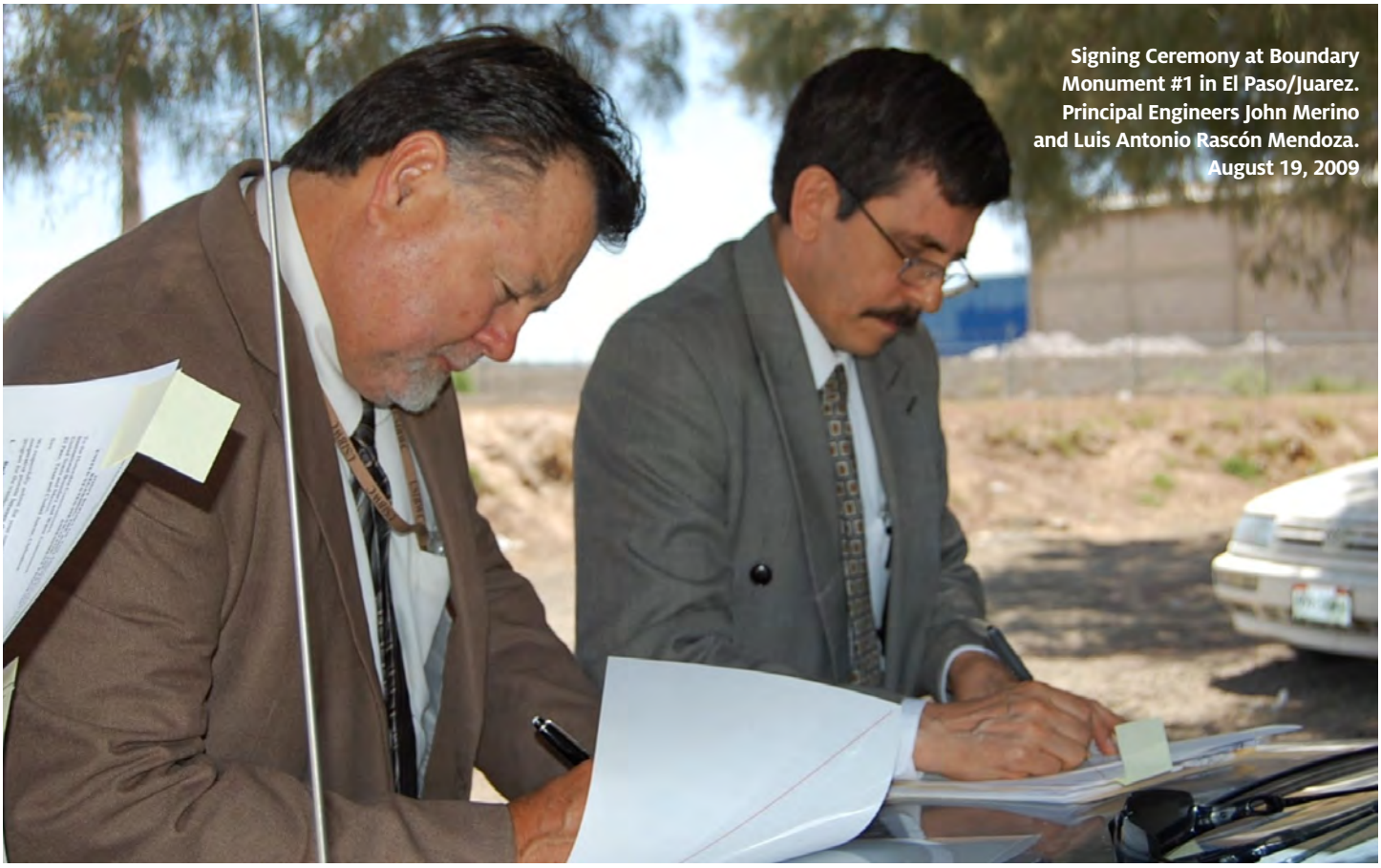


Signing Ceremony at Boundary Monument #1 in El Paso/Juarez. Principal Engineers John Merino and Luis Antonio Rascón Mendoza. August 19, 2009

Reflections on the 10th Anniversary of the Transboundary Aquifer Assessment Program and the Importance of its Joint Cooperative Process

by Sharon B. Megdal
08/23/2019

On August 19, 2009, the Principal Engineers representing the binational International Boundary and Water Commission (IBWC) signed the "Joint Report of the Principal Engineers Regarding the Joint Cooperative Process United States-Mexico for the Transboundary Aquifer Assessment Program" (Joint Report). The Joint Report enabled scientists and government officials from the United States and Mexico to partner in assessing their shared aquifers, an effort that aligns with principles that advance sustainable groundwater management and governance.

Our presentations and other materials on the binational Transboundary Aquifer Assessment Program (TAAP) regularly feature the photo shown here of the signing by IBWC Principal Engineers Luis Antonio Rascón Mendoza of the Mexican section and John Merino of the United States section. Given that the IBWC implements binational solutions to issues arising during application of U.S.-Mexico treaties involving water in the border region, it is fitting that the Joint Report was signed at a mile marker along the U.S.-Mexico border. The three-page Joint Report, my *Arizona Water Resource* column (Summer 2017) explaining its details and importance, and much more TAAP information can be found at https://wrrc.arizona.edu/TAAP. The Joint Report is a concise, well-developed framework for binational cooperation.

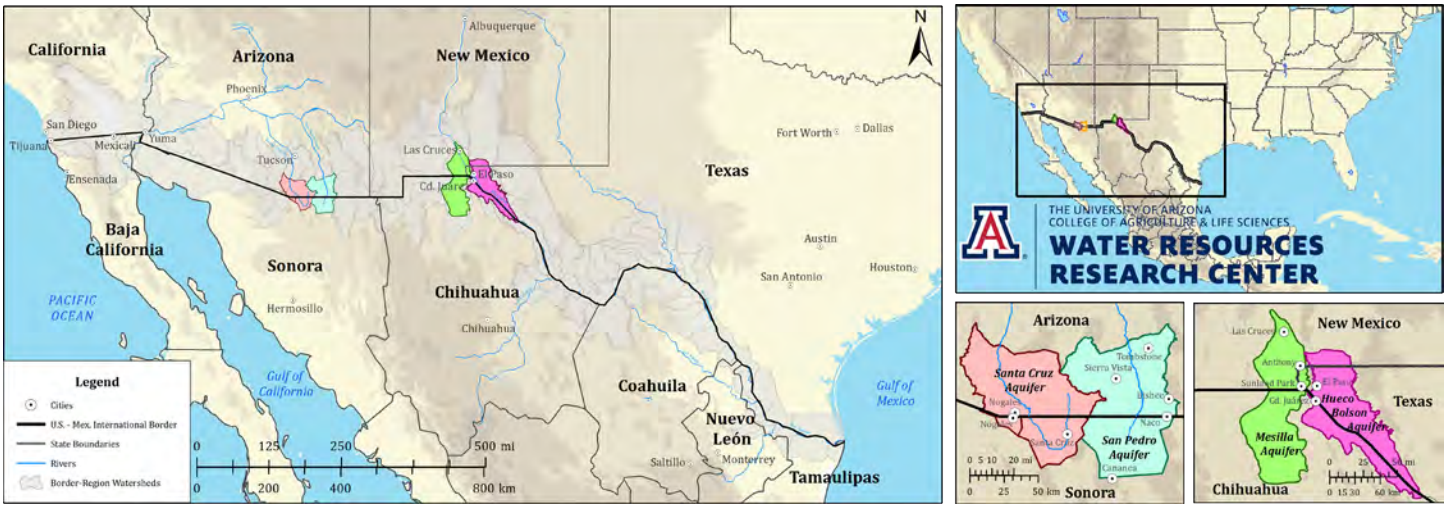
I would like to emphasize that TAAP as a binational partnership program began formally in 2009 when the Joint Report was signed. U.S. legislation in 2006 authorized participation by U.S. partners in a program of transboundary

aquifer assessment, which established a framework for collaboration involving the U.S. Geological Survey (USGS) and the participating Water Resources Research Institutes authorized by the 1964 Water Resources Research Act as amended. However, the U.S. legislation, P.L. 109-448, could not implement a program involving Mexico; actual implementation of a binational program required cooperation through the IBWC. P.L. 109-448 authorized funding for study of specified priority aquifers through what I assert is a unique partnership between USGS and the Water Resources Research Institutes at New Mexico State University, Texas A&M University, and the University of Arizona. Appropriated funds would be shared equally by the USGS and the water institutes. Although the 2006 legislation authorized $50 million in funding over a 10-year period, a total of $2 million was appropriated for the program through the budgets for federal fiscal years 2008 through 2010. After a drought in U.S. funding, Congress has authorized $1 million for the program annually since federal fiscal year 2016. Mexican funding has likewise depended on decisions of its federal government and has varied over time.

Just as a binational program cannot be established by one country, specifying the binational aquifers for study requires agreement. Four aquifers, shown on the map below, were jointly identified for study. A workshop was held in late 2009 to consider the study priorities along the binational border shared by the states of Arizona, USA and Sonora, MX. Work focusing on these two shared aquifers has been guided by the Joint Report. With IBWC in the key coordinating role, USGS, CONAGUA (Mexico's national water commission), the University of Arizona, and the University of Sonora have collaborated to produce the fully bilingual *2016 Binational Study of the Transboundary San Pedro Aquifer* and the companion study of the transboundary Santa Cruz aquifer, which is still in draft form. Some of the important lessons learned from the binational study of these two groundwater-dependent regions are chronicled in a 2018 article by Callegary et al., "Findings and lessons learned from the assessment of the Mexico-United States transboundary San Pedro and Santa Cruz aquifers: The utility of social science in applied hydrologic research," *Journal of Hydrology: Regional Studies*, 60-73. Work has also continued on the two other focal aquifers.

It is hard to believe that 10 years have passed since I had the great pleasure of announcing the approval of the Joint Report at Stockholm's World Water Week on August 20, 2009, the day immediately following its signature! Ten years later, I remain proud to be participating in this unique binational aquifer assessment program. Because reliance on groundwater is more important than ever, binationally agreed-upon characterization of this critical resource is essential. I look forward to continuing Transboundary Aquifer Assessment Program efforts.

Transboundary Aquifer Assessment Program Aquifers of Focus



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Reflections on a Successful Israeli Conference Experience

by Sharon B. Megdal
12/06/2019

As an educator, I feel fortunate to have opportunities to share knowledge with individuals of different ages, backgrounds, and perspectives. Recently, I organized a panel for the biennial WATEC (Water Technology and Environmental Control) conference, which was held November 19-21, 2019 in Tel Aviv, Israel. The panel focused on implementing technology, specifically desalination technology, in a binational setting and brought together experts from the United States, Mexico, and Israel to discuss opportunities as well as constraints when working across borders. It was appropriate that the panel was slotted as a "Water and People" session at a conference that was laser-focused on technology. After all, working across borders requires intensive consultation and communication among the people involved.

Our panel assembled in the early afternoon of the first day of the conference. It was one of four concurrent Table Discussion panels designed to foster exchange of ideas and interaction with audience members, who were seated at a large rectangular table with microphones spread around. The Israeli panelists spoke about the feasibility study done by the World Bank and implementation efforts related to the Red Sea-Dead Sea project. The U.S. and Mexican panelists spoke about an ongoing study to look at desalination opportunities in the Sea of Cortez. This study is being conducted through an International Boundary and Water Commission facilitated process and is part of ongoing cooperative measures (see **Minute 323)**. The order of presenters was as follows: Oded Fixler, Senior Deputy Director General, Ministry of Regional Cooperation, Israel; Dr. Doron Markel, Chief Scientist, KKL-JNF; Gregory Walch, General Counsel, Southern Nevada Water Authority; Chuck Cullom, Manager of Colorado River Programs, Central Arizona Project; Engineer Sergio Avila Ceceña, Executive Director, State Water Commission of Sonora; Andrea Alonso, Environmental Program Manager, Libra Ingenieros Civiles; and Lela Perkins, Client Services Manager, Black& Veatch. After the panelists provided their insights and overviews using Powerpoint slides, assembled into a single **slide deck**, I asked them to reflect on this question: *What are the most important variables or factors that contribute to implementing technologies across borders?*

Later in the day, at a session that summarized takeaways from the Table Discussions, I had the opportunity to share some insights from our panel. Interestingly, all agreed on the importance of food to building relationships and partnerships. A panelist succinctly stated, "Eat with your partners." They agreed that having good functioning relationships is crucial. When working across national boundaries, it is critical to identify what is beneficial to both nations in order to identify win-win opportunities. It was also acknowledged that identifying such

opportunities can be difficult and that relationships can have peaks and lows. Especially when working with neighbors with different cultures and languages, good communication, sincerity, and leadership will enable things to happen. Again, panelists came back to noting that eating together helps foster the friendships that then can facilitate the work required to forge formal agreements. The parallels between the two water-scarce regions of focus were clear to all. Desalinated seawater is an option for addressing the freshwater deficit, although there are the two main problems of energy requirements and brine disposal. It was noted that the Red Sea-Dead Sea project may be able to solve both problems by using elevation difference to generate hydropower and discharging the brine in a way that helps the Dead Sea, though there are questions about the scale of the desalination facilities and possible adverse impacts associated with changing Dead Sea water chemistry. With the driving factor, of course, being the need for water, trust is essential to identifying win-win opportunities.

On the second day of the conference, I participated in a Water and Politics panel, at which I spoke about the many layers of policy involved in coming to agreement on the Lower Colorado River Basin Drought Contingency Plan. At this panel, too, speakers noted that the process for complex deliberations is very important.

A great conference innovation this year was the addition of a third day dedicated to site visits. I went on the all-day field trip to Jerusalem waterworks, where presenters focused on how technology is being used to improve the safety and reliability of water delivery and wastewater treatment operations. It was exciting to visit the construction site for the fifth and very large water line to Jerusalem, where we donned hard hats and vests so that we could visit the tunnel boring and pipeline installation launching site.

The week-long visit was filled with many opportunities to share experiences, learn, and make connections with other experts. Although I woke up to a thunderstorm my first morning in Israel, they, like we in Arizona, had been experiencing a warm and dry Fall. So, the weather was great for being outdoors. Prior to the conference, I visited the Hula Valley Wetlands, which has such an interesting story behind it (**https://www.iisd.org/pdf/2011/hula.pdf**) and is an important bird flyway. On the day immediately prior to the start of the conference, a group from the United States and Mexico visited a pilot reverse osmosis facility, installed by a company that has recently been working in Arizona, at the regional Shafdan wastewater treatment plant. A great bonus was that we were in Tel Aviv for the reception celebrating the opening of the Arizona-Israel Trade and Investment Office. There we met up with other Arizonans, including several members of the Arizona Legislature (Representatives David Cook and Tony Rivero are pictured), along with representatives of the Arizona Commerce Authority and the business community.

I am grateful for a productive week of reinforcing and making professional connections, sharing experiences and lessons learned, and eating with my partners!

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Photos (clockwise from top left): Seminar at the Institute of Water Policy, Lee Kuan Yew School of Public Policy, National University of Singapore; Marina Barrage; Dr. Sharon B. Megdal with Director Dr. Eduardo Araral and Deputy Director Dr. Corinne Ong, Institute of Water Policy; PUB NEWater bottled water; PUB NEWater Visitor Centre and Treatment Plant; Punggol Waterway, ABC Water Catchment Programme

Reflections: Singapore – A Model for Integrated Water Management

by Sharon B. Megdal
02/07/2020

I had the great privilege of visiting the Institute of Water Policy, Lee Kuan Yew School of Public Policy, at National University of Singapore the week of January 20, 2020. There I delivered two seminars, visited with faculty and other researchers, and had the opportunity to learn about Singapore's water management. PUB, Singapore's National Water Agency operating under the Ministry of the Environment and Water Resources, "manages Singapore's water supply, water catchment and used water in an integrated way". Like many, I had heard about their NEWater, but I was not aware of the extent of PUB's integrated water management. I very much appreciate the hospitality of my hosts and their efforts to share their knowledge and information about Singapore's water management. I certainly learned a lot during my visit!

My two seminars were the first of what I am calling my spring semester sabbatical lecture tour. The first seminar was entitled "Wicked Water Problems and Bridging through Water". Since the concept of wicked water problems was discussed by Lisa Beutler at the WRRC's 2016 annual conference, I have noted how many water challenges fit the characterization of wicked problems, which are problems that defy simple, single-path solutions. Key to identifying solution pathways is working across disciplines and with all stakeholders. The second seminar focused on Arizona and Colorado River Basin water management. The comparative size of our regions is a key differentiator, with Arizona alone over 400 times the size of Singapore. They use no groundwater, and we lack their abundance of rain and seawater supplies. Despite the many differences, I suggested some key take-aways: regardless of circumstances, there is a need to be ever-vigilant about water supply, quality, and utilization; sharing experiences and lessons learned is important; solution sets may differ, but involvement of stakeholders is critical; academia has a role to play in evaluating options and opportunities; connecting to the practice of water management is helpful to students, researchers, and educators; the issues are complex; and all want to avoid "crisis management".

Through meetings and discussions, I had the opportunity to hear about the work of the Institute of Water Policy (IWP). Its research is applied, and much of it is connected to a five-year work plan funded by PUB. Singapore is unique in that it is an island city-state. All residents, who number over five million, are customers of PUB and all water catchments are managed by PUB. I visited PUB's NEWater Centre, which is co-located with a NEWater production facility, the PUB Marina Barrage Visitor Centre, and a large public housing complex where water savings and a community garden are featured.

Singapore has developed a diverse portfolio of water resources to meet its growing water needs. NEWater is the third of PUB's four national water taps. NEWater is described by PUB as the ultra-clean water produced from "used" water. In our terminology, it is highly treated or purified reclaimed water. Most of the NEWater is used by industry, but during dry periods some is added to the reservoirs where it blends with raw water, which is then treated for potable use. A small percentage is bottled, mostly for distribution at public events. I expected to be given a bottle at the NEWater Centre, but environmental concern about plastic water bottles has led to reduction in the distribution of NEWater bottles. I was given – and drank – a bottle of NEWater at one of my seminars.

The first of PUB's four national water taps is water from local catchments. Singapore receives a lot of rain and catching it before it drains into the surrounding salt water is important, especially given its small, highly developed land area. Singapore has made an effort to improve and beautify its catchments. PUB uses the tag ABC, which stands for Active, Beautiful, Clean Waters, to refer to the first national tap. The photo at right clearly shows that the catchments can be beautiful! It is interesting to note that, despite annual rainfall of over 90 inches, water scarcity is a concern. The second tap is imported water from the Malaysian state Johor; water importation agreements with Malaysia/Johor have a long history. The current agreement ends in 2061. As noted, the third national tap is NEWater; the fourth is desalinated water. As the PUB website notes: "In integrating the water system and maximising the efficiency of each of the four national taps, Singapore has overcome its lack of natural water resources to meet the needs of a growing nation."

There is also a strong focus on water conservation and general sustainability. The Marina Barrage Visitor Centre, located adjacent to the Marina Barrage, emphasizes the message of sustainability. The Marina Barrage is one of Singapore's key water infrastructure accomplishments. Completed as recently as 2008, the dam serves as a flood control structure that creates a key fresh water reservoir for Singapore while keeping the seawater out.

While in Singapore, I visited the Nanyang Technical University to spend some time with University of Arizona colleague Shane Snyder. It was interesting to hear about the multi-faceted efforts of the Nanyang Environment & Water Research Institute, for which Dr. Snyder serves as Executive Director.

A bonus for me was being in Singapore at the start of the Lunar New Year, a major holiday some liken to our Thanksgiving holiday because it is a time when families gather for meals and enjoy time away from work. Earlier that week I enjoyed a visit to Chinatown and seeing all the decorations in celebration of the Year of the Rat. On New Year's Eve day, I went to the Singapore Botanic Gardens, including its famous orchid garden. Spending time at this UNESCO World Heritage site made for a beautiful and relaxing last day.

With the start of the Lunar New Year, I'd like to wish everyone a happy and prosperous year.

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Jerusalem, March 7, 2020

Sharon B. Megdal and David Lehrer, Executive Director, Arava Institute for Environmental Studies

Reflections: Being on Sabbatical During the COVID-19 Pandemic

by Sharon B. Megdal
03/20/2020

This is the second *Reflections* on my Spring Semester sabbatical activities. While a sabbatical is intended as a time away from some routine faculty activities, it is not meant to be time off from professional endeavors. Faculty members must receive approval of their planned sabbatical program. My approved sabbatical program was to lecture on topics relevant to my research and Extension work on our region's water issues, for which there is a lot of interest globally. After visiting Singapore in late January (see my previous ***Reflections***) and Mexico City, my schedule from early March through early July was filled with an interesting mix of presentations in Arizona, elsewhere in the United States, Mexico, Israel, Australia, and France. Obviously, the seriousness of the COVID-19 pandemic has led to the almost complete curtailment of these planned activities. However, even as recently as early March, I had no idea of how this virus would change all of our lives. I write this *Reflections* piece as a mix between a travelogue and a record of just how quickly things changed in a way none of us could have anticipated.

The implications of COVID-19 were just getting press attention when I was in Singapore the week of January 20, 2020. I returned from Singapore on January 25th, the day after the second and third cases there were confirmed. I was there as families were readying for the Lunar New Year, a time of festivities, a break from work, and gatherings and meals with family. Several people there likened the holiday to our Thanksgiving Holiday. There were no major restrictions on travel in late January, so people were pretty much freely traveling, though some were wearing masks, including one flight attendant. Although I had thought our temperatures might be taken when we landed in LAX, they were not. Shortly after returning from Singapore, I traveled to the National Autonomous University of Mexico (UNAM) in Mexico City to give a lecture and attend a meeting of the Scientific Committee for a new UNESCO water security center. Few travelers were wearing masks, and the pace of life there seemed normal.

In February, my schedule had me mostly in Arizona, though I did take a personal trip to Los Angeles the last weekend of the month. Planes and restaurants were full, and scheduled large gatherings, such as university basketball games, occurred. I had one full day between my return from Los Angeles and my March 3rd departure for what was intended to be a visit of almost two weeks to Israel. Building upon my **previous work** connecting the water challenges of our region to that part of the Middle East, my schedule for Israel included a conference presentation, a lecture and meetings at the Arava Institute for Environmental Studies, a seminar at Tel Aviv University, and visits with colleagues to discuss ongoing and possible new collaborative efforts. Before departing

from Tucson, I did consider the advisability of traveling so far, as incidences of COVID-19 were increasing. I discovered that Israel had less than 10 confirmed cases, most of which were connected to people who had recently traveled to Italy. Maybe it was wishful thinking, but circumstances did not portend something as serious as what has developed. So, I left as scheduled. My travel and arrival were routine. After checking into my hotel in Tel Aviv, I joined a modest-sized group for a pre-conference dinner the evening of March 4th, where talk focused on the next day's conference, along with local politics. The very interesting one-day conference, Climate Stress and Regional Risks: The Jordan River Basin, went on without a hitch. I spoke about "Wicked Water Problems and Addressing Regional Water Stress". Drawing upon my experience working in our region and the Jordan River Basin, I discussed the importance of functioning mechanisms for cooperation and other factors that facilitate pathways to solutions to our complex water challenges.

Though the conference was held and the rhythm of life in Tel Aviv seemed routine, I carefully followed the news, where I read about possible actions to contain the spread of COVID-19 by limiting travel into Israel. The government started to require Israelis returning from certain COVID-19 hotspots to quarantine at home for 14 days. Restrictions were imposed on flights into Israel from certain locations, including several European countries. I traveled to Jerusalem for the weekend to meet with a colleague and spend some time exploring that wonderful city. However, I was uneasy. Israel was requiring 14-day quarantines of individuals entering from some countries, and the list of countries was growing. More restrictions on entry would translate into restrictions on flights. I wondered if the United Kingdom, my transfer point home, would be added to the list. What spurred me into action on Saturday afternoon, March 7, after only 3 days in the country, was news that the government might impose a quarantine on all travelers from selected U.S. hotspots. Although I was already in Israel, the uncertainty and risks of being stranded became more than I was ready to deal with. So, I got on the phone and rebooked my return for early the next morning. I am pleased to report that my travel home via London and Los Angeles on March 8th was on schedule and my entry into the U.S. at LAX was uneventful.

I share these reflections just before World Water Day, March 22nd. This is usually a time for meetings and dialogues that focus on earth's most vital resource. This year's discussion will occur, but by means, such as webinars, that maintain social distance—including the WRRC Brown Bags. However, all is overshadowed by the COVID-19 pandemic. So much has changed in the short time since I decided to come home. Life is unlike anything most of us have experienced. We do not know what is in our future in terms of our personal and professional activities. I am grateful that I returned when I did, and I was safely at home as the restrictions and guidance associated with the pandemic unfolded. Regarding my sabbatical, be on the lookout for more *Reflections* as I use time at home to reflect and write. As we travel through this experience, I hope you and your families are safe and stay well. And I'm here at **smegdal@arizona.edu** if you would like to get in touch. My calendar is quite open!

Wicked Water Problems and Addressing Regional Water Stress (pdf)

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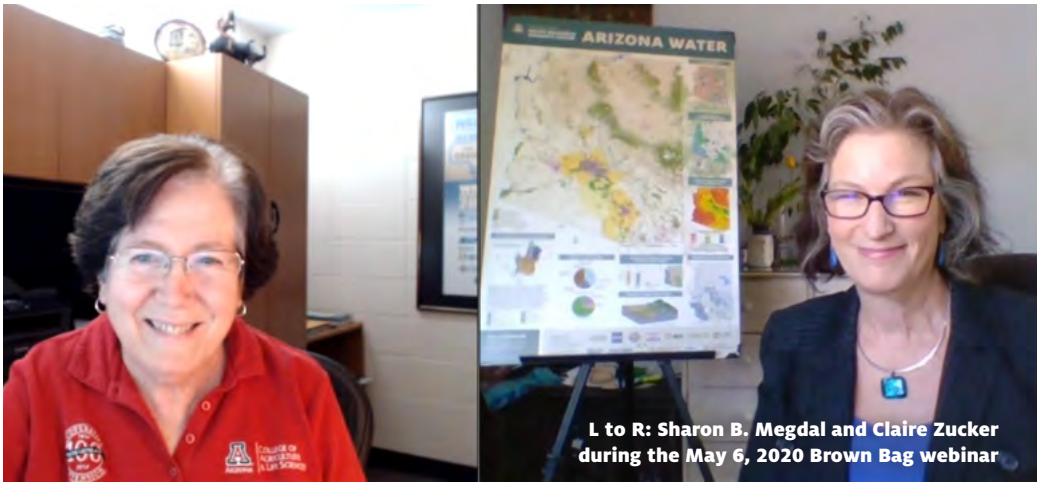

L to R: Sharon B. Megdal and Claire Zucker during the May 6, 2020 Brown Bag webinar

APW Water Scene Investigator Drippy

Reflections: Spring 2020 and COVID-19 – The Work Must Go On

by Sharon B. Megdal
06/05/2020

This has been a spring like no other. Who could have anticipated how our professional and personal lives would be severely disrupted by the COVID-19 pandemic? Like most, in mid-March we at the Water Resources Research Center quickly pivoted to working from home. The WRRC has been fortunate in that, for the most part, we have been able to keep our programs going by making the switch to remote delivery. We surely have faced challenges. Professor Jean McLain had to close her laboratory. We had to postpone and reformat our annual conference, which had been scheduled for late March. Arizona Project WET Director Kerry Schwartz and her staff had to re-plan its student-focused activities, along with its entire summer program of teacher workshops. Students could not engage in internships and attend classes and laboratories in person. As I think about the work staff and students have engaged in since the mid-March closure of the University of Arizona campus, the phrase "the show must go on" comes to mind, except that I replace the word "show" with "work". Though according to Wikipedia, the original phrase can be used "to convey the idea that an event or activity must continue even if there are problems or difficulties, with or without regard to actual show business," nevertheless, I prefer the word "work" because it emphasizes the seriousness of our commitment.

While it has not been easy, WRRC staff and students have worked hard to make sure there has been little-to-no interruption in our programmatic activities. Because we had been live-streaming all of our Brown Bag seminars and had worked with speakers from multiple remote locations as we delivered our pre-COVID-19, pre-conference briefings, pivoting to fully remote seminars was relatively easy for us. Since the cessation of in-person seminars, WRRC staff has worked closely with speakers, including yours truly, to make sure they are comfortable and prepared. WRRC Associate Director Claire Zucker has gone to great lengths to create a warm and conversational setting, as shown in the photo of her moderating questions after a presentation. As Claire has pointed out, we have switched from an in-person seminar, also available for remote viewing, to webinars, which at some future date may have live audiences. Attendance has been robust, and I can speak from the experience of delivering the May 6, 2020 webinar on wicked water problems that I felt very engaged!

Of course, migrating our entire conference to a virtual format has been a much more significant undertaking. Yet, here I am writing this column for inclusion in the conference packets. The virtual conference will be live, that is live from all of our (home) offices. Much thought and planning went into designing the June 18-19, 2020 event so that it would be engaging and not require anyone to sit at a computer all day. We found ways to incorporate polling of attendees' perspectives, and include speaker Q&A throughout, and add multiple happy hour options on the first afternoon. I invite those who read this column before the conference date to consider registering for it **here**. We thank our sponsors for remaining with us, thereby enabling very low conference registration rates, and we thank the conference speakers and registrants for their willingness to take this adventure with us!

We are fortunate for the staff dedication that enabled us to move to virtual program delivery. As just one example, Director Kerry Schwartz and Arizona Project WET staff and student workers diligently worked to create a virtual Water Festival to replace their in-person signature event for 4th graders. They developed engaging online curriculum, some of which stars **Drippy**, who will guide you through installing your aerator. The Arizona Department of Water Resources' feature on Arizona Project WET's curriculum for home-bound students can be accessed **here**.

I cannot do justice in this short piece to all the projects and activity in which WRRC staff and students have remained fully involved. One of our annual activities is drafting the WRRC Annual Report and Highlights, which contain more details. As we finalize the 2019 documents, I am grateful for the hard work of all WRRC personnel and partners. I could not be prouder of the accomplishments of our dedicated staff, students, and partners, past and present. Please take a look at our reports, which can be found on our **website** and which present the ways in which the WRRC strives to achieve its mission to tackle key water policy and management issues, empower informed decision-making, and enrich understanding through engagement, education, and applied research.

As for me, as I reported in my prior two ***Reflections***, my Spring semester sabbatical started off as planned with some invited lectures in Singapore and Israel. But my plans were upended by COVID-19, and I have been busy with a variety of activities since my March 8, 2020 return to Tucson. Some sabbatical lectures have moved to virtual platforms. In addition to reconnecting with staff and Cooperative Extension personnel through regular weekly Zoom meetings and working with several Ph.D. students on their dissertation research, I have participated in some special university projects. One of them focused on maintaining continuity of community-engaged research, education, and outreach during and beyond the COVID-19 pandemic.

Though these reflections accentuate the positive, circumstances have been challenging for us all. Working from home in casual clothes with our four-legged assistants has its positives, but it can get old. We yearn for the time when we can again interact regularly and travel to professional meetings, for the challenges of water management are not abating.

In closing, I'd like to note the lyrics from the Queen song, "The Show Must Go On".

Empty spaces, what are we living for?
Abandoned places, I guess we know the score, on and on
Does anybody know what we are looking for?

While the rest of the lyrics are mostly about romance, it mentions learning, turning the corner, and the dawn breaking. The COVID-19 pandemic has disrupted our lives. That is the bad news. The good news is that, collectively, we have demonstrated that the work will go on. We will turn the corner and there will be light as we emerge from these strange circumstances. We look forward to interacting with you virtually but even more to seeing and working with you again in person!

Sharon B. Megdal, Ph.D.
Director, Water Resources Research Center
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Reflections: Time to Retire the Water Buffalo Symbol?

by Sharon B. Megdal
07/10/2020

Your feedback is requested.

I am writing to invite your feedback on an important issue that came up at the Happy Hour discussion I hosted at the Water Resources Research Center's 2020 Annual Conference, *Water at the Crossroads: The Next 40 Years*. On June 18 and 19, 2020, the audience heard distinguished speakers and panelists address the history, current status, and future of Arizona water policy and management. We are grateful for the many individuals who joined us virtually. Keynote addresses, along with panel presentations and discussions, are available at our **conference website**. In addition to the formal sessions, at the end of the first day, two of our sponsors and I hosted informal Happy Hour discussions. The conversation at the Happy Hour I hosted was quite lively and brought up a controversy that has prompted me to write this *Reflections* essay.

What was the controversial matter? Was it the potential transfer of water from the Colorado River communities to Central Arizona? Was it the role of the Central Arizona Groundwater Replenishment District? Both were prominently discussed by Governor Bruce Babbitt in his opening keynote address. No, the controversial matter relates to something else Mr. Babbitt mentioned multiple times, namely, his reference to the water buffalo. He noted the more than 400 water buffalos assembled for the conference at the very beginning of his remarks. In fact, he mentioned water buffalos three times, and other speakers referred to the water buffalo as well. Some participants in our Happy Hour discussion, however, did not welcome the association. They did not interpret it as a term of endearment, as I have thought of it. I recall responding positively when I was seemingly welcomed to the water buffalo herd back in 2004. At the

Arizona Town Hall held that autumn at the Grand Canyon, CAP General Manager Sid Wilson handed me a "Darned Proud Water Buffalo" pin. That pin is shown on the collar worn by the water buffalo pictured above. That wood water buffalo statue is one of my herd of four water buffalo figures, all of which were given to me over the years by a professional friend.

What associates a person with the water buffalo? In our Happy Hour discussion, some participants indicated that the water buffalo is not a pleasant animal; they did not consider being called a water buffalo a compliment. They were also put off by the sense that the water buffalos were members of an exclusive club. When searching online for something written connecting the water buffalo and water management in Arizona, I found the 2004 Annual Report of the Central Arizona Project. General Manager Sid Wilson's letter to constituents opens: "The theme of Central Arizona Project's 2004 annual report, Water Buffalos Undeterred, is kind of an in-joke among the water community. However, it is the kind of joke that should include the public. Since before Arizona was a state a small group of individuals has always been concerned with water issues. These people, who are virtually unknown to the general public, are responsible for what we are today." A few paragraphs later, he writes: "Within the industry, those folks are called 'Water Buffalos.' There are a lot of theories about how the name evolved. Some say it's because they were just a bunch of grumpy old men. Some say it's because, like the water buffalo, these Water Buffalos plodded along and would not be deterred from accomplishing their goals."

A central focus of Bruce Babbitt's keynote address was the process for engaging in dialogue about difficult issues of water policy, such as the movement of water to Central Arizona from the Colorado River. The importance of process, particularly an inclusive process, came up many times during the conference. Process was vital for Arizona's coming to agreement on the terms of our State's participation in the Lower Colorado River Basin Drought Contingency Plan and will be critical to the renegotiation of the interim guidelines for sharing of Colorado River Shortage, both highlighted by U.S. Bureau of Reclamation Commissioner Brenda Burman in her keynote address.

In this time of national dialogue on the importance of inclusivity and rejection of stereotypes, I suggest it is time to retire the water buffalo as a symbol of those who care about and are involved in water policy and management. The Water Buffalos of the past deserve great respect for what they accomplished; but as we remain aware of our water history, let's think about a symbol that better captures the spirit of inclusivity, diversity, mutual respect, and general awareness of commonalities as well as differences in our perspectives. While it may be unnecessary or too early to agree upon a replacement symbol, I know we can agree that our gatherings for debate and dialogue, whether in-person or virtual, will include more than the water buffalo.

Please email your feedback, including your suggestion for a new symbol, to **smegdal@arizona.edu**.

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Ottoman era railway bridge over the Lower Jordan River.
Photo Credit: Sharon B. Megdal, 2014.

Reflections: On Wicked Water Problems

by Sharon B. Megdal
08/07/2020

Although my spring -summer sabbatical lecture tour did not take place as planned due to COVID-19, I did deliver more than a dozen lectures and participated in several programs and interviews. My topic of wicked water problems was the most requested and one on which I will continue to focus. Not only does this topic afford me an opportunity to explore significant water challenges at varying geographic and geopolitical scales, it enables me to focus on the process for forging pathways to addressing them.

I begin my discussion of wicked water problems by citing Lisa Beutler's excellent 2016 **article**, which was based on her keynote lecture at the Water Resource Research Center's 2016 annual conference. I encourage all to read her concise exposition. These quotations are particularly salient. "Lately, more and more water problems seemingly defy standard solutions. This typically occurs for four reasons: incomplete or contradictory knowledge, the number of people and opinions involved, the large economic burden, and the interconnected nature of these problems with other problems." Beutler points out that the necessary collaborations must involve more than water managers. She adds that "[i]nterdisciplinary collaboration that captures a broader knowledge of science, economics, statistics, technology, psychology, politics, and more is required…" to mitigate the negative consequences of wicked water problems. A key characteristic of wicked water problems, therefore, is that they are mitigated rather than solved, meaning that finding a pathway is the goal rather than trying to identify an ultimate solution. While partial or short-term solutions are implemented, the work continues.

Before fleshing out some examples, which I do not have space to do so in this essay, I point out the importance of context to analysis of wicked water problems. I often show a slide listing several of the factors that determine "on-the-ground" water policy and management. Among these are laws, regulations, and policies. The legal and institutional framework, including the degree to which decision-making is centralized, will be region-specific. Thus, maps always help clarify the geographic and geopolitical context for water issues of any kind, especially those that span

shared borders. In recent lectures, I have discussed four examples from the Colorado River Basin: overcommitment of groundwater in the Pinal Active Management Area; shortage of Colorado River flows relative to demands within Arizona and across the basin; limited consideration of water for natural systems; and the Navajo Nation's inadequate water infrastructure, which has been spotlighted by the COVID-19 pandemic. Additional examples of wicked problems I mention involve water in the Middle East and include Lower Jordan River flows and the Dead Sea, water and wastewater services, and water scarcity, particularly in Jordan. While many more wicked water problems can be identified – and I ask listeners to think about what water problems they would identify as wicked – these examples enable me to discuss factors that contribute to mitigating them.

Process is very important to the search for pathways to solutions, which are often common across the regions I discuss. Solutions include conservation, augmentation, reuse, water transactions, and other actions at individual, community, and regional levels. Partnerships are critical to developing information collaboratively so that the parties can be "on the same page". Whether within states and regions, across states, or across national boundaries, *functioning* cooperative mechanisms are critical. I emphasize the word "functioning" because it is not enough to have cooperative mechanisms on paper. Effective partnerships are built on respect and trust. Trust depends on mutually respectful, positive collaborative experiences. Stakeholder involvement is key. We are definitely seeing more inclusive processes, yet there is often room for improvement. Though live streaming of meetings had been increasing before the COVID-19 pandemic, since the demise of in-person meetings, meeting virtually has become the norm. Interestingly, this situation has enhanced participation of stakeholders who may not be officially "at the table" or able to travel long distances to in-person meetings. Good communication of all kinds is imperative to identifying and understanding the potential of alternative actions that contribute to mitigating wicked water problems. Because there are no quick fixes, both patience and persistence are necessary when working on complex matters over long periods of time.

For many years, I personally have had the opportunity to share lessons learned – both good and sometimes not-so-good – across different geographic and sociocultural communities. I have organized sessions for cross-regional learning and sharing, including but not limited to the 2009 Arizona-Israeli-Palestinian Water Management and Policy workshop in Tucson, the 2016 Middle East visit of the International Boundary and Water Commission commissioners, the 2017 Tel Aviv joint American Water Resources Association – Tel Aviv University conference on wicked water problems, and the 2019 Tel Aviv conference panel on implementing technologies across borders. All of these events are chronicled in previous **Public Policy Columns** and ***Reflections***. During the 2019 panel, I asked panelists: What are the most important variables or factors that contribute to collaborating on implementing technologies across borders? Very high on their lists were functioning relationships. Several noted that being able to get to know your partners through sitting down together for meals fosters the friendships and relationships that can facilitate the work required to forge formal agreements. There can be peaks and lows. Identifying win-win opportunities can be difficult, and when working with neighbors of different cultures and languages, good communication, sincerity, and leadership are essential.

In her article, Lisa Beutler states, "Managing wicked problems is a new kind of work. It requires changing the questions, managing uncertainty, and creating resilience. It does not solve existing problems but instead drives to a desired future state." Technology and economics are determinants of pathways to solutions, as are processes for working with and through stakeholders. Efforts to educate at all levels will contribute to identifying and evaluating options. Good work is continuing. But my recent webinar lectures on wicked water problems (**see, for example, my May 2020 WRRC webinar**) ended with this question, which is reflective of the COVID-19 times in which we live: When will we be able to meet and eat with our partners?

Addendum to my *Reflections: Time to Retire the Water Buffalo Symbol?* Please send your comments to me (**smegdal@arizona.edu**) by August 24, 2020. In September, I plan to share the very interesting feedback I've received.

Sharon B. Megdal, Ph.D.
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Then & Now

Photos (L to R): Sharon B. Megdal with Governor Bruce Babbitt taking questions from the press, 1985 (Courtesy of The Arizona Republic); Megdal introduces keynote speaker Bruce Babbitt at the WRRC 2020 Annual Conference, *Water at the Crossroads: The Next 40 Years*.

Reflections: Relevance Today of Comments on Arizona's Future from 1987

by Sharon B. Megdal
09/04/2020

I have lived in Arizona for close to 42 years. When I moved to Arizona from New Jersey, where I grew up and was educated, I had no idea I would become a water professional. I studied economics as an undergraduate at Rutgers University and as a graduate student at Princeton University. My fields of specialization were Public Sector Economics (the economics of government tax and expenditure policy), Econometrics (using statistical methods and models to characterize economic behavior), and International Economics. Note the absence of anything sounding like water, agricultural, or environmental economics.

Some interesting twists and turns in my professional career led me, since the early 1990s, to focus almost exclusively on water. The most pivotal event occurred in September 1985, when Governor Bruce Babbitt appointed me to fill a vacancy on the Arizona Corporation Commission (ACC), the body responsible for regulating privately owned utilities. I was therefore especially pleased to publicly thank Mr. Babbitt at the WRRC's June 2020 annual conference for profoundly influencing my career.

Recently, when scanning some publications from the 1980s, I came across a document I had totally forgotten: the proceedings of the October 27-28, 1987 Arizona Futures Symposium. My speaking assignment at the symposium was to react to Robert Theobald's comments, entitled "A Framework for Thinking About Transportation Issues." I was asked to focus on economic issues and Arizona's future carrying capacity. **Robert Theobald** (June 11, 1929 – November 27, 1999) was a distinguished consulting economist and futurist author. In October 1987, I had the experience of ACC service and my economics training to draw upon. I was a self-employed consultant and part-time Visiting Associate Professor at Northern Arizona University, teaching economics for NAU's MBA program.

As I reviewed the transcript of my **commentary**, I found portions pertinent to our situation today and our quest to address **wicked water problems**. To acknowledge the 35th anniversary of my appointment to the ACC, I would like to reflect upon observations from that time, specifically my 1987 symposium commentary. Perhaps you will find my comments relevant to some of our current-day water policy challenges and efforts to identify pathways to solutions and conclude, as I did, that "the more things change, the more they stay the same."

In late 1987, we were in the transition from the industrial era to the communications era, just a few years after the break-up of AT&T, the monopoly that provided most of the country with telephone service. These were uncertain times for the telecommunications industry. Judge Harold Greene, who presided over the breakup, wielded a lot of power. I asked the question: "Can we rely on the Judge, the state and federal regulatory bodies, the companies involved, and the market to coordinate so that the communications network develops in an appropriate fashion? There are some

who are quite pessimistic about the answer to this question. The infrastructure we will have in place to handle our transportation and communications needs will depend on many parties and many actions, and is not likely to be 'optimal'."

I pointed out that communications and transportation systems can be substitutes, something we are so keenly aware of now that COVID-19 has upended our work, educational, and personal lives. Then, teleconferencing and facsimile transmission were two examples of how the communications network could be used instead of the transportation network. Who would have imagined that we'd have the virtual meeting platforms we now have?!

When looking toward the future, I asked: "What will make things change so that a farsighted public policy replaces the crisis management spirit that pervades so much of government's – and the private sector's – operations? We are talking about things that require a long lead time. Shorter run problems require more immediate attention and resources. How can a community that cannot determine its carrying capacity in the short run (or does so only by default) ever find the resources to devote to longer term problem solving?" I noted the need to "formulate the questions now and educate the public – including decision makers – on the questions and also on the future implications of current decisions. Too often we search for answers when the questions have not even been properly articulated."

Drawing upon the fiscal federalism framework that has shaped my thinking about a multitude of public policy matters, I spoke about jurisdictional responsibility. "What level of government should have the responsibility of dealing with these issues? We live in a federal system of states, counties, cities, school districts, improvement districts, etc. Arizona is made up of many different regions, each with its own character and problems and, therefore, solutions. Most observers of demographic and economic trends point to the disappearance of the bell-shaped income distribution. Instead we see a bimodal distribution – lots of poor and lots of well-to-do, with little in between…How will such an income distribution affect social and physical infrastructure requirements?"

Whether transportation, water, or other governmental responsibilities, I have long been interested in the diversity of situations. I suggest to you that these 1987 observations could be made today and in the context of water: "Economic conditions vary not only within counties, but also between counties. There is already a feeling within the state of the 'haves' and the 'have nots'. Fiscal constraints are going to be no less important [in the future] than they are today. In fact, they may become more severe." I further observed that "the challenges of developing appropriate policy for the future will necessitate cooperation among many levels of government and between the private and public sectors. I think this is a reality that must be recognized."

I ended my remarks with some statements that I again suggest have relevance to today's water policy dialogues. "What can be done so that we have a chance of choosing a policy vector that leads us to a desirable future? We must recognize that we are borrowing from future generations so that we may have today. We are borrowing for things we should not be [borrowing for] and not borrowing for things (such as building of infrastructure) that we should be. There are no easy solutions. We have difficulty solving today's problems. Management is rewarded on quarterly profits. Elected public officials are judged on what they did while in office, not on the basis of what they might have done for the very long run."

I am going to end this essay as I ended my commentary. I have been consistent in my call for education at all levels and in acknowledging that both the private and public sectors have important roles to play in resolving our thorny public policy challenges. "I am convinced that more resources have to go into public education on issues related to our future. There needs to be a continual effort to formulate questions and discuss issues and potential solutions…The commitment of resources will have to come from the government and the private sector, as both have a stake in our future."

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WATER RESOURCES
RESEARCH CENTER

Reflections: Varying Views on My Water Buffalo Symbol Question

Graphic by John Polle based on reader suggestions.
Images from pexels.com, Wikimedia Commons, and reader submissions.

by Sharon B. Megdal
10/09/2020

In July I released a ***Reflections* essay** asking for feedback on whether it is time to retire the water buffalo symbol. I received 39 communications from 38 individuals. Some chided me for writing an essay that was a distraction from the more important water matters we face, while others thanked me for raising what they see as issues of elitism and exclusivity in water debates. Because I found the feedback so interesting and divergent, I shared commentary in batches with those who submitted remarks, making sure I blind copied the recipients and removed any identifying information. One person shared some additional perspective after seeing the earlier commentary that I shared.

What was most striking to me were the intense feelings on the question. Some view with affection and admiration the water buffalo affiliation. Others strongly hold an opposing view. Rather than summarize the comments here, I provide them to you below. They are not all exact quotes because, as noted, I removed all identifying information, including mention of the state the person was from. My categorization of the 38 individual viewpoints is 11 against, 12 neutral, and 15 for retiring the water buffalo symbol. Thus, this non-scientific survey revealed no clear leaning. I will note that of those inclined to retire the symbol, some suggested that no symbol is needed, while others offered alternatives, some of which are humorous.

What are my takeaways from this exercise? There is great recognition of and respect for the contributions of those who have shaped and are shaping water policy and management for Arizona and the Colorado River Basin. At the same time, there is a strong desire for inclusion of and respect for diverse voices and viewpoints. On what I hope there is little debate, we need all good minds and ideas "at the table" as we tackle the many wicked water problems we face (see my **August 2020 *Reflections*** on this topic). It was noted that the new virtual meeting environment has helped expand participation, and the increased attendance at our virtual events since March bears out that observation. Even as I applaud this advantage of online meetings, I join with the many, many friends, colleagues, and water stakeholders (this means you!) in looking forward to being able to gather in person at whatever tables are configured and to see each other again sooner rather than later.

As always, I welcome your feedback at **smegdal@arizona.edu**.

Comments Received About the Water Buffalo Symbol

1. I think something that more comprehensively acknowledges the criticality of water and in this region is the right direction but will need to think more on a choice suggestion.

2. I had suggested a Colorado pikeminnow, but perhaps a pupfish is more appropriate. I will ponder it some more.

3. I recently read your WRRC article suggesting to get rid of the water buffalo symbol, and since you invited comment I would like to offer mine. As a desert ecologist, I have just recently joined the water world. I came to hear and understand the term water buffalo early on in my new career. I have always taken the symbol to mean those who are strong enough, persistent enough, resilient enough and smart enough to carry the very heavy burden of managing one of our most precious and essential resources to all biological life. This is an extremely honorable term and I feel nothing but the highest respect being one who shares carrying that burden. Aren't we getting a little too "millennial sensitive" here? What else could the symbol be? A dolphin???

4. In truth, I've always regarded the term as describing old white guys, politically conservative, exclusionary, and hide-bound. I've thought of it as the opposite of the more inclusive, forward thinking, holistic values that many of us, including you, try to promote. I think it's viewed by many as a group that seeks to have its way on all water matters without necessarily caring about the views of others. This is changing, obviously, and people like us are changing it, but it may not be a tradition one would want to preserve. Having said all that, as your letter points out, we've got way bigger things to worry about.

5. I think the phrase was coined by Marc Reisner in *Cadillac Desert* in 1986 (or 1985). I know he used the term in the revised edition in 2003, seeming to refer back to the first edition... There is such an animal in Asia; it's mean and ornery and likes to camp out in mudholes and keep others away. It's a charming if obscure reference used by Reisner to criticize managers of western water districts for hoarding water by having senior rights to immense quantities and being unwilling to even consider letting others have some. Now, what is a Cadillac Desert?

6. Without taking sides on such an important and controversial topic, I would only offer this definition which you can find on Google; "These words are symbolically associated with the water buffalo: Strength, Service ,Dedication, Connection to Earth Mother."

7. When I first heard the term, I thought of water buffaloes as beloved animals in Southeast Asia, patient and thorough. So I never had a negative impression of the term. (The Cape buffalo, on the other hand, is a dangerous animal.) And the people I met to whom that honorific was applied all seemed friendly and helpful. I did wonder if it was a term applied only to men, but if they gave you those things and didn't call you an affiliate, or an associate, or an honorary water buffalo, apparently not. My career has been in engineering, not water resources, so I remain an interested onlooker. Thanks for asking all of us!

8. Power and money run with the water buffalo. The water world in Arizona has often been exclusionary. In my view, the water buffalo symbolizes that exclusionary world. I am glad you have created a space for some dialogue around symbols and words, but deeds and actions count more. The problem is not the symbology of the water buffalo, it is the history of ignoring the needs and concerns of a broader gamut of affected communities, particularly minorities and neighbors.

9. I'm personally tired of people tearing down statues and history and creating new words that have no meaning. The only exclusivity about Water Buffaloes was that so few people actually cared about water. It wasn't a closed club, but few people wanted to participate. Now more people do and we need to expand the herd and bring in more water buffaloes – anyone and everyone who cares about water in Arizona. I can't believe the things people take "offense" at. Everyone is offended by something, and being a grown up means being tolerant and accepting or at least being receptive to ideas you don't necessarily agree with. I'd say it's an honor to be included in the Water Buffaloes – it means you care enough to do something. Where do I get a t-shirt?

10. I suspect I might be referred to as a water buffalo, but I don't know if there is some sort of 'club' I have to be in, and I've never been formally indoctrinated as one.....I suspect the club is made up of mostly old white guys.....and that is not a picture of our future.....I hope it is not. Nope, I don't like the name water buffalo. It isn't native to the US. It doesn't belong in a desert. It is also now a domesticated animal tilling fields, producing milk and meat. I don't resonate with that picture. It is not environmentally friendly, as a domesticated animal. I support putting the term 'water buffalo' as it relates to water professionals in a museum, and finding another name for water professionals that better represents our world today that includes diversity, and environmental stewardship.

11. As I sit and ponder the vagaries, challenges, and conundrums of this age of George Floyd, global pandemic, global warming/ extended drought, and Arizona's wildfire season – it occurs to me that despite my support for the concept of "Think Global/ Act Local" I must stifle a small yawn for the debate over water buffalo. I've been called one by some...folks (sometimes hard to tell if it's a good or bad thing they've got in mind) but I've never been initiated into the Order of the Buffalo Pin... the only place (aside from Governor Babbitt's remarks) I've ever heard the term used with any frequency had been CRWUA conferences. And, if you wanted to circulate amongst a larger collection of buffalii, I don't know where you'd find them. In closing, I thoroughly comprehend and acknowledge the current need to re-examine our labels and referents. However, this is one I'm not really willing to expend any bullets on.

12. Thanks for bringing up this discussion. I think when one talks about symbols, the true importance is always larger than the symbol itself. Any discussion of a symbol is ultimately about whatever it is that the symbol stands for. I always perceived the Water Buffalo symbol as a cutesy moniker that denotes a clique. There has always been a sense of cliquishness in the Arizona water management world anyway…One way members of a clique know who's in and who's out is by the language they use. The Arizona water clique uses (deliberately, I think) a very specialized and unique jargon that outsiders wouldn't have a full grasp of if at all. The use of the moniker "Water Buffalo" serves the same purpose as the jargon - to enhance the exclusivity of the club. I agree that it's time for the term to go, and I further assert that no replacement is needed. We don't need a mascot.

13. I thought it was well written and wanted to offer a couple of thoughts. I would have been honored for someone to have thought of me as an Arizona Water Buffalo during my career. …I had the typical initial reaction of "why do we need to change this". In looking up the definition of "water buffalo" on the internet, I came across this one: "Domesticated over 5,000 years ago, the water buffalo is used throughout China to plow the wet rice fields. The water buffalo thus came to symbolize strength, benevolence, patience, submissiveness, and steady toil." Anyone who has been involved with major water projects or major water legislation in this state has definitely had strength, patience, and plenty of "steady toil". And I'm sure benevolence fits in there as well, since the purpose of those who work in the water field is to improve the lives of the people who live and work here. I'm not sure that submissiveness fits, but matching 4 out 5 qualities seems to be pretty good. In the last sentence of your article, you note that "…we can agree that our gatherings for debate and dialogue, whether in-person or virtual, will include more than the water buffalo." That statement made me think of our gatherings as an oasis, where different animals gather to get the water they need to survive. The water world has a lot of different animal types - eagles and hawks that soar above the earth to get a big picture view of the landscape and have the vision to plan for what's needed; the water buffaloes whose steady toil keeps projects or legislation moving over long periods of time; beavers who build water infrastructure projects; and desert tortoises (engineers) who slowly but steadily get projects designed and problems solved, but who may retreat into their shell when asked to engage with politicians or the public at large - just to provide a few examples. So maybe there is no one animal to describe all of us. Maybe a better symbol is a water drop. Living in a desert environment, we know that every drop of water is important, and they are all unique in some way. Put together, they can form lakes and rivers, provide water supply for millions of people, and create an energy source (hydropower) for many communities in the desert Southwest. Maybe those who rise to the level of "Water Buffalo" can be known as "Thunderclouds". Or something else. Just some ideas for thought - although, I'd still be honored to be considered a Water Buffalo!

14. Thank you for your reflection on retiring the water buffalo symbol. I absolutely agree the symbol should be retired. I have never related to this and in my mind water buffalo equaled an exclusive old boys club that was not open to new ideas (and focused on expensive engineered solutions to water management). I'm not sure that we need a new symbol. I think we need a new culture, that is inclusive, engages the community, hears diverse voices, and ensures water management is open to the people - and not left to the "experts." Thank you for asking for feedback.

15. Unreal, you all need to stay focused on what's important! Keep the Water Buffalo and to hell with stereotypes!

16. WRT the water buffalo question. As someone who will never be one but who is very often surrounded by them, I think it is a great term for the in-crowd of experts and should be kept. Implicitly it conveys the water buffalo's commitment, contribution achievement and personal cost for the greater good. I actually think that is an exemplary way to be *inclusive* and *to include* within your community. Though of course by definition being a water buffalo means you are part of an exclusive club, and that can be completely fine so long as it clear and transparent how one gets to join that "club" and what it is a nickname for having achieved professionally. So long as "membership" is not used in a discriminatory and systemically racist way. It must also be politically inclusionary in every and any way if academics or local, state and/or federal employees are to be included as water buffalos. When used at conferences like yours I do think the term should not be used by speakers, *unless* it is clearly defined and used for a reason that helps the audience (e.g. one of your PhD students or an undergrad political science student) understand a point and how they could aspire to be a part or this esteemed group. BTW, water buffalos are not aggressive animals at all. Cape buffalo are aggressive human killers…Water buffalo take on the hardest physical work in many parts of the world where people cannot afford machines to provide this superhuman energy and in environments where machines just cannot do the work.

17. To me, the term or reference has always been associated with someone who has a long record of working in the Arizona water arena. To me, I always associate it with time, commitment, experience, and a lot of accumulated lessons. The person referred to as the WB is a veteran of the water arena in Arizona. Anyone who can survive that environment has some endurance/ fortitude and probably a thick hide, like a literal WB. I have been around the term in Arizona for…seasons in the ag field where water has been at the center of everything we do. I did not know there was a formal club until ~ [X]years ago. Even if you did away with the formal group, the name and reference would continue and rightfully so in my view. Interesting discussion – thanks for sharing.

18. Just a perspective, I was told…that the water buffalo symbolized the water policy people because the buffalos would often fight among themselves, but when threatened from the outside, they would immediately set individual differences aside to protect the herd. I would suggest a mascot that recognizes disputes among individual interests will arise, but that focuses on the long-term protection of "the herd". Not sure exactly what that mascot might be, but since water buffalos are generally irritable and can be obnoxious, a new symbol may be more reflective of today's water policy leaders.

19. I'd be glad to have us deem the "Water Buffalo's" as the 19th and 20th century water leaders in the Colorado Basin states … but to also deem that a new type of more inclusive and open leadership is needed for the future … one requiring resilience in the face of significant uncertainty both in our hydrology and the future of our economies and communities. Stubborn, single minded pursuit of narrow objectives (a hallmark of water buffalos) is no longer what we need. Water Gazelle's perhaps … or maybe just community leaders who care about water (ok so we probably need something that at least could be turned into a catchy acronym).

20. I've heard about the term "Water Buffalo" but never really knew the detailed meaning of it and now that I see that most of it is negative. For the Plains people, the Buffalo or more correctly Bison is a sacred animal.

21. I…read your essay about the water buffalo. I enjoyed it! -- it was both light hearted and funny, but also very serious and timely. I can tell you that I always appreciate the effort to make certain spaces feel more inclusive to others who may feel like "outsiders." I don't know if it was how I was raised, but I often feel like that and I know many around me do too. So thank you for breaking down barriers. It's more timely now than ever.

22. I'm not one to normally speak up and would much rather listen and learn, but thought I'd put in my 2 cents on this one. You characterized it well when you introduced this subject, essentially very pressing and relevant concerns were not discussed and a symbol took center stage. For someone who has been involved in water resources since 1985 I find this pettiness silly and condescending. This seems just one more example of left-leaning folks who choose to be offended seemingly to divert attention and resources from relevant issues and subvert a tradition because they have not been officially designated a 'water buffalo'. I have never been officially welcomed into this brotherhood / sisterhood and feel no worse for it. I heard a quote and unfortunately don't know who to attribute it to. "In any argument those with the greater intelligence are always wrong because they did not use their intelligence to avoid the argument in the first place." Let's be smart and choose to channel our intelligence and resources into topics and challenges that will make a difference for generations to come and not to placate the whims of a small group who chooses to argue over irrelevant issues.

23. Your observations about "water buffalo" symbolism brought up some interesting thoughts. I recall first being exposed to the terminology when…I was interested in how water decisions were being made. I was told… - "don't worry about it - the Water Buffaloes of [X] have it all figured out". Timing is everything and over the …years have watched and learned how water decisions are made…Should the term be "retired"? I think the time has come. While they still exist - case in point is the ongoing discussion of who should and who cannot be in the "room" for the development of the DCP and 2026 Guidelines shows that there still exists a hierarchy of dialogue and decisions on water. I also think that this topic exposes an interesting line of thinking that deserves to be explored as the West (and Arizona) deals with our water futures. Sociologically this is a fascinating new topic to explore. Good job on raising it.

24. Lawyer XX used the term water buffalo as a term of derision for the water developers of the past who loved to wallow in as much water as they possibly could, even beyond what was necessary. That is the definition I've always associated with the term. I reserve the term, much like XX did, for irresponsible water project development.

25. Years ago, when I first heard the term water buffalo, the way it was explained to me, water buffalos sounded like another "good ole boys" network; an exclusive group of white men with power over water, and who had it, and who wouldn't get it. Power always implies money. When I finally found out that a couple of water buffalos were women, it changed my perception slightly, but the thought of it being an exclusive "club" of power people was still there. I wondered, "How do get you get to be a water buffalo?" and basically assumed it would be a status not attained by anyone outside the power structure. It seemed obvious, you could only be chosen to be part of the group. So in that sense, it felt elitist. On the other hand, if you look at the history of water here in the state (or elsewhere), you can also see where the term connotes a high degree of respect for people who've dedicated their lives to tackle tough water issues. They do their best to ensure their State has water resources. Looking at the term itself, I am not offended by the term water buffalo… My only issue with the term is related to the felt sense of elitism. It leaves me with the questions of "How can I become a water buffalo?" or "What does it take to become a water buffalo?" "Is there room for more at the table or is it just for the chosen few?" These thoughts led me to the think about diversity, equity, and inclusion issues. How many minorities or indigenous people are water buffalos? Shouldn't they have a seat at the table too? So if I had to change anything about the term, I'd say the group should be less exclusive and more inclusive. It should be open to anyone who works tirelessly in the field of water to promote the best interests of the public.

26. I guess I'll always be an old Water Buffalo and consider the use of it for those who have spent a lifetime resolving water issues and problems as a tribute and matter of respect to those so recognized. Water buffalos can be aggressive, as are all mammals when the need arises. But they are a communal herd animal. I have spent time among them in XX and treasure that experience. Water buffalos persist in spite of mankind's predation. Those who fear or object to use of the Water Buffalo do so because they aren't really Water Buffalos. They should consider an alternative name for themselves. How about the Water Ducks or some other choice cause even ducks can be aggressive and bad tempered under certain circumstances. I think the conference discussion on this matter should be considered interesting debate…but should not be considered a call to action.

27. Amen. The term conjures a hopefully outdated and elitist (read: white male) approach to water management. If we are looking to promote an inclusive and equitable approach to managing water resources, the term has no place in our conversation. Enough said. And thanks for raising this issue!

28. This is an interesting perspective you wrote. I had never heard the term water buffalo and I don't know anyone associated with the group, so I'm not one to comment on its legacy or exclusivity. It sounds like the group's intent was to protect AZ water (something we all strive for) during a time when crucial decisions needed to be made. Perhaps it is time to open the dialogue with fresh, diverse views on how to best move forward with protecting our water resources, and somehow preserve the work the group had laid out.

29. First, I'd like to say thank you for drafting a very thought provoking commentary about the use of the term Water Buffalo as a symbol of those who care about or are involved in water policy or its management in Arizona. As requested, I would like to provide my views regarding your July 10, 2020 Reflections commentary where you asked if it's time to retire the Water Buffalo Symbol? My simplest answer to your question, is No. Like many of us, I have worked in the Arizona water policy/management business for the past XX years and have seen the Water Buffalo term used ubiquitously over my tenure as your Reflections article mentions. You eloquently conveyed that some colleagues in a Happy Hour you attended expressed disdain for the term's use to describe those in the water business. You also referenced comments from a CAP 2004 Annual Report that "like the water buffalo, these Water Buffalos plodded along and would not be deterred from accomplishing their goals". I think the comments are a fair caricature of how that term has been used over time. However, I would like to submit that there is more to the Water Buffalo reference than what was mentioned or your Happy Hour participants conveyed with their interpretation of its use. Over the years I…share the parallels, metaphorically speaking, between the behaviors of the Water Buffalo and how we conduct water management/policy in our State. So hopefully these will resonate, eh? We know Water Buffalos seem to enjoy a good wallow while hanging out either within or adjacent to water. The parallel, metaphorically speaking, to using this term is that we all like to hang out together at conferences or after a meeting, where we often congregate in groups, commonly at happy hours, discussing and debating the water management/policy issues of day. Sound familiar? Additionally, the Water Buffalo moves slowly and often together in herds. The parallel here is that any changes to water policy or its management, especially at the State-level, is best made on a consensus basis (where we move collectively as a herd) and the decisions we make to change a policy or management practice are best never made in haste. That is, the changes we make are slow and intentional, similar to the actions of the Water Buffalo. I am disappointed to think that some believe the Water Buffalo symbol lacks inclusivity or is no longer a term of endearment for those in the Arizona water business. I hope my additional parallels, metaphorically speaking, will help them better understand its use? I for one, will continue to embrace the use of this term to describe myself, and hopefully others (?) who care about or are involved in water policy or its management in Arizona. Lastly, I would like to thank you for bringing this topic forward and allowing the opportunity for the thought provoking dialogue it deserves…

30. I agree the 'water buffalo' should be retired. To me, it not only speaks to an exclusive club, but also to a 'stuck in your ways' mentality, and our future water management solutions require broader thinking and innovation. I don't know why, but I think of the buffalo digging her hooves in the dirt and being unmovable, and that's not a great representation.

31. I suggest that the "water buffalo" be retired. It is not native. In Australia, the water buffalo has been a major environmental disaster in the wetlands of the top end of the Northern Territory; they eat large volumes of grasses and other plants, removing this food source for native wildlife, and they can damage the trees they regularly rub against. Something like this might be more inclusive – maybe multiple colored hand or b/w generic.

32. A respondent pointed me to a 2014 entry on CAP's website, which starts off by saying: Just what is a water buffalo? In Arizona, they are those iconic figures who had the foresight to plan ahead to meet the water needs of a growing desert community. Without them, we might not have the Central Arizona Project and the state's water situation might be bleak. It goes on to direct people to oral histories and goes on to note: There you'll see the stories of several water buffalos come to life: Bruce Babbitt, Jack Pfister, John Rhodes, Stuart Udall and more. There are about 40 oral histories recorded thus far, with more planned for the future. So this Thanksgiving, CAP raises a water toast to those water buffalos responsible for putting CAP water on tables across much of Arizona.
to https://www.cap-az.com/public/blog/272-cap-thankful-for-arizonas-water-buffalos

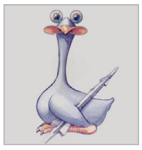
33. I believe that water buffaloes are misunderstood and stereotyped. I was interested to learn that they are quite social and typically led by a dominant female. The females are very protective of their young. Younger males travel in male groups, but older males tend to hang out with the females. They are related to cows and herbivores. Some are endangered.

34. I like the water buffalo term and don't think we need to change it. Water Buffaloes - Farm Animals Facts & News by World Animal Foundation
https://worldanimalfoundation.org/advocate/farm-animals/params/post/1280085/water-buffaloes

35. Second set of comments from an individual: It is interesting to read your two pieces together, along with the feedback you've gotten so far on the Water Buffalos. I see a somewhat unaddressed tension between the desire (and need) for more inclusivity in decision-making, and the importance of relationships. Of course it's not surprising that those in the inner circles of decision-making emphasize the importance of relationships and face-to-face interaction. Those things *are* incredibly important, but also a bit self-serving. Ironically, in some cases the remote work experience has expanded the relationship-building opportunities by lowering barriers to participation (which you point out) and providing glimpses into our non-professional lives… Those kinds of humanizing things can be essential when navigating difficult issues. But the shared experiences, common vocabulary, inside jokes and technical trivia among the insiders are the very things that can also be barriers to participation. These are in fact the quintessential characteristics that I associate with the less endearing attributes of the Water Buffalos. Moreover, there are inherent scale limitations of personal relationship building. Scaling-up decision-making often comes down to processes and institutions, and that is where I see the greatest challenges for Arizona water professionals (and our society more broadly, but that's for another day). On the one hand, even though it was incredibly messy, the Arizona DCP process had most of the hallmarks of a good process, and set the template for things to come…To my mind, the thing that ties together the themes of personal relationship building and institutional-scale processes, is trust. From my rather narrow perch, there's work to be done on building confidence, establishing facts, and perhaps most importantly, finding ways to extract and convey meaning from issues that have all the dimensions of wickedness…Ultimately the weightiest decisions will still be made by a small group of people who work, and sometimes eat, together. But only if those that are quite literally not at the table have enough trust in those people, the institutions they work for, and the processes they have put in place.

36. I saw your short post on Waterwired on the term, water buffalo. Predating its use among water professionals, the U.S. Army used the term to refer to this, **https://www.armyproperty.com/Equipment-Info/Water-Buffalo.htm**, a 400 gallon, towable, water tank. These units have since been replaced by the Camel II, **https://asc.army.mil/web/portfolio-item/cs-css-unit-water-pod-system-camel-ii/**. I am not sure what symbol might replace the non-Army water buffalo, but perhaps the term, water doyen.

37. On the Buffalo issue, I always thought it an apt description. Lumbering, slow witted and male. The folks who for years kept the secrets of water law and policy carefully guarded secrets. Now that the internet and other technology make water materials widely available, another word is needed Water minnows? Water ouzels? Water snakes? Or my personal favorite the water dippers (Nike missile optional).



38. Should we call ourselves water nymphs? Or water lilies? Or water bugs? Or water snakes? Or zanjeros? Or Cape Buffalo (much more dangerous)? I, for one, don't care what you call me as long as you don't call me late for dinner.

39. Oh, yes. Way overdue.

Animas River before and after the Gold King Mine Spill of 2015.
Photo: modified from https://images.app.goo.gl/Wx8ueh4wjs4eK9T99

Reflections: The Importance of Dialogue, Process, and Participation

by Sharon B. Megdal
11/13/2020

I write this after participating in the American Water Resources Association (AWRA) annual conference, which was held November 9-11, 2020. Though delivered virtually, the highly engaging conference had all the richness and much of the structure of an in-person event in terms of schedule and sessions, as can be seen by visiting the **conference website**. Alongside the live plenary and featured panel sessions were topical sessions, which were a combination of pre-recorded presentations and live question and answer discussions. I congratulate the conference committee and staff for making the complex pivot to virtual delivery. As an AWRA board member, I contributed in a limited way: In addition to the interactive panel I organized on Wicked Water Problems, I recommended two University of Arizona (UArizona) colleagues, Dr. Diana Liverman and Dr. Karletta Chief, as speakers for two other panels. Now that the conference is over, I am struck by how our three distinct panels addressed some of the same fundamental issues of dialogue, process, and participation. However, before I address some key take-aways, I will offer comments on the conference experience itself and, given that I am involved in planning multiple conferences, invite you to share with me (**smegdal@arizona.edu**) some of your experiences with virtual conferences now that we are eight months into the COVID-19 pandemic.

This conference resembled other conferences in that tough choices had to be made in terms of which sessions to attend. In fact, the panels featuring my two colleagues were set at the same time. Fortunately, their presentations did not fully overlap, so I was able to move from one virtual conference room to the other fairly seamlessly – in fact easier than might have been the case at an in-person conference. Some events that are so important at in-person conferences were indeed different. The conference reception featured a competitive trivia game, which kept the participants engaged and was fun! The awards luncheon program was the same as it might have been had we assembled in-person, *sans* lunch service of course. The sponsors' exhibits were of course different. Interestingly, there was a higher than usual level of student engagement through posters and registrations. All in all, the conference kept me busy and involved.

What were my conference take-aways related to water resources management and policy? Here, I would like to focus on some key issues discussed at the three sessions involving my two UArizona colleagues and me. The Wicked Water Problems session featured Lisa Beutler of Stantec Consulting Services, Inc., who introduced me to the concept of wicked problems in water at the 2016 Water Resources Research Center (WRRC) Annual Conference. Readers who follow my activities will know that I've spoken and written on this topic quite a bit in 2020. Lisa provided a great overview of what characterizes wicked problems. She noted that societal wicked problems, such as poverty, sustainability, equality, health and wellness, and water, are problems of indeterminate scope and scale. Her remarks were followed by those of Betsy A. Cody of Cody Research & Consulting, who offered California's Central Valley Project as a case study. Oregon State University Professor Michael Campana spoke to his favorite topic – groundwater. Specifically, he spoke about the depletion of groundwater in the West Texas portion of the Ogallala aquifer and suggested that "managed aquifer depletion" might be the way to approach this wicked problem. After mentioning some wicked problems of the Colorado River Basin and the Middle East, I highlighted the importance of inclusive and respectful processes when developing, evaluating, and implementing wicked water problem solution sets. While building relationships and establishing trust can be more difficult during the COVID-19 pandemic, a silver lining is that virtual meetings and discussions can enable more participation by avoiding travel time and costs. Through the chat and facilitated discussion that followed panelists' remarks, many issues were brought forward. A particularly noteworthy comment written in the chat connects to Karletta Chief's remarks noted below: "I find it refreshing to hear the rights of Native Americans being openly and frankly discussed in these professional meetings. That is really a marked change from the past."

The importance of process and communication was emphasized in the two-part panel on Water Justice Issues and Potential Solutions. Excellent speakers highlighted processes of working together to co-solve wicked issues of Tribal Nations (Navajo Nation), older urban water systems and infrastructure (Camden, N.J.), urban rivers (Anacostia River, Washington, DC), and at all scales (EPA). My Extension colleague Dr. Karletta Chief focused on the impacts of the Gold King Mine Spill, which had devastating societal, environmental, economic, and spiritual effects on the Navajo Nation. She described how overcoming distrust was aided by a community-driven partnership that involved UArizona personnel and team members from many other organizations. She noted how citizens and experts all came together to co-learn and co-solve, and she connected this experience to working with the Navajo Nation in response to COVID-19. Dr. Chief mentioned the involvement of more than 100 students in Gold King Mine Spill partnership efforts, more than half of whom were Native American.

Unfortunately, the first part of the water justice session overlapped with the session on International Policy to Address Climate Change. There, I was only able to listen to the remarks of UArizona Regents Professor Diana Liverman, lead author for the Intergovernmental Panel on Climate Change (IPCC) Special Report on 1.5°C and member of the Earth Commission. In her remarks, she commented on differential vulnerabilities to the adverse effects of climate change and abilities to build resilience caused by societal and income disparities, noting a strong parallel of climate change and COVID-19. She also spoke to the importance of student engagement, including the youth climate movement.

The panel presentations and Q&A sessions of the other concurrent sessions all allowed for comments and questions to be entered in real-time throughout the sessions. This actually facilitated meaningful dialogue and sharing of perspectives throughout the AWRA conference. It was interesting to see how so much of the discussions focused on the crucial role of inclusive processes to identifying pathways to solutions to wicked problems. Participation is key to understanding the nature of our challenges so we can tackle the issues we face as a society. This is in keeping with the WRRC's mission, which is to tackle key water policy and management issues, empower informed decision-making, and enrich understanding through engagement, education, and applied research. We at the WRRC strive to improve and strengthen our processes for including more diverse voices and facilitating more learning opportunities and dialogue. We look forward to your participating with us!

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End of 2020 Reflections

Photo: Colorado River, Sharon B. Megdal

by Sharon B. Megdal
12/18/2020

It is that season when we look back at the year about to end and ahead toward the coming year. What does one say at the end of this COVID-19 pandemic year? The pandemic changed things in ways we never could have imagined. We had to minimize or eliminate in-person interactions. Dislocation was experienced everywhere, including in the educational realm. Our lives were profoundly affected.

Regionally, the year was disappointing in terms of precipitation and temperatures. In 2020, we experienced the first federally required curtailment of deliveries of Colorado River water by the Central Arizona Project. We will be in **Tier Zero** of cutbacks again in 2021. Absent good winter precipitation and spring run-off, we could see deeper, more impactful cuts in 2022.

Individually and collectively, we continue to face significant uncertainties in both our personal and professional lives.

As I look back at 2020, the year seems to have gone by quickly while also plodding along slowly. In prior ***Reflections***, I have written about how our work at the WRRC has continued. I think adaptation is the operative word, as we all have had to adapt. While acknowledging the tragedies and challenges experienced by so many, we have to be thankful for the positives. Our programs pivoted successfully to virtual delivery. Our annual conference was favorably reviewed. Our Brown Bag webinar series is thriving. Subscriptions to our Weekly Wave are growing. Arizona Project WET is educating K-12 teacher and their students in novel and exciting ways. Applied research projects continue. Student workers are engaged in our various programs. We will provide a fuller accounting of 2020 when we compile our annual report and assemble our strategic plan metrics.

I started and ended the year speaking about the concept of wicked water problems and efforts to resolve them. Our water challenges seem only to be growing, meaning the hard work of securing clean and reliable water is more important than ever. Though my service as an elected member of the board of the Central Arizona Project officially ends on December 31, after 12 years, I do not expect to have time on my hands. Ongoing and new projects and programs will keep me quite busy. I am looking forward to teaching my graduate course "Water Policy in Arizona and Semi-arid Regions" this Spring, which will be offered as a fully online class. Delivering it online reduces uncertainty and avoids mid-semester pivots in one direction or another. The students, guest lecturers, and I will be meeting via Zoom for the entire semester.

This is the time to step back and reflect on the year 2020, to consider the devastating impacts of this virus on communities and families along with what we learned about ourselves and our adaptability. It is time to consider the possibilities of a better 2021, when we hope that sufficiently available and administered vaccinations make it safe to see our family, friends, and colleagues again. Please join me in taking a deep breath as we get ready to dive into the unpredictable adventures of a new year.

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Billboard example showing Lake Mead level and directing viewers to a website. Source for bucket graphic: CAP, Jan. 2021.

Reflections: A Reexamination of Past Water Wishes

by Sharon B. Megdal
01/15/2021

Prior to beginning my series of *Reflections* essays, I published a column in each issue of the now-discontinued WRRC *Arizona Water Resource* newsletter. Because these short columns addressed relevant current-day water issues, I ask students in my graduate class, Water Policy in Arizona and Semi-arid Regions, to read the 75 columns I wrote between 2002 and 2018 and prepare some questions for discussion. In reviewing the columns before our first class meeting on January 15, I was reminded of my "15 Water Wishes for 2015" from six years ago. I decided to revisit these wishes and look at whether they were fulfilled. The column can be found in the **compendium** available on the WRRC website. Below, I reproduce my 15 wishes and provide brief updates and/or commentary on each.

1. *I wish that people both inside and outside the professional water community would watch the movie shown at the CRWUA opening plenary session. Entitled "Challenged but Unbroken: Sustaining the Colorado River," this 9-minute movie effectively captures the essence of where we are with Colorado River supply and demand. It discusses the long-term drought, the structural deficit, and the growing demands associated with growth.*
Of course, I do not know who watched the **video**. Having watched it again, I stand by my recommendation and plan to assign viewing it to my students. Six years later, the video's appeal for conservation, augmentation, investments, and cooperative efforts are only amplified.

2. *I wish to see the general public get excited but not alarmed about water. Actions will be required in Arizona and the Colorado River Basin to close the gap between demand and supply. Some of the paths to addressing the gap are long-term and will be expensive. An informed public will assist decision makers in selecting among options.*
Six years later, the need for a water-informed public remains and efforts to share information are more important than ever. While we do not know if 2021 will be as extremely hot and dry as 2020, we do know that Arizona experienced official cutback in Central Arizona Project water deliveries in 2020 and will again experience **Tier Zero** cutbacks in 2021. The near future may very well involve greater cutbacks, imposing more significant burdens on Central Arizona. The public will need to understand the many implications of suggested options for addressing the imbalance between water demands and supplies.

3. *I wish to see additional public information and education campaigns, including the new video-based project we are working on at the WRRC called ClipStack™.*
This wish has been largely fulfilled, although the need continues. The ClipStack™ effort evolved into "Beyond the Mirage," an award-winning program that included a **documentary** shown nationwide on public television stations and an online **platform** for viewing and creating short informational videos. It would be an interesting and instructive exercise to catalogue the many subsequent informational campaigns and documentaries.

4. *I wish to explore developing an electronic billboard campaign that shows Lake Mead elevation levels and links to sources of information about what these levels mean for Central Arizona Project water deliveries. It could be an interesting way to engage the public.*
I did try to generate interest in this idea, which was borrowed from San Antonio's efforts to keep people informed about groundwater levels, and I think it would have even more impact now. My thought was that if people saw a billboard showing Lake Mead elevation, which is so important to the determination of cutbacks, they would ask, "Why is this important?" and seek additional information, such as visiting a website. This effort would be most effective if coordinated with a broader, multi-faceted informational and branded campaign.

5. *I wish for good precipitation in Arizona and the Colorado River Basin so that Lake Mead and Lake Powell levels rise and our lands are not so parched.*
With a few exceptions, most notably the winter of 2018-2019, the Colorado River Basin remains parched. Wishing for precipitation is not a sound preparedness strategy.

6. *I wish to see continued efforts to publicize and build upon the great cooperation associated with the Minute 319 Colorado River Pulse Flow, because it demonstrated how the partners, working with the International Boundary and Water Commission, enabled something not thought doable just a few years ago. It showed the great power of binational collaboration across NGO and academic communities, water suppliers, and governments. I recommend people watch the Robert Redford narrated movie, Renewal – A Reborn Colorado River Once Again Finds Her Path to the Sea. It can be accessed* ***here****.*
Here the story six years later is encouraging. **Minute 323**, which was adopted at the expiration of Minute 319, builds upon the prior cooperation and sets the framework for binational sharing of shortage and surplus through 2026, when current guidelines for sharing Colorado River shortages among the basin states will expire. Pursuant to Minute 323, **binational study** of opportunities for seawater desalination in the Sea of Cortez has been undertaken.

7. *I wish that each and every water user, regardless of size and type of water use, conserves water. There is great opportunity to use water more efficiently. Conservation should be part of every region's approach to closing the gap between supply and demand.*
Per capita water use has decreased in cities across the Western United States. A **recent study** by Richter et al. found that residential water use in several cities declined over the study period. This finding is consistent with data that have been presented for many Arizona communities. Conservation in other sectors has been documented as well. It is recognized, however, that conservation alone will not solve the water imbalances noted above.

8. *I wish to build on the extensive engagement effort involved in formulating the "Roadmap for Considering Water for Arizona's Natural Areas"…Developing pathways requires creativity and cooperation across water-using sectors. This WRRC project benefitted from extensive input and engagement of many, including our very dedicated project steering committee. We should keep putting our heads together to identify voluntary options for addressing the water needs of our state's natural areas.*
While documenting ongoing efforts to consider water to support our valuable natural areas is beyond the scope of this essay, I recommend readers view Kristen Wolfe's October 2020 seminar, **Water for Nature**, to get a sense of the work that has been done and still needs to be done.

9. *I wish for a productive dialogue on Arizona's Strategic Vision for Water Supply Sustainability. The vision document released by Arizona Department of Water Resources in January 2014 can [now] be accessed* ***here****.*
The dialogue on Arizona's efforts for water supply sustainability continues on many fronts, including most notably the deliberations of the **Governor's Water Augmentation, Conservation and Innovation Council** and its committees, along with the more recently formed **Arizona Reconsultation Committee**, to formulate Arizona's positions related to basin-wide renegotiation of the shortage sharing guidelines due to expire in 2026. In addition, deliberations on the management plans for the Active Management Areas and regional meetings to look at options for certain groundwater basins outside Active Management Areas continue. Working on water sustainability is high priority throughout Arizona.

10. *I wish that we determine our solution paths here in Arizona and throughout the Colorado River Basin before a crisis develops. It might take some event(s), however, such as a shortage declaration on the Colorado River, to interest the general public and spur action. Although we do know a shortage declaration is likely, even without one, Arizona will voluntarily use less Colorado River water over the next three years pursuant to the recently signed Memorandum of Understanding to leave water in Lake Mead with the hopes of forestalling a shortage declaration.*
Here is a brief update. In mid-2018, after a period of some discord within the water community, the prognosis for 2019 and beyond looked bleak. Arizona water interests put aside some differences and came together to work on Arizona's

approach to drought contingency planning. Arizona water interests came to agreement so that, in January 2019, legislation was signed that enabled Arizona to join with the other six Colorado River Basin states in supporting the Drought Contingency Plans for the Upper and Lower Colorado River Basins. It was worry about a potential crisis that spurred action. Throughout 2018, when the hard work was ongoing, we did not know that Spring 2019 runoff would be above average, due to the ample winter precipitation mentioned above. The crisis did not occur in calendar year 2019, when the DCPs were approved by the federal government, but 2020 was not so kind. Here we are in 2021, hoping to avoid another abysmal precipitation year, better prepared for the possibility. Though it will not be pleasant, we know what the rules of engagement are through 2026. The good precipitation of 2018-2019 enabled us to avoid the hardship of a Tier One curtailment – or worse. We may not be so fortunate over the upcoming few years, thus finding solutions is still essential.

11. *I wish that the students enrolled in my graduate class in Arizona Water Policy are highly inquisitive and interested in water resources as a key component of their careers.*
I enjoy teaching my course, now entitled Water Policy in Arizona and Semi-Arid Regions, each spring. It is gratifying to watch the next generation of water professionals and leaders progress as students, with many focusing on water careers.

12. *I wish for an informative and stimulating WRRC 2015 annual conference, which will focus on Tribal water management and be held June 9-10, 2015.*
This wish was granted. In June 2015, the WRRC hosted the conference, Indigenous Perspectives on Sustainable Water Practices, for which we posted the **recordings** of the presentations and published a summary as our **Fall 2015 *Arizona Water Resource* Newsletter**. I am excited to report that we are planning the 2021 WRRC annual conference, which will again focus on Indigenous perspectives. We expect to hold the conference, most likely virtually, in the summer or fall. Please follow our **Weekly Wave** for more information on the conference and other aspects of our Indigenous Water Dialogues effort.

13. *I wish to continue and expand WRRC partnerships in the coming year. Partnerships are essential to everything we do. Please look at the partnership metrics we compiled as part of our annual strategic planning metrics reporting. The WRRC's strategic plan and metrics, along with our Annual Reports, can be found at* ***https://wrrc.arizona.edu/about****.*
We at the WRRC work in earnest with existing partners and look forward to enhancing and expanding partnerships. We report on our activities every year through our Annual Report and strategic planning metrics and are in the process of compiling our reports for 2020. Despite the pandemic and moving our programming to virtual platforms, the WRRC was very active and productive.

14. *I wish for continued success of the WRRC's many programs, projects, and activities. Please visit our web site or contact us to learn how you can become engaged.*
Of course, this wish is a constant for us at the WRRC, and I wish each and every one of you great success!

15. *And, of course, I wish every water stakeholder (everyone) a healthy and productive 2015!!*
Looking back, I am glad to see that I wished everyone a healthy year six years ago. Of course, concern for everyone's health has been *the* primary concern for all of us as the pandemic took hold. This past year underscored the fact that none of us can take good health for granted. So, for 2021 and beyond, I will restate my wish of six years ago. I wish everyone good health first and foremost.

In closing, I thank those of you who have traveled down this short memory lane with me. My take-away from this exercise is that, though things change, many of the same challenges remain. This is not surprising given the 'wicked' nature of our water problems. Only by working collectively and diligently over time will we identify pathways to solutions.

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Earthquake damage, Mexicali Valley, 2010. Source (clockwise from top left): 1-2, Jeffrey Silvertooth; 3, Mexican Section, IBWC; 4-5, CONAGUA

Reflections: On April 4, Easter, and the Earthquake

by Sharon B. Megdal
04/09/2021

In 2021, the Easter holiday once again fell on April 4, which happens to be my birthday. This coincidence previously happened in 1999 and 2010. For different reasons, I think back to both. In 1999, Tucson, Arizona experienced snow on Easter morning. The highly unusual April snowfall was beautiful and brief, with all signs of snow quickly disappearing as the sun came out and temperatures warmed. A very different natural phenomenon occurred during the afternoon hours of Easter 2010; a devastating earthquake lasting about 1.5 minutes hit northwestern Mexico and southern California. Measuring 7.2 on the moment magnitude scale, the 2010 Easter earthquake inflicted terrible damage, including destruction of water delivery infrastructure in Mexico.

I often refer to the **Easter earthquake** when I point out drivers of water policy changes. Because many water users in Mexico were unable to receive and use Colorado River water, a major shift resulted in United States-Mexico water collaboration. In the interest of binational cooperation, for the first time, the U.S. allowed Mexico to store water in Lake Mead, the large reservoir heretofore used to store water for the Lower Colorado River Basin states (Arizona, California, and Nevada). This action set the foundation for innovative binational collaboration through numerous **Minutes** to the 1944 Treaty for Utilization of Waters from the Colorado and Tijuana Rivers and of the Rio Grande between the United States and Mexico.

Minutes, which are binding interpretations of the 1944 Treaty, are approved by the Commissioners of the U.S. and Mexican Sections of the International Boundary and Water Commission (IBWC). At the time of the earthquake, Roberto Salmón was just one year into his term as Mexican Section Commissioner. Commissioner of the U.S. Section, Edward Drusina, was less than three months into his position.

In response to this natural disaster, the IBWC Commissioners, staff, and stakeholders got to work on mitigating earthquake impacts. On June 17, 2010, the Commissioners signed Minute 317, "Conceptual Framework for U.S.-Mexico Discussions on Colorado River Cooperative Actions," in which they agreed to establish a binational Consultative Council to consider legal, administrative, and policy matters associated with cooperative actions. The Consultative Council could receive assistance from the binational Core Group and any relevant binational Work Group. Importantly, through this process, the Commission would "explore opportunities for binational cooperative projects that: minimize the impacts of potential Colorado River shortage conditions; generate additional volumes of water using new water sources by investing in infrastructure such as desalinization facilities; conserve water through investments in a variety of current and potential uses, including agriculture, among others; and envision the possibility of permitting Mexico to use U.S. infrastructure to store water."

Following many binational meetings, six months later, on December 17, 2010, the Commissioners signed Minute 318, "Adjustment of Delivery Schedules for Water Allotted to Mexico for the Years 2010 through 2013 as a Result of Infrastructure Damage in Irrigation District 014, Rio Colorado, Caused by the April 2010 Earthquake in the Mexicali Valley, Baja California." This Minute established an accounting protocol for water left in Lake Mead in lieu of physical delivery to Mexico per the 1944 Treaty. What followed from Minute 317's cooperative framework is perhaps the most well-known of the Minutes addressing Colorado River water matters – Minute 319. Though modestly entitled "Interim International Cooperative Measures in the Colorado River Basin through 2017 and Extension of Minute 318 Cooperative Measures to Address the Continued Effects of the April 2010 Earthquake in the Mexicali Valley, Baja California," Minute 319 contained path-breaking provisions. Because I cannot describe these provisions better than the **fact sheet** on it, I reproduce the bullets here:

- Establishes proactive basin operations through the sharing of benefits of water that may be available temporarily through high Lake Mead reservoir conditions and also reducing water delivery when reservoir conditions are low in order to reduce the risk of more severe reductions in the future.
- Establishes a program of Intentionally Created Mexican Allocation (ICMA) whereby Mexican water resulting from conservation and new water sources projects could essentially be held in the United States for subsequent delivery to Mexico in the future.
- Implements measures to address salinity impacts stemming from the joint cooperative actions.
- Through conservation projects generates water for the environment of the Colorado River limitrophe (boundary segment) and delta.
- Establishes a pilot exchange program under which U.S. entities assist in funding water infrastructure and environmental projects in Mexico. These investments provide water benefits to the U.S. agencies in exchange for their funding and generate water for Mexico over the long term.
- Outlines potential opportunities for future cooperation between the United States and Mexico on topics such as environmental restoration, water conservation, system operations, and new water sources projects.
- Establishes the expectation that the Commission will conclude another agreement in the future to extend or replace the substantive provisions of Minute 319.

Importantly, Minute 319 enabled the famously impactful **2014 pulse flow**, when Colorado River water flowed in its natural path all the way to the river's delta. This immensely collaborative effort included binational representatives from federal and state governments, water utilities, NGOs, and universities.

Established as an interim Minute, Minute 319 was succeeded by Minute 323, "Extension of Cooperative Measures and Adoption of a Binational Water Scarcity Contingency Plan in the Colorado River Basin." In addition to extending the cooperative and complex activities related to binational sharing of Colorado River shortage and surplus, Minute 323 established an Environmental Working Group and resulted in the first binational study of desalination opportunities in the Sea of Cortez.

In my recent discussions of Wicked Water Problems, I emphasize functioning collaborative mechanisms as important contributors to developing pathways to solutions. Wicked water problems, such as surface water shortages and the imbalance between water supply and demand, were precisely the complex challenges faced by the Colorado River Basin. In these discussions, I also express hope that we address challenges proactively and not wait for a crisis to develop. However, some crises, such as the Easter Earthquake, cannot be predicted. What is notable is how the preexisting binational mechanism for collaboration – the International Boundary and Water Commission – was able to spring into action after disaster hit.

Bringing us back to Easter events, April 4, 2021 was another notable weather day – at least in Tucson. The temperature hit 96 degrees Fahrenheit, a record for the day. Following on 2020, Arizona's driest year on record and second hottest year, 2021 does not look to be a good year for Colorado River runoff. At a time when hydrologic conditions suggest that a Lower Colorado River Basin Tier 1 shortage declaration is highly likely as soon as 2022, we can be thankful for the strong, foundational binational mechanisms and agreements already in place.

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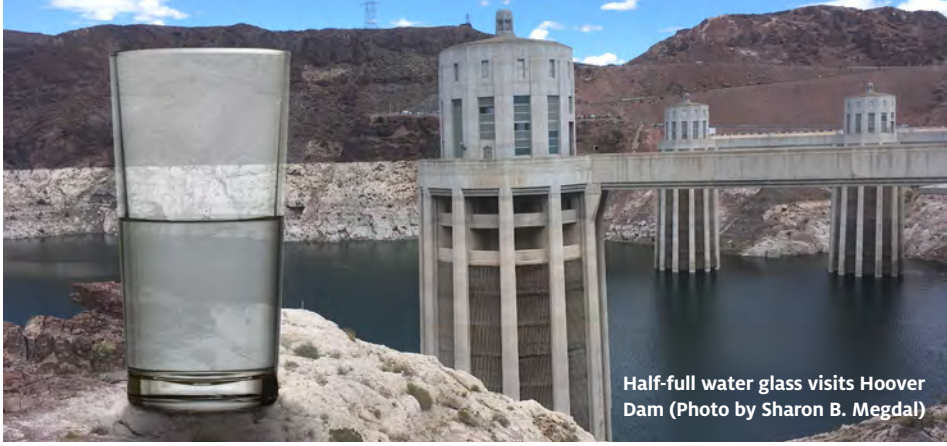
Reflections: Returning to the (Virtual) Classroom

by Sharon B. Megdal
06/18/2021



Half-full water glass visits Hoover Dam (Photo by Sharon B. Megdal)

Each Spring Semester I teach a graduate class, Water Policy in Arizona and Semi-arid Regions. This year marked my return to teaching after a one-year hiatus due to my 2020 sabbatical. It was my first experience with a semester-long virtual course. Perhaps because of the two-year gap between classes and/or heightened interest in water management in these challenging times, I hosted the largest class ever – 18 students, including two enrolled auditors. Reflecting on the semester's experience, I am very upbeat about the high level of interest and capabilities of my students. Though we are facing unprecedented water challenges, I am encouraged by the work of our emerging leaders. I found the students ready to tackle the water and environmental challenges we face as the growing stresses to our physical and human systems become more interwoven and complex.

Because the water policy context changes over time, I approach each Spring Semester almost as if teaching a new course. There are some elements that stay the same, such as providing an overview of Arizona water policy and explaining the role of recharge in furthering water management goals. Yet, especially with the two-year gap between classes, much had changed. For example, in 2019 the ***Lower Colorado River Basin Drought Contingency Plan (DCP)*** had just been approved and Colorado River Basin runoff was good. Two years later, we risk shortage declarations that could go deep. No one anticipated the pandemic, which has generated heightened awareness of the need to address access to clean water for tribal communities. An ever-changing water picture means that readings and topical coverage during class meetings must be modified.

One advantage of the virtual class format was that distance from Tucson did not stop guest experts from joining the class. Speakers like former Arizona Governor and US Interior Secretary Bruce Babbitt, representatives from the Navajo Nation, and Roberto Salmón, former International Boundary and Water Commissioner for Mexico, could easily join us from afar. However, the downside of virtual class meetings cannot be overlooked. Distinct disadvantages were that we could not go on a field trip to see water management in action, nor could the students interact with the speakers as they would have under normal circumstances. Nevertheless, I did feel that I got to know the students over the course of the semester. I hope the students felt the same.

In addition to class discussions, the students' research papers very much reflected the challenges we face in Arizona, the broader region, and across the world. Groundwater always figures prominently in the class. Students examined the implications of current regulations in the Active Management Areas (AMAs), the lack of groundwater regulations outside the AMAs, and what we might learn from California's bold approach to groundwater regulations. Multiple papers addressed the imbalance of water demand and supply and drought. Papers investigated water transfer and transport, as well as water augmentation opportunities, such as desalination and water reuse. Tribal water management and perspectives were featured in papers on uranium contamination, tribal recharge and recovery, and the potential for water policy collaboration between Indigenous and non-Indigenous communities. Issues at the Arizona-Sonora border were considered from multiple perspectives, and one paper explored what the US might learn from Israel's approach to developing and deploying innovative water technologies.

An interesting implication of missing the all-day field trip was that we could consider more topics through class meetings—and there were so many topics to explore. Yet, that additional class coverage came at a steep price. I have always considered our all-day field trip to Tucson Water's recharge and wetlands sites, Central Arizona Project's Twin Peaks Pumping Plant, and a hosted lunch to be the highlight of the class. The field trip provides not only the opportunity for students to see water management in the field, but also the chance to speak with experts in an informal setting.

Over the semester, I learned a great deal about the advantages and disadvantages of the virtual classroom, and I will do some things differently if I have to teach a full semester virtually again. However, my most important lesson from the Spring 2021 semester is that students are preparing themselves and eager to address head-on the grand water challenges we face. I am optimistic. The future is not as bleak as it may sometimes seem. The water glass *is* half full.

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Reflections: On the Meaning of Water Resilience

by Sharon B. Megdal
07/16/2021

Resilience seems to have replaced *security* in discussions of water availability. Because the term was appearing everywhere, I started thinking about the definition of resilience even before we titled the WRRC 2021 Annual Conference "Tribal Water Resilience in a Changing Environment." A Google search yielded the following definition from Oxford Languages: "the capacity to recover quickly from difficulties; toughness." This definition was not satisfying. It only triggered additional questions: What does it mean to recover and what is the time dimension for quickly?

At the May 2021 International Arid Lands Consortium Conference, **Addressing the Environmental Challenges of Arid Lands**, University of Arizona Professor Don Falk advised attendees to think about the definition of resilience somewhat differently in the context of forests and fires. He noted that the traditional definition implies returning to the former state, but ecosystems reorganize and shift over space and time. They are always changing. He asked whether we should incorporate this natural reorganization into the definition of resilience as an essential process by which ecosystems adapt to changing conditions. Resilience can therefore mean maintaining the integrity of the system through adaptation as well as resistance (toughness) and recovery.

With the help of WRRC student assistant Peyton Smith, I identified a few relevant definitions. From Professor Kathy Jacobs of the Arizona Institutes for Resilience came this definition of resilience in the systems context: "Resilience is the capacity of a system to respond to a disturbance by resisting damage and recovering quickly without losing function or services. Resilience in human systems involves the capacity to manage risks and to identify opportunities for innovation." The Udall Center for Studies in Public Policy posts a definition by Professor Chris Scott, which specifically mentions water: Resilience is "[t]he capacity of systems to retain essential functions, including provision of water and other ecosystem services." Peyton used various sources to compile another definition, which specifically mentions human action: "Drought resilience combines natural environmental healing processes to return an environment to its original strength with human action toward a sustainable and non-stressful lifestyle."

Do any of these definitions capture the Indigenous view of resilience? University of Arizona colleague Karletta Chief notes that an Indigenous definition of resilience would be more culturally based. Nikki Tulley, Ph.D.

candidate in Environmental Sciences, recently offered this in a panel discussion: "Preparing for future generations is a way of resilience within Indigenous communities."

Photo: MAR 5 Site, Sharon B. Megdal

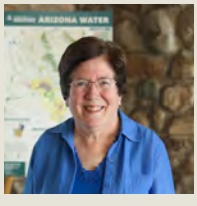
Not surprisingly, the definitions on Google and in academic papers seem to focus on a western perspective of function. The pending shortage declaration on the Colorado River system due to reduced water supplies, along with the extreme heat in much of the western United States, has generated a great deal of media coverage, and I have received an unusual number of requests for comments by journalists. It is time to start thinking about the stresses experienced by our natural systems and the people and other living beings in them in a new way. We must think about how we as humans can adapt to the changing conditions, as our water systems may not return to their prior conditions. In fact, geological history indicates otherwise.

I would like to highlight key words from the above definitions – adapt, reorganize, capacity, functions, sustainable, lifestyle, future. Water resilience is not only about supply. It is about how the natural and human-connected systems live with the water. Perhaps a term to think about is coexistence: how we as humans co-exist with our natural water systems. Our ability to be resilient requires us to think about this co-existence in everything we do, including how we build and design our communities and their structures. In a recent **article in the Guardian**, Colby Pellegrino of the Southern Nevada Water Authority stated: "We live in the desert…We have to act like it." While many of us in Arizona do "act like it," community design, landscaping, and water use practices indicate that some do not. We have to set an example for those moving to our area from elsewhere and build for our natural arid and semi-arid conditions. We can hope the Colorado River system recovers to its status for much of the last century; however, the past 20 years suggest we cannot count on that recovery. In addition, we must recognize that because most groundwater used in the region is fossil groundwater, it is not being replenished naturally at the rate it is being used.

While we can point to prudent preparations for adverse Colorado River water conditions, such as water banking, the Drought Contingency Plan, conservation programs, and technologies that augment usable water supplies, let's take time to listen and learn about the various perceptions, perspectives, and practices of those whose ancestors have lived in our region since time immemorial. I encourage you to join us for our **annual conference**, Tribal Water Resilience in a Changing Environment, which will be held virtually in three-hour segments over three days, from August 30 through September 1, 2021. **Registration** is free. The program for the conference, which is dedicated to the legacy of pioneering tribal water rights lawyer Rod Lewis, will be posted soon.

We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

Free Registration for the 2021 Conference ››



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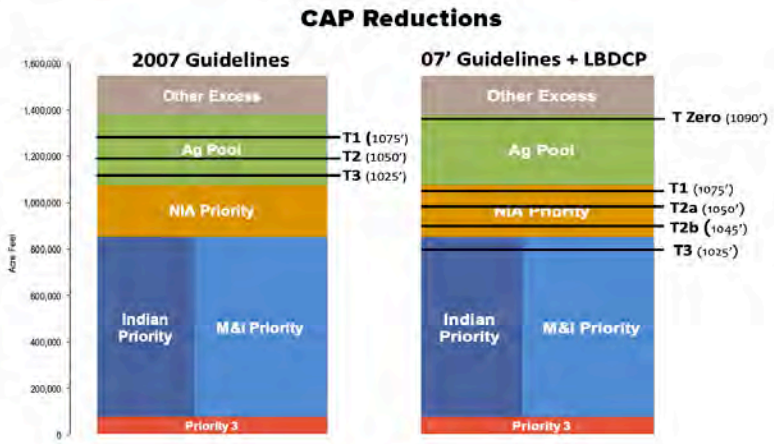
Reflections: Adapting to a Drier Future

by Sharon B. Megdal
08/20/2021

Photo: Sharon B. Megdal, Hoover Dam.

On August 16, 2021, the United States Bureau of Reclamation announced a Tier 1 Shortage to go into effect on January 1, 2022. This declaration of cutbacks in water deliveries was in accordance with established Colorado River operating criteria. Local, national, and international media have been covering the poor health of the Colorado River system for some time, with the shortage declaration bringing media interest to a crescendo. Like many, I've spoken with reporters, who ask about who will be most impacted by the cutbacks in water deliveries. The answer to this question is Central Arizona irrigators who have been utilizing "Ag Pool" water. Central Arizona Project (CAP) has lower priority than many other suppliers and users of Colorado River water, and Ag Pool deliveries are lowest priority within the CAP. Tier 1 curtailments do not affect Municipal & Industrial (M&I) Priority or Indian Priority water. For the most part, Non-Indian Agricultural (NIA) Priority water deliveries are not impacted until a declaration of a Tier 2 Shortage. As the block graphic shows, were we to experience a Tier 3 Shortage, all NIA water deliveries would be eliminated and even some M&I and Indian Priority deliveries would be reduced. While it is true that water stored by the Arizona Water Banking Authority can be drawn upon to offset some cutbacks to high priority users within the CAP system, reduced water availability is always a concern, especially when the duration and severity of the poor Colorado River conditions are unknown. It is this uncertainty that makes planning particularly difficult. Whereas the sophisticated modeling of the Colorado River system supports projections of future river conditions, we just do not know when there might be a wet cycle – or if, as most expect, runoff conditions will continue to worsen. No one has that crystal ball for precisely predicting the future.



Source: Central Arizona Project

The system for allocating Colorado River water is complex in so many ways. It varies between the Upper Basin and the Lower Basin, and there are different systems for allocating water within a state. As discussed above, we need to look no farther than Arizona to drive home the latter point. These details are important. I often hear it stated that Arizona has lower priority than California or that Arizona has lowest priority, but that's not true for many Colorado River water users located in Western Arizona. In addition, the ability to lease water varies across users. Details matter.

Following are some points I have made when speaking with the media.

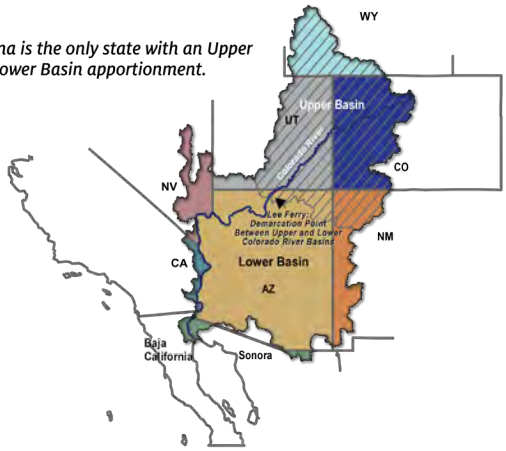
We have been living beyond our means for some time. The "structural deficit" in water allocations to the Lower Basin States – Arizona, California, and Nevada – has been acknowledged. Even if climate reverted to pre-2000 conditions, more water is allocated than average river flows can support. The allocations to the Upper Basin states – Colorado, New Mexico, Utah, and Wyoming – are based on percentages, as shown in the figure below. Lake Mead's large storage capacity has served as a savings account, but withdrawals or outflows have exceeded inflows or deposits. Over time, this practice leads to depletion of the savings. Just how long of a period will depend, at least in part, on conditions that water users cannot control. For several years during the last decade, efforts were made

to bolster deposits to prop up savings (Lake Mead's water level) to avoid a Tier 1 Shortage. But that was not enough. In fact, concerns that the system could "crash," meaning Lake Mead's level could fall below "**dead pool**," were growing during the latter part of the last decade. In 2019, the seven basin states and the federal government came to agreement on the Drought Contingency Plan (DCP) overlay to the **2007 Interim Shortage Sharing Guidelines**. Two years later, we find that DCP (Tier 0) cutbacks were not enough. Mother Nature has not been kind. I stated in one interview that Reclamation's declaration "is a stark reminder that the over-allocation of the Colorado River system must be reckoned with."

I have noted that there is not a widespread feeling of panic. Given CAP's low priority and that water flows vary even in the best of times, we have prepared — particularly by storing water underground. CAP water is not the sole source of water for many users, including Central Arizona farmers. In 2019, Arizona adopted a DCP implementation plan with voluntary agreements to mitigate some of the negative impacts of reduced water deliveries. However, we cannot deny that the situation is bad and has worsened sooner and faster than we thought it would. Rather than a "business as usual" mindset, adjustment – adaptation – is necessary. After so many years of reduced precipitation and runoff, 30-year rolling averages reflect the "new normal." While we can hope for better-than-average flows, we need to prepare for worse-than-average conditions.

COLORADO RIVER APPORTIONMENTS

Arizona is the only state with an Upper and Lower Basin apportionment.



The 1922 Colorado River Compact divided the Basin into Upper and Lower Basins, each of which was apportioned 7.5 million acre feet (MAF) of Colorado River water per year. The 7.5 MAF are divided among the states according to the 1928 Boulder Canyon Project Act (Lower) and the 1948 Upper Colorado River Basin Compact. The Lower Basin apportionments in a year of normal water supply are shown below, while the Upper Basin apportionments are based on percentages of river flow, which can vary from year to year. Additionally, 1.5 MAF are allotted annually to Mexico, pursuant to a 1944 treaty between the U.S. and Mexico. The compacts, agreements, contracts, laws, etc. governing the Colorado River are known as the "Law of the River."

Upper Basin*
- Colorado - 51.5% - 3.86 MAF
- Utah - 23% - 1.71 MAF
- Wyoming - 14% - 1.04 MAF
- New Mexico - 11% - 0.84 MAF
- Arizona Upper Basin - 0.5% - 0.05 MAF

Lower Basin
- California - 4.4 MAF
- Arizona Lower Basin - 2.8 MAF
- Nevada - 0.3 MAF
- Mexico - 1.5 MAF

*Numbers based on a full allocation of 7.5 MAF

Source: Water Resources Research Center, Arizona Water Map Poster

In terms of adjustments, all eyes are on Central Arizona agriculture. The options for farmers are known. The decisions of individual farmers and landowners will shape that sector's future. We already know of plans to increase reliance on groundwater and fallowing lands. However, less is known at this time about planned investments in irrigation technologies that use less water and changes in cropping patterns.

On the municipal front, we can expect to have more visible and active discussions of community and utility drought plans. I hope we see some adjustments to how we design our communities and their houses and buildings. Land planners, developers, and homebuilders can be leaders in showing transplants how to live in the desert and be good water stewards. Let's inform people that many of our green spaces, including golf courses, are irrigated with reclaimed water.

As has been demonstrated during Arizona DCP discussions and basin-wide, the circumstances and role of Native Nations must be considered.

Many adjustments will be needed. The Tier 1 Shortage Declaration for 2022 is based on operating criteria developed in 2007. The regulations were deemed interim at the time of their adoption and are due to expire in five years. Discussions on the next set of operating guidelines are already underway and will preoccupy the Colorado River Basin water community. Inclusivity and transparency are critical as we adapt to a drier future.

These are challenging times. Shortage is real. In the face of many uncertainties as to future conditions, to say it will be difficult to identify pathways forward is an understatement. Yet, I am optimistic that we will adapt – because we must.

Selected news items

- **The Hill** - Historic water cuts hit a thirsty West (second story)
- **Washington Post** - First-ever water shortage declared on the Colorado River, triggering water cuts for some states in the West
- **NY Times** - In a First, U.S. Declares Shortage on Colorado River, Forcing Water Cuts
- **AZPM** - Water cutbacks coming to Arizona
- **Bloomberg** - Can the Southwest Survive With Less Water?

To stay informed

- Colorado River Shortage Preparedness
- Colorado River Shortage

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Image: Foreground - Karletta Chief. Background - Beverly Chief, paternal great-grandmother of Karletta Chief, and her daughters.

Reflections: On the Meaning of Indigenous Water Resilience

by Sharon B. Megdal
10/22/2021

Prior to the WRRC's 2021 Annual Conference, *Tribal Water Resilience in a Changing Environment*, I penned an essay entitled "**On the Meaning of Water Resilience**." The concept of resilience is ubiquitous in conversations and the literature on water challenges. I questioned whether any of the commonly used definitions captured the Indigenous view of resilience. I highlighted key words from some of the cited definitions: adapt, reorganize, capacity, functions, sustainable, lifestyle, future. I noted: "Water resilience is not only about supply. It is about how the natural and human-connected systems live with the water. Perhaps a term to think about is coexistence: how we as humans co-exist with our natural water systems. Our ability to be resilient requires us to think about this co-existence in everything we do, including how we build and design our communities and their structures." And I invited the reader to attend the conference, held virtually August 30 through September 1, 2021.

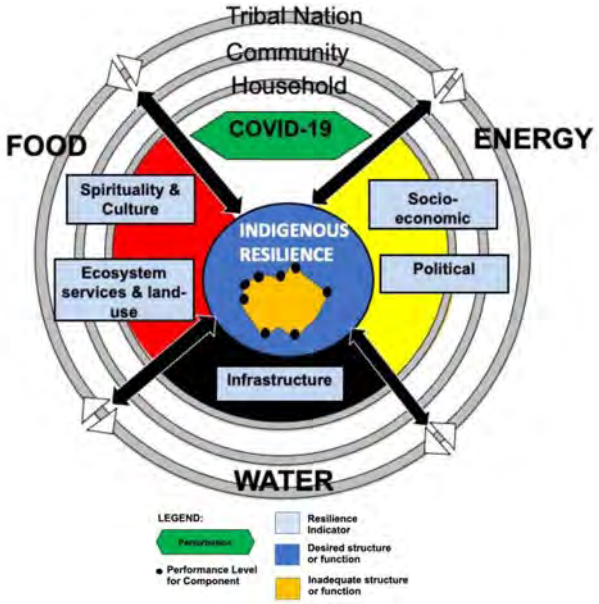


Image: Karletta Chief, Water Resources IMPACT, Volume 23, Number 1

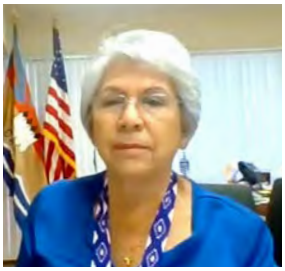
Post-conference, I now invite the reader to listen to the remarks of the outstanding speakers and panels. All sessions were recorded and are freely **available**. Speakers shared insightful perspectives on water and community resilience. Combining traditional knowledge with science contributes to resiliency. Conveying traditional knowledge from generation to generation enables resiliency. The active exercise of sovereignty is necessary for community resiliency. And so much more was explored.

Dr. Karletta Chief stated that Indigenous resilience is "the ability to survive and maintain livelihood." She observed that Indigenous views of resilience differ across peoples, and Indigenous resilience is multi-layered. Neocolonial practices fail to acknowledge Indigenous strengths. As a corrective, Indigenous resilience discussions should focus now on how Indigenous communities can achieve resilience, that is, how they can survive and maintain their livelihoods and traditions, taking into consideration socioeconomics, politics, infrastructure, ecosystem services and land use, and spirituality and culture.

The themes and concepts introduced by Dr. Chief were reinforced throughout the conference. Speakers emphasized intergenerational teachings and awareness of the needs of others. All generations, especially Elders, have a role in educating the youth. Sharing knowledge and perspectives with non-tribal stakeholders must occur as well. Having Tribes at the table for policymaking, planning, and problem solving expands understanding of needs and solutions. Tribal participation can help people identify how neighbors can help neighbors overcome challenges.

Concern for Mother Earth being out of balance and efforts to address this imbalance were considered. Emphasized concepts included restoration, conservation, water reliability, partnerships, legal frameworks, self-sufficiency, self-determination, technology, data, and culture. Toughness and strength, coping, adaptability, recovering, and shared responsibility were cited as important factors for resilience.

Personal health and river health are connected. As most readers know and discussed in my ***August Reflections***, the Colorado River's health is poor. Amelia Flores, Chairwoman of the Colorado River Indian Tribes, spoke of our obligation to the Colorado River: "Our Creator provided the River to take care of us. Now we must do all … we can do to take care of the River."



Chairwoman Amelia Flores

Whether virtual or in person, WRRC conferences are designed to provide opportunities for meaningful and respectful dialogue and learning. I recently asked David Eduardo Morales, a new graduate student assistant at the WRRC and first-year student in the master's program in hydrology, to review the conference sessions and highlight for me comments related to resilience. David offered an excellent summary of his take-aways regarding tribal resilience, which I provide to you as evidence that we are doing our job as educators: *Indigenous resilience is, ultimately, the ability for communities to survive and maintain their livelihoods. This ability is reinforced through tribal sovereignty, which itself is a function of a community's self-determination and self-sufficiency. Indigenous resilience is conceptualized differently from land to land; however, identifying Indigenous resiliency frameworks that incorporate Indigenous perspectives will facilitate the measuring and evaluation of resiliency. A fundamental aspect of resilience is understanding others' needs. This understanding is strengthened across generations through the collecting and teaching of traditional knowledge and teachings. Resiliency is not a given quality, but a state of being. It seems to be widely agreed that challenges promote resiliency, and [from] this acknowledgement stems the call for collaboration across Tribal Nations. Indigenous resilience focuses not on the mitigation of risks, but on a community's ability to withstand and adapt to … shocks and difficulties.*

David Eduardo Morales

I invite your take-aways from the conference and/or perspectives on Indigenous water resilience. Please email me anytime at **smegdal@arizona.edu**.

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Photos (L to R): MAR 5 ceremonial opening, March 2019, and October 2021. Sharon B. Megdal

Reflections: Water, Recharge, and Life

by Sharon B. Megdal
11/12/2021

Managed aquifer recharge (MAR), the term commonly used for the practice of storing water underground, often for later recovery or use, is a widely deployed water management tool. Through legislative action and regulatory programs, Arizona has established a robust program of MAR project permitting and stored water accounting, which facilitates the utilization of MAR. Notably, the Arizona Water Banking Authority has stored millions of acre-feet of Colorado River water in aquifers for recovery during times of shortage. Tucson Water has positioned itself well to deal with cutbacks in Central Arizona Project (CAP) deliveries by relying on recharge and recovery of CAP water to supply its customers and store the water it receives in excess of customer demand. And there are many other examples of how Arizona's storage and recovery framework has enabled cost-effective approaches to meeting water management objectives.

Photo: Gila River MAR 5 Interpretive Trail, Sharon B. Megdal

On October 22, 2021, approximately 60 people who had attended the WRRC 2021 Annual Conference, ***Tribal Water Resilience in a Changing Environment***, visited the Gila River Indian Community (GRIC)'s MAR 5 recharge project and **Gila River Interpretive Trail**. Field trip participants learned from GRIC Governor Stephen Roe Lewis how MAR 5 represents the legacy of his late father, **Rodney "Rod" Blaine Lewis**. Rod Lewis fought for the water that supports the environment, culture, education, and economy of the Community. His vision of reconnecting the Akimel O'odham - River People - to water led to their innovative water projects, of which MAR 5 is just one, though perhaps the most prominent.

What is particularly inspiring about MAR 5 is how it showcases GRIC's integrated approach to managing its various water sources – one that is as close an example of integrated water resources management (IWRM) as I have observed. IWRM is defined by the **Global Water Partnership** as "a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment." The MAR 5 project accomplishes these objectives through GRIC's unique approach to using its water, including a voluntary partnership with the Arizona Department of Water Resources (ADWR). Although sovereign and not subject to ADWR regulations, by voluntarily agreeing to conform to ADWR groundwater storage permitting and accounting practices, GRIC has accumulated and marketed valuable long-term storage credits.

I was excited to have the opportunity to visit the site again. I had the honor of visiting MAR 5 for its ceremonial opening in March 2019, as well as two other times that same spring. The transformation of the site in the subsequent two and a half years shows what water means in the desert. The side-by-side photos above demonstrate the multi-benefit nature of replenishing aquifers and supporting plant growth. Flora provides locally sourced materials for traditional basket weaving. Interpretive signs inform people about the plant growth. The frog we observed while walking the Interpretive Trail is further evidence that *water is life*. (In the photo its body reflects the sunlight.)

Photo: Find the hidden frog, MAR 5, Sharon B. Megdal

My interest in MAR has spanned decades. Since the early 1990s, when I served as the executive director of the short-lived Santa Cruz Valley Water District, I have been intrigued by aquifer recharge as a mechanism for achieving water management objectives. I have worked on on-the-ground recharge projects. I have written book chapters, journal articles, and edited journal issues dedicated to MAR. For students in my spring semester water policy graduate class, I schedule a field trip to one or more recharge sites. I am participating in the planning of the 11th International Symposium on Managed Aquifer Recharge (**ISMAR11**), which will be held in April 2022 and will include a focus on governance and policy aspects of recharge. But no other recharge project has resulted in as much personal reflection as MAR 5.

"The frog does not drink up the pond in which he lives" is a proverb that I believe is attributed to the Lakota. I cite this proverb at the end of many of my presentations. My recent visit to MAR 5 underscores the truth that if you have water, you can support life in so many ways. We should be as smart as the frog.

Acknowledgement: I thank Governor Stephen Roe Lewis, David DeJong, Henrietta Lopez, Yolanda Elias, Kristina Morago, Sam Rector, and others who hosted our visit to MAR 5 and the Gila River Interpretive Trail.

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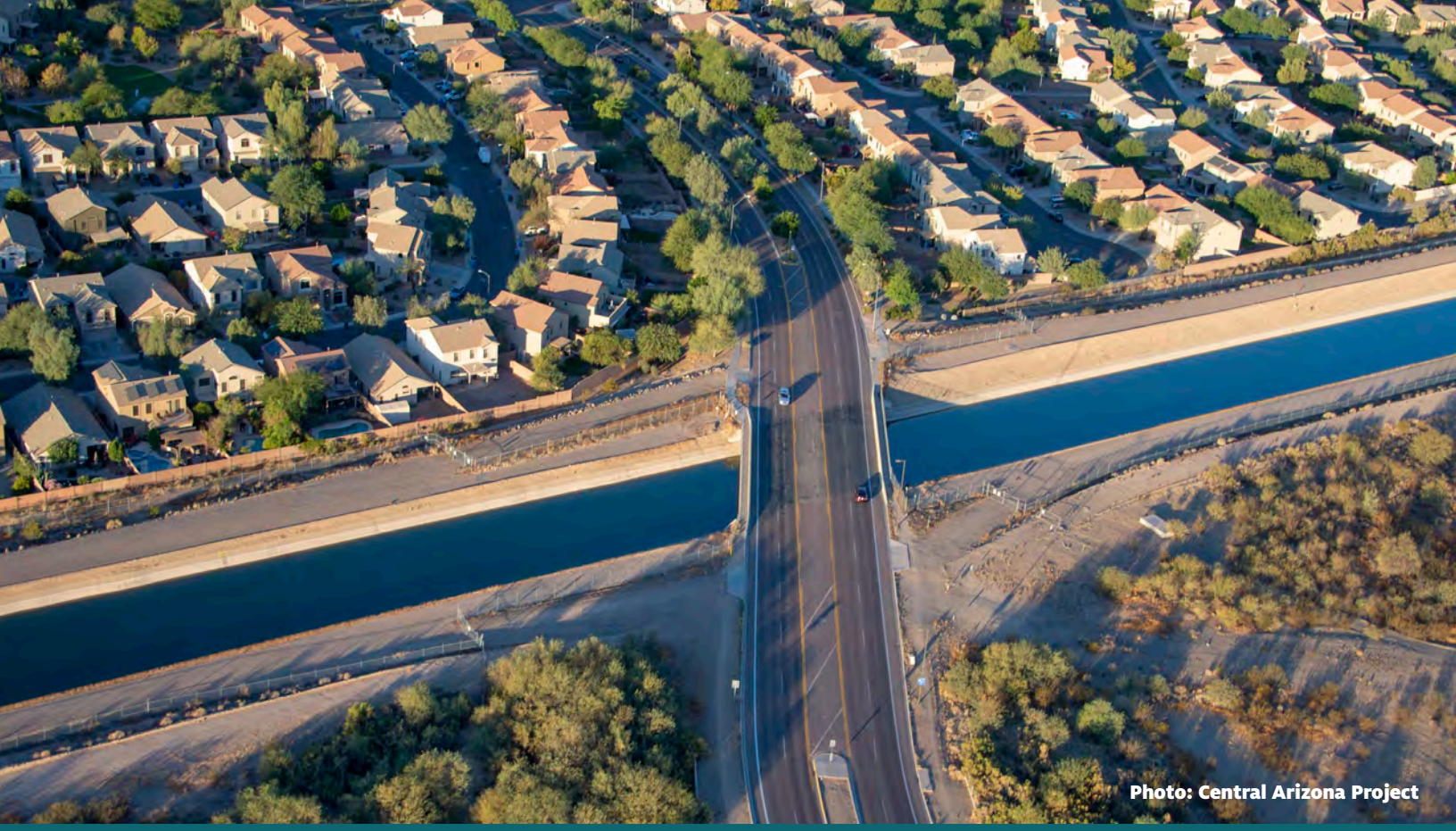

Photo: Central Arizona Project

Reflections: On Connecting Land Planning and Water Planning

by Sharon B. Megdal
01/21/2022

Land planners and water planners often work in separate silos. Though all recognize that different land uses have different water requirements, land use decision-making may not be tightly connected to water resource planning. I remember some years ago noting that land use planners were often sparsely represented at water dialogues, with the reverse also true. The lack of connection is understandable considering the differences in background and focus between the two professions. Planning professionals are very busy attending to the day-to-day requirements of their positions, along with other professional responsibilities, such as participating in focused meetings and conferences.

The **Lincoln Institute of Land Policy**, recognizing the importance of connecting the two communities, established the **Babbitt Center for Land and Water Policy** "to advance the integration of land and water management to meet the current and future water needs of Colorado River Basin communities, economies, and the environment." When Babbitt Center Director Jim Holway approached me about organizing a conference to bring together water and land planning professionals, I jumped at the chance. With tremendous help from many, we developed the July 2021 conference, *Connecting Land & Water for Healthy Communities*. Co-hosted with the American Water Resources Association (AWRA), the **conference** was a dynamic three-day virtual event. In advance of the conference, the March-April 2021 issue of ***Water Resources IMPACT*** was dedicated to the topic, and that issue is still available for free download.

A key outcome of the conference was the development of a findings statement and call to action, which have been issued jointly by the AWRA Board of Directors, on which I sit, the Babbitt Center for Land and Water Policy, the American Planning Association (APA) Water and Planning Network, and the American Water Works Association (AWWA). I am pleased to share this statement, which also can be accessed from the **AWRA website**. I share the hope expressed there for continued connections in dialogues and action!

Findings Statement and Call to Action from the Specialty Conference: Connecting Land & Water for Healthy Communities

Policy Statement

The management of land and water are intricately related, but their interrelationships are often not adequately recognized or supported. The individuals working with land and water often lack opportunities for connection. This conference convened stakeholders across multiple disciplines, types of organizations, and professions to address the design, integration, and implementation of programs necessary to better connect land and water planning, management, and policy.

Findings

The conveners and attendees of the conference recognize the inextricable linkages between land planning and water use and supply, and the importance of connecting land and water professions, institutions, public policies, management practices, and decision-making processes at multiple scales. They acknowledge the following observations:

- Fostering connections between land and water resource decision-making is critical to the health and safety, economy, environment, and cultural enrichment and humanity of the communities and people our professions serve.
- Fragmentation occurs when:
    - The impacts of climate change and possible responses (i.e., adaptation and mitigation) are not considered in integrated land and water planning and decision-making;
    - There is a disconnect between local entities which drive land use decisions, states which oversee water resource use and allocation, and the federal government which establishes and enforces basic water quality standards and laws affecting land and water resources (e.g., rangelands, forests, fish and wildlife);
    - Groundwater and surface water are not sufficiently managed conjunctively;
    - Land and water governance institutions respond differently to conflicting and competing administrative mandates;
    - Planning for water and wastewater services and local land use planning are not well coordinated;
    - Disparate data sets are collected and interpreted by separate academic disciplines and government agencies;
    - Multiple and diverse property owners exercise divided decision-making authorities over land and water management;
    - Non-government actors and disenfranchised communities are not able to navigate the complex political landscape or participate in the projects that directly impact their communities;
    - Short-term decision-making concerning land and water management is divorced from long-range planning;
    - Land and water professions are siloed into their own organizational structures, areas of responsibilities and specialization, and professional affiliations.
- The failure to create connection often results in:
    - Unsustainable growth and land use change in arid regions, at-risk flood plains and coastal zones, and fire-prone wildland-urban interface areas;
    - Increased vulnerability of communities to extreme weather events, water scarcity, flooding, water quality degradation, groundwater overdraft, land subsidence, and other water-related insecurities; and,
    - Further degradation of forests, rangelands, wetlands, flood plains, and riparian ecosystems, which contributes to even greater vulnerabilities for the very people and resources our professions seek to serve.

The urgent need to connect land and water management is exacerbated by the compounding pressures of economic development patterns incompatible with local land and water resources, and migration and geographic concentration of growing populations in areas facing water insecurities, and climate change impacts. Greater integration of the land and water sectors will better equip professionals in both to address critical challenges they repeatedly confront.

Call to Action

Land and water management must be holistically managed to better mitigate risks and uncertainty, promote long-term sustainability, and ensure healthy, resilient communities. The American Water Resources Association (AWRA), the Babbitt Center for Land and Water Policy, the APA Water and Planning Network, and the American Water Works Association (AWWA) promote integrated approaches to effectively manage hydrologically and ecologically connected lands and water resources for urban and rural communities. These organizations, along with conference participants, call for adoption of guiding principles to promote this aim.

Commitment

The land and water professionals of the AWRA Summer Specialty Conference on Connecting Land & Water for Healthy Communities commit to the following guiding principles:

- Recognize the fundamental interconnectivity of land, water, and climate to balance the health of human and ecological communities;
- Delineate and protect land critical to drinking water source protection in order to ensure water quality and availability that underpins public health and healthy communities;
- Honor, respect, and learn from traditional ecological knowledge and work with tribal and other place-based communities to holistically integrate management of land, water, and other natural resources;
- Foster diversity in land and water integration by incorporating perspectives, knowledge, and skills of people from different cultural, disciplinary, gender, occupational, and other backgrounds;
- Utilize collaboration, engagement, and boundary spanning tools to connect people, institutions, water utilities, and governments that exert different authorities and responsibilities over land and water;
- Promote integrative conceptual, scientific, and management frameworks, practices, and technologies to foster activities aimed at connecting land and water policies and practices.

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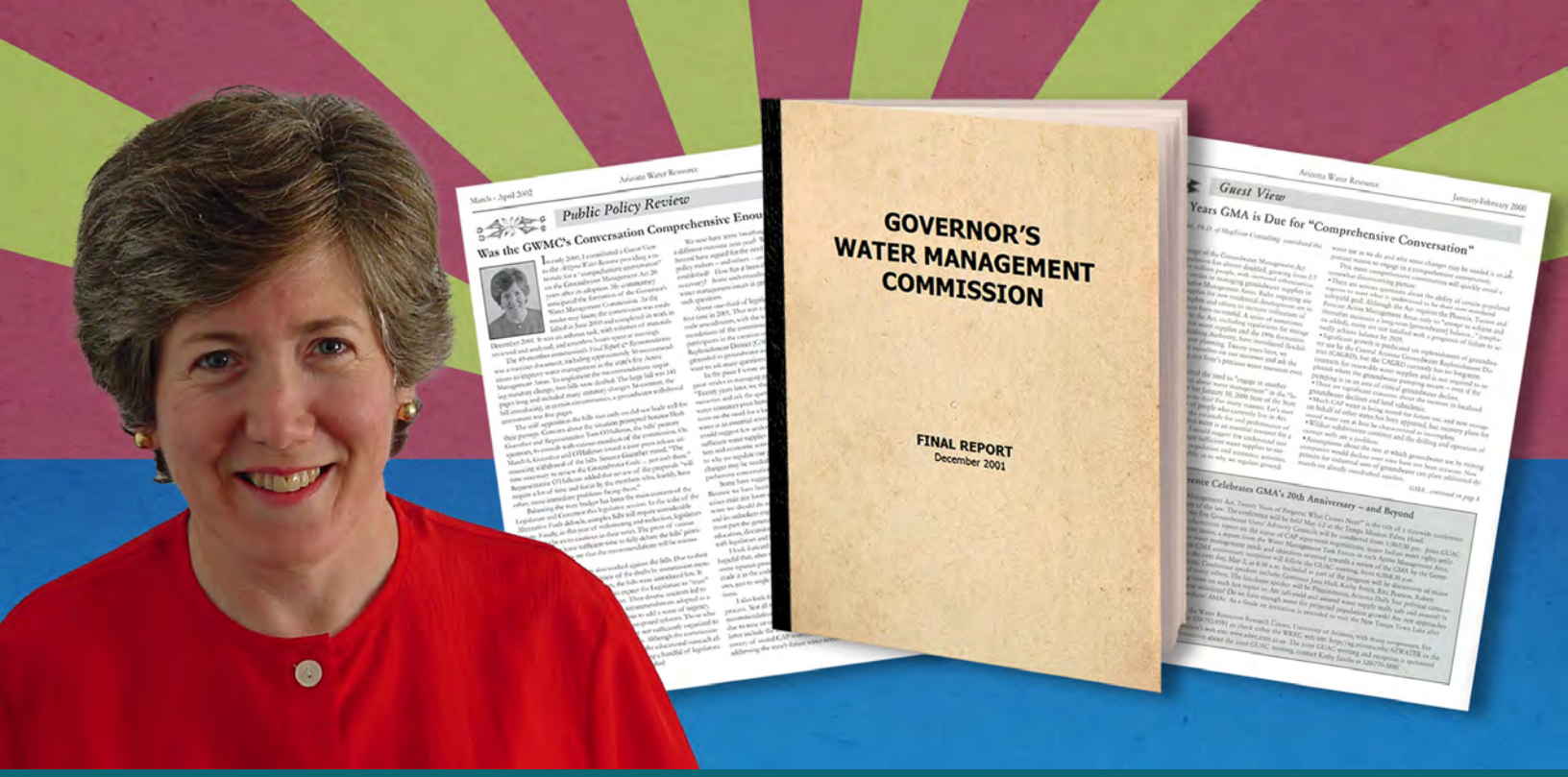

Reflections: Looking Back 20 Years and a Call to Action

by Sharon B. Megdal
02/18/2022

February 14 is an important date for me – and not only because it is Valentine's Day and Arizona Statehood Day. February 14 is also the anniversary date of my joining the Water Resources Research Center and Arizona Cooperative Extension faculty. This year marks 20 years! How did statehood day come to be my work anniversary? There is a story to that. As has occurred over the years, state budget considerations were causing the University of Arizona to tighten its belt and look carefully at its hiring. Eugene Sander, then Dean of the College of Agriculture and Life Sciences, was key to my returning to the University of Arizona. He and then WRRC Director Peter Wierenga were in negotiations with me when, in late January 2002, Dean Sander asked, "How soon can you start?" There was some worry of a hiring freeze. It did not take me long to identify Arizona Statehood Day as a fitting day to return to the University of Arizona, and I joined the WRRC as Associate Director on February 14, 2002. (I became WRRC Director on July 1, 2004.) Twenty years later, I am truly grateful for the opportunity to get to know the many individuals and communities, broadly construed, with whom I have worked over the years to foster understanding of the critical water issues faced by Arizona and other semi-arid regions and explore pathways to address them.

My association with the WRRC is connected to the 20-year anniversary of Arizona's 1980 Groundwater Management Act (Act). Early in 2000, I published a "Guest View" for the WRRC's *Arizona Water Resource* newsletter. At the May 2000 conference, organized by the WRRC to commemorate 20 years since passage of the Act, I served as a panel moderator. In her conference keynote, Governor Jane Dee Hull announced formation of the Governor's Water Management Commission (GWMC), on which I had the privilege of serving. It was during the meetings of the Commission that Peter Wierenga suggested I apply for the WRRC Associate Director position.

Going back some years, I got my feet wet in the mid-1980s, when, as a member of the Arizona Corporation Commission, I was responsible for regulating privately owned water utilities. My full immersion in water occurred in the early 1990s as Executive Director of a short-lived regional water augmentation district, which ceased operations in 1994. In the early 2000s, I was busy working as a consultant on water policy and management issues, focusing on groundwater recharge and regional cooperation. When I interviewed at the WRRC, among the matters we discussed was my desire to bring attention to water policy and management through writing a column for the Arizona Water Resource (AWR), which was published four to six times per year through 2018. Indeed, my first column was published in the March-April 2002 edition of the AWR, with the title "**Was the GWMC's Conversation Comprehensive Enough**?" The title's reference to the Governor's Water Management Commission was connected to the Guest View mentioned above. (I will come back to this Guest View in a moment.)

Between 2002 and 2018, when we stopped publishing the AWR due to staffing limitations and our desire to focus on the WRRC's Weekly Wave as our mechanism for sharing news, my public policy column occupied a place toward the end of each AWR issue. Several years ago, when looking back at my columns, which are posted on the WRRC website as a **Compendium**, it struck me that so many of the water policy issues I have written about over the years remain active today. Consequently, to familiarize students in my graduate class, Water Policy in Arizona and Semi-arid Regions, with water policy challenges, each Spring semester the first assignment is to read the columns and submit multiple questions. Then, at our next class meeting(s), we discuss their questions and explore current water debates.

Indeed, many of the issues debated at the Governor's Water Management Commission still require attention. A copy of the GWMC's final recommendations can be found **here**. That many issues remain unresolved should not be a total surprise. Many of the water problems of our day can be characterized as "Wicked Water Problems," and such complex problems are not readily solved. However, what surprised me is just how relevant the issues I discussed in my 2000 Guest View are today. Rather than enumerate the issues and their similarity, I have reproduced that Guest View here in its entirety. Certain numbers, such as those for population, are outdated, as are a few statements [comments are inserted in brackets]. Because they remain unresolved, it is clear that work on our many water challenges must continue – and continue in earnest. Indeed, these and additional issues have been identified and analyzed by the **Governor's Water Augmentation, Innovation, and Conservation Council** and are under consideration by the Arizona Legislature.

"After 20 years GMA is Due for 'Comprehensive Conversation'"

Published as a Guest View in the January-February 2000 Arizona Water Resource.


Arizona Water Resource January-February 2000

Guest View

After 20 Years GMA is Due for "Comprehensive Conversation"

Conference Celebrates GMA's 20th Anniversary – and Beyond

Guest view as it appeared in the Jan-Feb 2000 AWR.

Since the 1980 passage of the Groundwater Management Act (Act), Arizona's population has almost doubled, growing from 2.7 million to about five million people, with increased urbanization. We have made great strides in managing groundwater supplied in the five designated Active Management Areas. Rules requiring use of renewable water supplies for new residential development are in place. The CAP is complete and efforts to increase utilization of Arizona's allocation have been successful. A series of sometimes complex amendments to the Act, including regulations for storage and recovery of renewable water supplies and the 1996 formation of the Arizona Water Banking Authority, have introduced flexibility and foresight into water planning. Twenty years later, we should both congratulate ourselves on our successes and ask the question: Can we management our State's precious water resources even better?

Governor Hull recognized the need to "engage in another comprehensive conversation about water management" in the "Issues of Interest" portion of her January 20, 2000, State of the State address. Why do we need to do this? For many reasons. Let's start with a simple one. Millions of people who currently live in Arizona have no knowledge of the rationale for and performance of the Act. While many know that water is an essential resource for a rapidly growing, desert state, I would suggest few understand just how we are attempting to ensure sufficient water supplies to sustain our current and growing population and economic activities. Therefore, education of the public as to why regulate groundwater use as we do and why some changes may be needed is an important reason to engage in a comprehensive conversation.

This more comprehensive conversation will quickly reveal a somewhat disconcerting picture:

- There are serious questions about the ability of certain populated regions to meet what is understood to be their state mandated safe-yield goal. Although the Act requires the Phoenix, Tucson, and Prescott Active Management Areas only to "attempt to achieve and thereafter maintain a long-term [groundwater] balance…"(emphasis added), many are not satisfied with a prognosis of failure to actually achieve balance by 2025.
- Significant growth is predicated on replenishment of groundwater use by the Central Arizona Groundwater Replenishment District (CAGRD), but the CAGRD currently has no long-term contracts for renewable water supplies and is not required to replenish where the groundwater pumping occurs – even if the pumping is in an area of critical groundwater decline. [*Update: Some contracts for CAP water, along with long-term storage credits, have been acquired by the CAGRD.*]

- There are significant concerns about the increase in localized groundwater declines and land subsidence.
- Much CAP water is being stored for future use, and now storage on behalf of other states has been approved, but recovery plans for stored water can at best be characterized as incomplete. [*Update: Work on recovery planning continues in earnest.*]
- Wildcat subdivisions continue and the drilling and operation of exempt wells are a problem.
- Assumptions about the rate at which groundwater use by mining companies would decline over time have not been accurate. New permits for industrial uses of groundwater can place additional demands on already overdrafted aquifers.
- Legal rights to pump groundwater far exceed actual pumping, which means groundwater mining could be worse than we are currently experiencing.
- Farming interests, which are currently using significant quantities of CAP water, could return to reliance on groundwater in future years, prolonging agriculture's use of groundwater beyond earlier projections. [*Update: Pinal Active Management Area agriculture is increasing groundwater pumping due to cutbacks of Colorado River water.*]
- Conservation programs are complex, and frequently water conservation targets are not being met or subject to challenges.
- Areas outside of Active Management Areas are growing rapidly and are facing water availability and management challenges.

In the near term, it is expected that some significant Indian water rights claims and the dispute between CAP and the federal government over CAP repayment and other matters will be settled. These settlements will reduce or eliminate some significant uncertainties that have impeded long-term water planning in certain parts of the State. [*Update: Though some Tribes have finalized water settlements since 2000, several water rights claims remain unresolved, and access to water remains an issue for many.*]

Many challenges to achieving state water goals, however, will not go away. Since its inception, the framers of the Act have argued that in 1980 a delicate balance of competing interests was achieved and, consequently, that efforts to amend the Act should be avoided. Yet the Act has been amended frequently, with the amendments often times being substantive and complex.

It is time to take stock of where are, where we are likely to head under current law, and where we believe some changes in course are desirable. If we wish to maintain and enhance our vibrant, growing economy as well as the property values of property owners, a comprehensive conversation on the Groundwater Management Act is the only prudent thing to do.

Epilogue and Call to Action

Have we failed? I think not, but there is much work to do. As I reflect, what is clear is that we must engage in realistic, comprehensive, and difficult conversations. Policies must be identified and debated so that we can adapt our water use practices. It is time for action on many fronts so that, 20 years from now and beyond, the residents of Arizona and the region will acknowledge the foresighted decisions made.

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Reflections: Commemorating World Water Day 2022, Part I

by Sharon B. Megdal
03/18/2022

On World Water Day, 2019, I published my first *Reflections* essay. The United Nations established March 22 as World Water Day in 1993 to raise awareness of global water challenges, including lack of access to water and sanitation. My introduction to World Water Day was in 2013, when after attending an international groundwater meeting in the Netherlands, I had the privilege of participating on the program of a major international gathering in The Hague celebrating World Water Day. The theme that year was International Water Cooperation. Subsequent themes have been Water and Energy, Water and Sustainable Development, Better Water, Better Jobs, Why Waste Water?, Nature for Water, Leaving No One Behind, Water and Climate Change, and Valuing Water.

This year's World Water Day theme is Groundwater, Making the Invisible Visible. This emphasis on groundwater is timely. A vital water resource for arid and semi-arid regions throughout the world, including Arizona, groundwater is under stress, as the **World Water Day Factsheet** notes:

- *Groundwater is being over-used in many areas, where more water is abstracted from aquifers than is recharged by rain and snow. Continuous over-use leads eventually to depletion of the resource.*
- *Groundwater is polluted in many areas and remediation is often a long and difficult process. This increases the costs of processing groundwater, and sometimes even prevents its use.*
- *In other places, we do not know how much groundwater lies beneath our feet, which means we could be failing to harness a potentially vital water resource.*
- *Exploring, protecting and sustainably using groundwater will be central to surviving and adapting to climate change and meeting the needs of a growing population.*

Water is Life! Everyone is a water stakeholder because everyone needs water to live. It is crucially important that people know where their water comes from and what challenges there may be to their water security. Some know first-hand what it is like to be water insecure on a daily basis. Others may experience water insecurity when there is a failure in the water delivery system or a contamination incident.

For many, groundwater is the key to water security. The WRRC houses many projects and programs that have contributed to increased understanding and awareness of groundwater resources. In a 2016 *Public Policy Review* (the predecessor to my *Reflections* series), titled "**Invisible Water**," I reported on multiple efforts to raise the visibility of groundwater. We also have published several studies and papers on **groundwater governance and management**, including the **2018 paper** "Invisible water: the importance of good groundwater governance and management." The **Transboundary Aquifer Assessment Program** is dedicated to the study of aquifers along the shared border between the United States and Mexico. In addition, WRRC conferences and webinars have underscored groundwater's importance to Arizona's quality of life, environment, and economy.

Programs to commemorate World Water Day through learning and dialogue have increased over the years. Such programs provide a great opportunity to highlight the status of groundwater resources and opportunities to improve upon its management. I am excited to be participating in multiple programs connected to World Water Day. Part II of this essay commemorating World Water Day will discuss these activities.

In closing, I wish to share that the pandemic is on my mind as I think of water and World Water Day. Two years into the pandemic, the world has changed in ways we could not have anticipated. Likewise, the condition of the Colorado River system, on which so many in the western United States depend, has changed more quickly than anyone expected. The Tier 1 cutbacks in Colorado River water deliveries to Central Arizona have heightened awareness of groundwater's importance. With deeper cuts on the horizon, it is imperative that we remain mindful of the need to be good groundwater – and all-water – stewards.

Part II will be published on April 1

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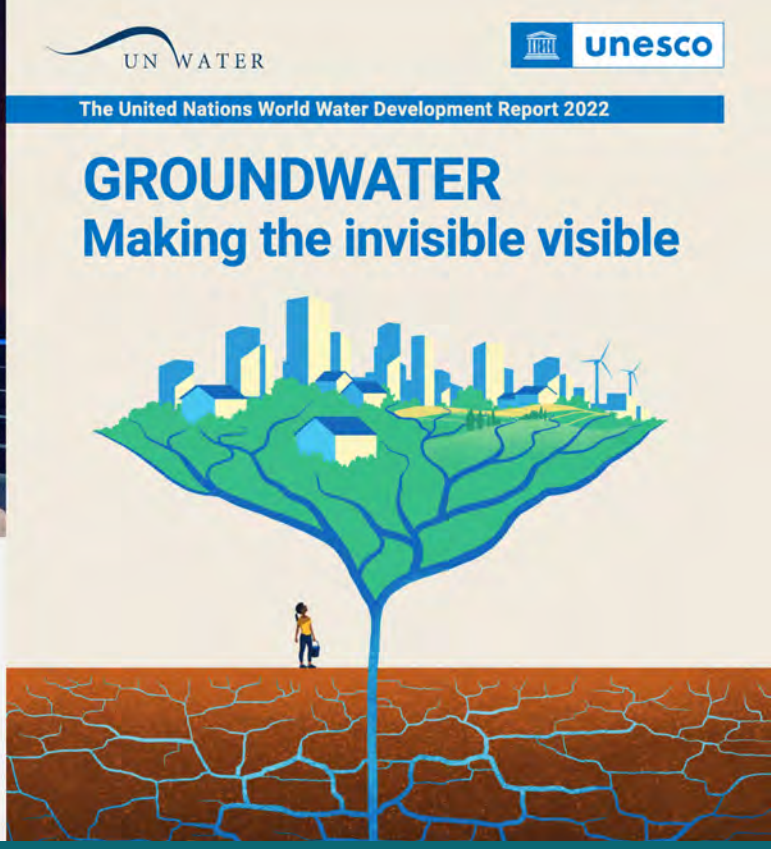

EXPO 2020 DUBAI UAE

Reflections: Commemorating World Water Day 2022, Part II

by Sharon B. Megdal
04/01/2022

In **Part I** of this two-part *Reflections*, I discussed how World Water Day is celebrated each year on March 22. The **2022 World Water Development Report** (WWDR), *Groundwater, Making the Invisible Visible*, was released by the United Nations the day before this year's celebration. The report is an almost 250-page document on everything groundwater. Though I had the opportunity to contribute to Chapter 8's discussion of groundwater in North America, I did not see the document until its release. As noted in the Preface by M. Miletto and R. Connor:

> *This latest WWDR is particularly unique: it is the first time that our report has focused on a specific element of the global water cycle – in this case, groundwater. In other words, the topic (or theme) of this year's report is more than just an angle or perspective through which to explore the role of water across various social, economic and environmental goals and objectives, it is about the resource itself. And more importantly, it concerns a critical freshwater resource that has remained 'under the radar' for far too long.*

This comprehensive volume will surely serve as an excellent reference on groundwater for some time. I highly recommend that people download it and keep it on their electronic bookshelves!

I had the honor of delivering keynote lectures at two international World Water Day 2022 programs held in Dubai. On this visit, my first to the United Arab Emirates, I participated in the three-day "International Conference on Water Resources Management and Sustainability: Solutions for Arid Regions," which was hosted by United Arab Emirates University in collaboration with the government of South Australia. Participants from 57 countries shared their knowledge and perspectives. Following a day of workshops in the Australian Dubai Expo 2020 Pavilion, the conference's opening ceremonies and keynotes were held at the Expo's Dubai Exposition Center. My keynote lecture, "Managed Aquifer Recharge in Semi-Arid Regions," explored how groundwater recharge is used in Arizona and similarly challenged regions throughout the world to achieve water management goals. In addition to listening to several excellent conference presentations, I participated in the post-conference site visit to Al Rafisah Dam in Khor Fakkan, Northern Emirates, where we received a briefing on United Arab Emirates' approach to harnessing stormwater. The conference discussions confirmed the commonality of water challenges faced by arid and semi-arid regions.

Field Trip to Al Rafisah Dam in Khor Fakkan, Northern Emirates, March 25, 2022. Photos: Sharon B. Megdal

Naser Alkatheri, Director of the Dams Department, Speaks with Field Trip Participants.

While in Dubai, I also had the opportunity to give the opening keynote at the World Water Day event held in Israel's Pavilion at the Dubai Expo. My lecture, "Addressing Water Scarcity through Innovation and Collaboration," framed some of the challenges arid regions face in the context of wicked water problems and included a significant focus on groundwater. I provided several examples of how collaboration, including efforts that cross jurisdictional borders, is necessary to identifying and implementing solutions. Indeed, both multi-day Dubai programs featured numerous examples of how collaboration and partnerships boost our capacity to address the profound water challenges of arid and semi-arid regions. They surely contributed to making the invisible visible!

With the assistance of technology, I was able to contribute to three additional World Water Day programs, two of which were close to home. As part of the WRRC's participation in the World Water Day **Teach-In** hosted by Pima County District 5 Supervisor Adelita Grijalva, I provided prerecorded introductory remarks on the importance of groundwater to the Tucson region. Groundwater awareness can be difficult because the resource is hidden from sight, but knowing where our water comes from is essential to being good water stewards. Educating the public on water resources is a key goal of the United Nations. Fostering dialogues among water professionals is another key goal. To this end, I was able to deliver prerecorded remarks at the AZ Water Association's annual Research Symposium, also held on March 22. I spoke to the assembled group of water professionals and researchers from throughout Arizona on collaborative research for water resilience, with a focus on good practices for university engagement in real-world-connected research.

My final World Water Day contribution was a prerecorded panel session aired by the English language television station (ILTV) based in Tel Aviv, Israel. I was one of four panelists interviewed during the **30-minute program**, "The Future of Water: Securing the world's future, one drop at a time." This program explored the ways in which research, technology, policy, and partnerships come together to identify pathways to water solutions.

A common thread through all these programs was the focus on solutions that address groundwater and other water challenges of arid and semi-arid regions. The news about climate and water resources is concerning. It is therefore essential that we work diligently to identify solutions and to foster greater understanding of the tradeoffs associated with different options. It will take all of us working together to ensure safe and reliable water for all; partnerships will be essential to furthering the water security of individuals and communities across the globe. It is tremendous that World Water Day brings greater focus on water matters and our responsibility to work toward water security every day – because everyone needs water every day.

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Spring 2022 Field Trip to Sweetwater Wetlands. (Photo by David Quanrud)

Reflections: Energized by Highly Engaged Students

by Sharon B. Megdal
05/27/2022

This Spring Semester I once again taught my graduate class, Water Policy in Arizona and Semi-arid Regions. Like last year, I had a good-sized seminar class, with 18 students, including two auditors. Unlike last year, we met in person, with virtual participation available for any student who could not attend class and for some guest speakers. Though it took some learning to deliver the class effectively in a hybrid setting, the dual platform for delivery enabled consistent participation throughout the semester. I do think this is the way future classes will be offered.

The three-unit class met Friday mornings for 2.5 hours. Because many people may wonder what a course in water policy is about, I share, here, the course expectations we go over at the first meeting.

Course Outcomes

- Interpret the role of regulation, institutions, and the legal framework for water allocation and use in determining the utilization of water across types of uses, geography, and time.
- Synthesize the complexities associated with developing and implementing water policies to address water challenges.
- Evaluate how policies and policy proposals meet public policy objectives.

Expected Student Outcomes

- Assess water policy and management challenges through class readings, discussions, and in-depth analysis of the research paper topic.
- Choose a water policy and/or water management strategy to serve as the subject of an individual research paper.
- Describe the context and appraise water management solutions through presentation and completion of the final paper on the selected paper topic.
- Explain your research paper findings and recommendations.

Also during the first class, I highlight the slide pictured. I regularly include this slide in presentations to diverse audiences. It enables me to underscore the importance of the many factors that determine water policy and management, especially those underlined. I also highlight the importance of context, especially that associated with the water cycle and geographic scale.

A key contributor to the student's grade is the work connected to their policy research paper. One of the challenges for students to produce a policy-focused research paper by the end of the semester is that, for many, this course is their first in-depth exposure to water policy – and often their very first exposure. Each student must select a topic, write a paper abstract, make a presentation, and submit a 5,000-to-6,000-word paper – all within a single semester. I require students to interview at least three experts as part of their research; those interviews must be fit into the semester as well. I learn from the students' papers, and the students learn from each other through the paper presentations, which are scheduled for the last two class meetings. Allowing time for 16 paper presentations, followed by Q&A, necessarily means that paper presentations are short. Presenting research topics and findings in 12 minutes is itself a challenging assignment. All did a great job!

Another key component of their grade is participation. I was very pleased with how engaged the students were throughout the semester. They took advantage of opportunities to ask thoughtful and informed questions of guest speakers, each other, and me. They walked with me to a meeting of the Ag 100, a group of leaders from Arizona's agricultural sector, to observe a panel discussion of some of the water issues the agricultural community is facing. I observed several students networking with members of the Ag 100 during the break. Due to the pandemic, I did not schedule the traditional field trip to multiple water projects in the Tucson region, but most students were able to participate in an optional Saturday field trip to Tucson Water's Sweetwater Wetlands. There we were joined by Dr. David Quanrud and a few of his students. Also joining us were two of my students from Spring 2021, when we were unable to meet in person for anything class related. At the following class, Tucson Water hydrologist Margaret Snyder joined us via Zoom to provide additional information and answer questions that neither Dr. Quanrud nor I could address. As can be seen from some of the photos, Sweetwater Wetlands is an excellent stop not only to learn about Tucson Water's approach to water reuse, but also to observe the region's plants, birds, and on that day, turtles!

Left to right: Sweetwater Wetlands Basin, Dr. David Quanrud, Resident Turtle. (Photos by Sharon B. Megdal)

I was truly energized throughout the semester by the students' intellect and inquisitiveness. I find it noteworthy that many of their papers included recommendations for more efforts to educate the public on the water issues they researched. The students recognized that there is much to be learned about water policy and, importantly, much to be gained from sharing information and insights about water challenges and possible solutions through broad-based public participation. I am gratified that, through this course, I have added to the students' understanding of water policy. Whatever their future careers, I hope they will reflect and draw upon this class to contribute to tackling the water challenges of Arizona and other semi-arid regions.

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Edible Farm at the Great Park in Irvine, CA (Photo: A.G. Kawamura)

Reflections: On Key Themes from the WRRC's 20th Annual Conference

by Sharon B. Megdal
07/22/2022

The Water Resources Research Center's annual conference, *Arizona's Agricultural Outlook: Water, Climate, and Sustainability*, was held July 12–14, 2022. This conference marked the 20th anniversary of our signature event, which is designed to share up-to-date information and insights on a water topic of importance to Arizona and the region. Though topics and locations have varied, the constant has been a conference program that offers a broad view to a broadly based audience.

Since 2020, the WRRC, like most other organizations, has taken advantage of virtual programming to keep our tradition going, and each of the past three years has been something of an adventure. In 2020, the COVID-19 shutdown occurred just a few weeks before approximately 400 people were scheduled to convene in Phoenix to explore *Water at the Crossroads: The Next 40 Years*. We adapted and delivered an all-virtual conference three months later. For 2021, we wisely followed our advisors' guidance by planning from the start an all-virtual conference, *Tribal Water Resilience in a Changing Environment*. Though COVID-related uncertainty abounded as we began planning this year's conference, we followed the advice of an engaged group of expert conference advisors and tried a hybrid format. A full day of in-person programming, with non-interactive live-streaming, was followed by two days of shorter, fully virtual and interactive programming. That we attracted over 600 registrants for each day, including more than 200 who registered to join us at the University of Arizona Student Union Memorial Center for the first day, suggests we achieved our objectives in terms of the platform for delivery. Importantly — and confirmed by comments we received during and immediately after the conference — we delivered a program diverse in terms of speaker experience, perspective, and geography. The agenda, along with session recordings and materials, can be found on the conference **website**, where you can also find bios for the 44 speakers and moderators, information about the many conference sponsors, and archived materials from past WRRC conferences.

The 2022 conference topic was selected shortly after last summer's conference on Tribal water resilience, where water security, food production, and traditional practices were discussed. Also in the summer of 2021, the U.S. Bureau of Reclamation announced the first-ever Colorado River Tier 1 shortage for 2022, signaling significantly reduced Central Arizona Project agricultural water deliveries to Central Arizona irrigators. Consequently, many questions arose about the outlook for agriculture in Arizona. Hence, the idea for our 2022 conference germinated.

The idea was to look at agriculture in Arizona through a wider lens than that associated with our 2017 conference on irrigated agriculture in Arizona. The goal was, in a limited timeframe, to consider the breadth of Arizona agriculture and its impacts, including large-scale and smaller scale agriculture, irrigated agriculture and ranching, traditional agriculture, new technology, research developments, rural community development, policy developments, and more. Of course, during our conference planning, we could not have predicted the June 14, 2022 announcement by Reclamation Commissioner Camille Calimlim Touton of what can only be described as gargantuan additional Colorado River cutbacks, nor could we have known the outcome of the 2022 Arizona legislative session. Due to poor Colorado River basin hydrology, cutbacks of between two and four million acre-feet will be required in 2023. These developments heightened the urgency of this discussion for many conference participants.


Conference Attendees (Photo: Clayton B. Lyon)

Given my own need to absorb and review the diverse experiences and excellent insights that were shared at the conference and the short length of my ***Reflections*** essays, I only attempt here to share some key conference take-aways in the form of a few key words and themes. The first is adaptation — of people, plant species, animals, the environment, you name it. To start the second day of the conference, moderator Kathy Jacobs provided some good definitions of (human) adaptation to climate change, and we heard about adaptation throughout the program. Another theme is partnership, including value of partnerships in incentivizing and researching the potential of new techniques and/or technologies. We can do much more together than individually. A third theme is the importance of acting with the younger generation(s) in mind; we must educate, encourage, and enable younger generations and remember to think and plan for generations not yet born. A fourth theme is community, remembering that communities can be large or small and based on geography, affinity group, culture, business relationships, or other characteristics. People connect to agriculture, ranching, and food production/preparation through different communities. The final theme I'll mention here is respect — respect for different experiences, cultures, and outlooks. The comments I heard during and since the conference indicate that respect for and recognition of the diversity of people and their perspectives are essential. There is much need to work together to address the significant water challenges Arizona and the region face. Working together is facilitated greatly by mutual respect.

During the conference, several speakers offered remarks that demonstrated optimism. Opening day keynote speaker A.G. Kawamura of Orange County, California, expressed optimism through his focus on the water in the partially-filled glass rather than the empty part. Indeed, many participants focused on opportunities in the face of water scarcity. The information, insights, and results they presented were not filtered through rose-colored glasses. They acknowledged that not everything tried will be successful, yet the general willingness to partner in order to adapt for the benefit of current and future generations was demonstrated throughout the conference.

I believe it is possible to maintain some optimism while dealing with the harsh reality of the imbalance between diminishing water supplies and growing water demands. I think some dose of optimism is healthy and perhaps even necessary if we are to discover pathways and implement solutions to the wicked water problems we face.

NOTE: Since the 2018 edition, the topic of the WRRC's annual *Arroyo* publication is connected to the prior year's annual conference. Find the recently published 2022 edition, *Water Resilience – Indigenous Perspectives*, and all past *Arroyos* **here**.

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Aerial view of the Colorado River, near Parshall, Colorado in September 2020. (Photo: Mitch Tobin, The Water Desk)

Reflections: The Colorado River Is Not Waiting

by Sharon B. Megdal
08/26/2022

The week of August 15 was full of news about the Colorado River. As announced by US Bureau of Reclamation Commissioner Camille Calimlim Touton in mid-June, Monday, August 15, was the deadline for the seven basin states to submit their proposal(s) for accomplishing the targeted two-to-four million acre feet of additional basin-wide cutbacks. The deadline passed without agreement among the states on a plan. On August 16, Reclamation released its **Colorado River Basin August 2022 24-Month Study**. Based on projected river conditions, a Tier 2a shortage was announced for January 2023. For Central Arizona, this means deeper cuts in water deliveries by the Central Arizona Project.

As would be expected, the news media were active, and I had the opportunity to speak with several outlets. I will not attempt to summarize the news of the week; instead, I refer you to the short summary **story** included in the Water Resources Research Center's August 19 Weekly Wave.

Regarding expectations, most stakeholders anticipated more on August 16 than Reclamation's declaration of a Tier 2a shortage, which follows from current regulations, specifically the **2007 Interim Shortage Sharing Guidelines** and the **Lower Basin Drought Contingency Plan**. The announced water delivery curtailments will be just 108,000 acre feet beyond the cuts that were effective in 2022. The split is as follows: 80,000 acre feet are cut from the Central Arizona Project; 4,000 acre feet are cut from Nevada; and Mexico's additional delivery cut is 24,000 acre feet. When asked about the millions of acre feet in cuts that Reclamation asked for in June, officials spoke about continuing to work with all Colorado River water users. No deadlines were announced by Reclamation, nor did the agency announce any refinement of the reduction target.

It's not surprising that the parties were unable to come to agreement on a plan in two months. The June request was unprecedented in terms of the size of water delivery cutbacks and the time frame for achieving consensus. Had Reclamation announced unilateral plans, as some were expecting, there likely would have been a rush to the courthouse(s). I thought Reclamation might have given an idea of their thinking, asking the states to provide feedback, but they did not.

Conditions are constantly changing. For example, back in June, the funding now available through the Inflation Reduction Act was not in the picture. Though most negotiations are occurring in private, public statements by some parties suggest acrimony. The situation reminds me of how dialogue in Arizona became tense and acrimonious several years ago, during the early stages of discussions that led up to agreement on the terms of the Lower Basin Drought Contingency Plan (DCP). It looked like relationships were falling apart in Arizona, but Arizona got its act together. The parties got back on track and came to terms, though not quickly.

Now, however, time is of the essence. Basin-wide, we must get our act together soon. The Colorado River is not waiting.

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Source: Global Strategy Document, Women in Water Diplomacy Network
Illustration: Radhika Gupta

Reflections: Connecting Globally at Stockholm World Water Week

by Sharon B. Megdal
09/09/2022

Stockholm World Water Week (WWW) is a highly regarded international conference, well known for bringing together diverse water experts from different parts of the world. This year's WWW theme was *Seeing the Unseen: The Value of Water*.

Speaking at valuing groundwater seminar.
Photo: Oudi Kgomongwe

I participated in part two of a three-part seminar on valuing groundwater organized by the Stockholm International Water Institute. Our session's focus was Innovative groundwater management: From the ground to the sky. Three experts in Australian water management, who are listed below, and I collaborated on the presentation, "Water Storage to Maximize Aquifer Value in a Changing Climate." Drawing from my co-authors' knowledge of the Murray Darling Basin and my own Arizona experience, we offered the following findings:

- Increased climate variability increases the value of water storage.
- Enhancing aquifer storage can be a cost-effective water security strategy.
- Technical studies and pilot projects are needed, as are new policies and governance frameworks.
- The Arizona Water Banking Authority is an example of securing water supplies (in part) for times of drought.
- Groundwater quality protection and improvement are possible, including when recycled water is stored in aquifers.
- The value of aquifers is maximized when they are used to store critical water supplies that sustain communities and the environment.

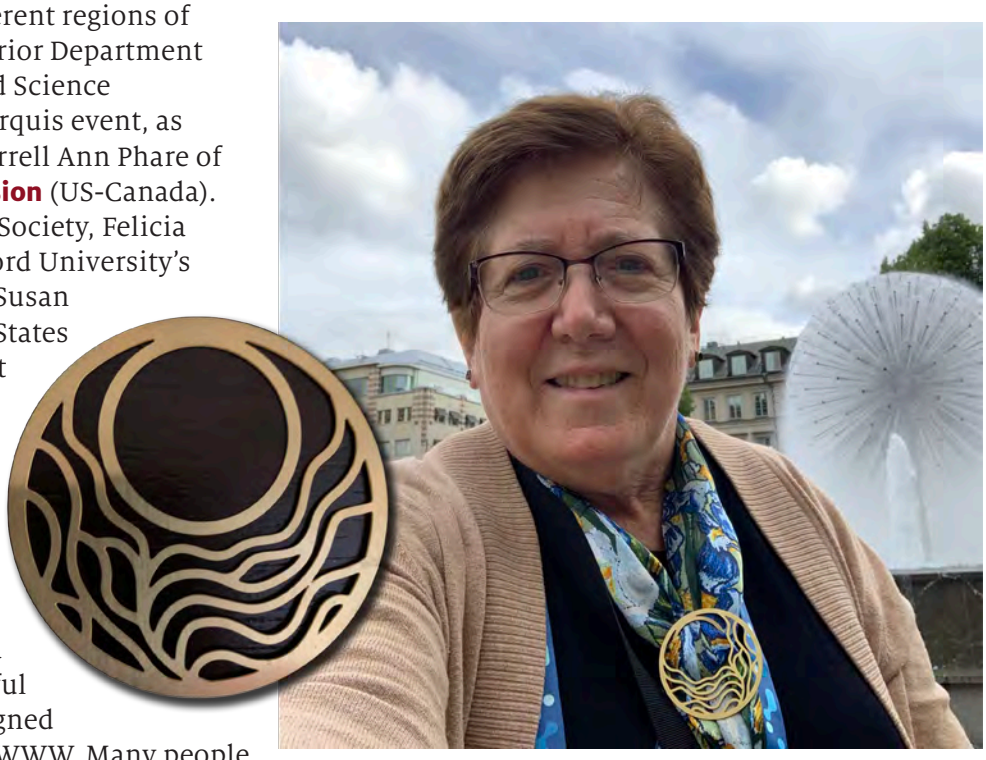
Our overall conclusion, drawn from our years of research and practical experience in groundwater recharge, was that there is great potential for aquifer storage, banking, and recovery to assist in meeting water policy goals globally.

World Water Week offers participants so many options that I faced hard choices in selecting sessions to attend. In fact, my session competed directly with the public award of this year's World Water Prize by Sweden's King Carl XVI Gustaf. I worried that no one would attend our session, but the room was almost full. Because the size of meeting rooms was limited, I found myself unable to find a seat in a few chosen sessions. The consolation was that, with all sessions livestreamed (and recorded), I could sit right outside the room listening with my earbuds. In person or by earbuds, I did attend some excellent sessions and would like to highlight some of my WWW experiences.

A key highlight was my participation in the Women in Water Diplomacy Network, which is an extension of the network formed for the Nile River Basin. It is so exciting to be included in this network as it expands into North America. The network held a two-day side meeting, culminating with the WWW release of the network's **strategy document**, *A Path Forward for Women, Water, Peace and Security: Women in Water Diplomacy Network Nile and Beyond Global Strategy 2022-2027*. The strategy includes five pillars:

1. Gender and Youth Empowerment in transboundary water decision making
2. Peer-to-peer Learning, Capacity Development and Experience Exchange
3. Research Cooperation
4. Linkages to basin, regional and global processes
5. Process Support (analysis; design, monitoring and evaluation; communications; and strategy and partnership development)

Released at the same time and included in the document was the 2022 Global Women in Water Diplomacy Network Joint Statement: 'A Rising Tide' of support for women in water diplomacy. This statement was read by representatives from the different regions of the network. Tanya Trujillo, Interior Department Assistant Secretary for Water and Science participated in the network's marquis event, as did Canadian Commissioner Merrell Ann Phare of the **International Joint Commission** (US-Canada). Jennifer Pitt, National Audubon Society, Felicia Marcus, Visiting Fellow at Stanford University's Water in the West Program, and Susan Daniel, Secretary for the United States Section of the International Joint Commission, also represented North America. Connecting to women – and men – from different parts of the world, all of whom are passionate about solving water challenges, was so meaningful. Network members and supporters made a huge splash by wearing a beautiful water-themed clip that was designed for the network and unveiled at WWW. Many people asked what it symbolized and where they could get one!



Water-themed clip worn by Women in Water Diplomacy Network members and supporters.

A second highlight relates to the emphasis throughout the conference on inclusive participation in water debates and dialogues. The session, "Thousands of Years of Lessons: Voices of Indigenous people," emphasized that Indigenous people must be involved in deciding their rivers' futures. Speakers underscored

the need for a systematic approach, full participation, capacity building, and intergenerational knowledge transfer. Another session, focused on Community Voices, involved the Australian Water Partnership. The Honorable Karlene Maywald, former South Australia Water Minister, whom I met last March in Dubai, facilitated some role-playing to address transboundary river water quantity and quality issues. As background, she summarized the Australian perspective on community and stakeholder engagement articulated by the Australian Water Partnership in **Community Voices – a Summary**. Because I think their six key principles for addressing water reform along with other water policies related to building water resilience, are universal and well-stated, I share them here:

1. Leadership: Create "leaderful" communities and commit to inclusive, transparent, and well-resourced engagement with a wide range of stakeholders. In "leaderful" communities, everyone involved can be heard, listen, and play a part in the reform process. Leadership is shared because the resource is essential to the lives and livelihoods of all.
2. Building Trusted Relationships: Provide a safe environment to build trusted relationships through exploration of values, culture, and conflict – people matter.
3. Clarity of Purpose: Provide clarity on the reform purpose, roles, responsibility, and accountabilities.
4. Problem Definition and Joint Discovery: Share power through knowledge exploration, problem definition and joint discovery of workable solutions.
5. Time, Flexibility, and Windows of Opportunity: Allow for flexibility in time and process.
6. Decision Making and Change Management: Demonstrate how decision making and reform implementation reflect the outcomes of the engagement process.

A final highlight relates to the value of in-person meetings where we can reconnect with people not seen for some time and meet others for the first time. While we have accomplished so much through virtual platforms, which enable us to work together without the monetary and time costs of travel, we must recognize that virtual interaction is not a perfect substitute for in-person experiences. I very much enjoyed my conversations over meals and in the hallways. I enjoyed seeing several representatives from Arizona and the U.S. speak about their exciting projects, some of which the WRRC has featured in Brown Bag webinars. Not surprisingly, I got some ideas for additional webinars while there! Most of all, I enjoyed the collegiality of interacting with and learning from so many people who focus primarily on working through partnerships to address significant water challenges.

Notes

My coauthors were Peter Dillon, CSIRO Land and Water and Flinders University, Australia, Declan Page and Dennis Gonzalez, CSIRO Land and Water, Australia, and John Ward, Mekong Region Futures Institute, Laos.

This **September 2, 2022 article** in *The Water Diplomat* provides a nice overview of the Women in Water Diplomacy Network.

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Land Acknowledgement

Solomon's Pillars, Timna Park, Israel.
Photo: Sharon B. Megdal

Reflections: Partnering to Address Food, Water, and Energy Security

by Sharon B. Megdal
11/18/2022

The Colorado River Basin's water and energy problems are well chronicled in studies and news reports. With the Colorado River's low flows extending more than two decades and drawdown of water from Lakes Powell and Mead, water in storage is at historic lows. Moreover, the system's hydropower is in jeopardy. Most critically, a "crash" of the system, wherein water would not flow below Hoover Dam, could be more than just a bad sci-fi story. Work is ongoing to develop a consensus strategy that, at the least, increases water delivery cutbacks substantially over those associated with the official 2007 federal guidelines for sharing shortage. Partnerships among stakeholders with diverse expertise, experience, and perspectives will be vital to restoring system security.

While situations vary across the globe, water insecurity like that in the Colorado River Basin is pervasive. Many people remain without access to electricity. Food insecurity, including threats to food chain reliability, has been magnified by the war in Ukraine and low flows in usually reliable river transportation systems. Growing populations and increases in income levels stimulate demand for more food at a time when the quantity — and quality — of water supplies is uncertain. Concerns about the availability of sufficient, good quality water apply both to surface water and groundwater. In response to these thorny and worsening challenges, work on identifying and implementing solutions to food, water, and energy insecurity is intensifying. My recent travels were related directly to this work and the global connections needed to meet these challenges and identify pathways to solutions.

My first stop was connected to the work of the Kasser Joint Institute for Food, Energy, and Water Security, a unique partnership of the University of Arizona, Jewish National Fund (JNF)-USA, and the Arava Valley in the South of Israel. After a three-year hiatus, the partners met in late October in Israel. An overarching goal of the Kasser Joint Institute is to assist communities in Africa and elsewhere address their food, water, and energy insecurities cost-effectively and sustainably. Since late 2019, researchers associated with the institute have explored the performance of agrivoltaic systems in varied climate, water, and crop conditions. Aquaponic research involving the growth of fish feed as part of fish farming systems is ongoing, as is study of off-grid, solar-powered water treatment. A team of Kasser Joint Institute volunteers and researchers traveled to Kenya this past summer to identify communities for cooperation. Despite the COVID-associated challenges, great progress was made. Joaquin Ruiz, UArizona Vice President, Global Environmental Futures, and I represent the University of Arizona on the Kasser Joint Institute Board of Governors. Professors Greg Barron-Gafford, Kim Ogden, and Kevin Fitzsimmons, along with UArizona Tech Parks Vice President Carol Stewart, joined the October meetings in Israel. A highlight

was the participation of Beth and Mike Kasser of Tucson at the October 24, 2022, institute dedication ceremony, which took place in Sapir, Israel.

During a few additional days in Israel, I met with many water colleagues, all of whom focus on managing scarce water resources in the face of growing demands. I saw the test fields of N-Drip, a company working with Arizona farmers, assessing the performance of gravity-fed drip irrigation. I met with researchers and drainage authority personnel concerned with flash flooding. I learned about agriculturally focused research and received an update on the continuing expansion of desalination in the region. In my lecture at a weekly seminar of the Porter School of the Environment and Earth Sciences at Tel Aviv University, I spoke about transboundary cooperation in the Colorado River Basin.

Agrivoltaics in the Arava Valley, Israel. Photo: Sharon B. Megdal

Immediately upon returning to the US from Israel, I participated in the first annual meeting of a USDA-funded project on groundwater-dependent agriculture in California's Central Valley, Arizona's Pinal County, and New Mexico. The host institution for the five-year grant is the Agricultural Water Center, established at University of California, Davis. The Center's vision is to alleviate groundwater overdraft and water quality deterioration in major aquifer systems and advance socioeconomic resilience through agroecological and technological innovations. In addition to connecting groundwater to production of food and fodder, the project is concerned with the health of communities that depend on agricultural activities. Many universities and government researchers are partnering in this project.

From Davis, California, I traveled to Boston, Massachusetts, to the annual conference of JNF-USA, where I shared information and insights related to water scarcity and food, water, and energy security issues through a keynote and panel remarks. The mix of conference attendees confirmed for me the value of interacting and partnering with interested stakeholders of varied backgrounds. I often say that everyone is a water stakeholder because everyone depends on water. The viewpoints of water users are important inputs to the water investment and policy decisions of those who decide; water users are decision maker influencers.

Boston was not the end of my travel itinerary. My last stop was the American Water Resources Association annual conference in Seattle, Washington, where I was joined by colleagues from UArizona. Our participation in this multi-faceted conference dealt with issues of diversity, equity, inclusion, and justice and water priorities of Indigenous individuals and communities. There is growing recognition that as we consider alternative solutions to food, water, and energy security, different situations and diverse perspectives must be considered and factored into decisions.

Dead Sea. Photo: Sharon B. Megdal

During these 2.5 weeks of travel, I had several opportunities to share my perspectives through presentations and panel remarks. In many instances, I invoked the wicked water problems framework, which highlights the complex nature of the problems we are working on. The imbalance between the demand for and supply of Colorado River water is a wicked water problem. The shrinking of the Dead Sea is another. We cannot guarantee solutions to the underlying problems, but we can work together to develop pathways to address the problems. Working together is the key. It will be through partnerships that respect differences in expertise, experience, and perspectives that we will make progress in strengthening food, water, and energy security.

Additional Info:

- **About the Kasser Joint Institute**
- **UC Davis Center, which includes info about the meeting / Presentations**

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Land Acknowledgement

Seine River, Paris. Photo: Sharon B. Megdal

Reflections: Thoughts at the Start of 2023 About Pathways to Water Solutions

by Sharon B. Megdal
01/06/2023

As reflected in past essays, I consider it useful to think about our serious water challenges as wicked problems. Wicked problems are complex, and addressing them can be complicated by factors such as poverty, climate change, and geopolitics. There is rarely a single solution to a wicked water problem; rather, pathways to solutions must be considered. Discussing our myriad water challenges in the context of wicked problems helps temper expectations that there will be quick fixes and explain that it will take much cooperation, study, and innovation, as well as resources (time and money), to tackle them. The complexities associated with finding solutions to wicked water problems were underscored at two December 2022 conferences I attended. The first, the United Nations (UN) Groundwater Summit, held in Paris, focused on groundwater-related aspects of achieving Goal 6 of the UN Sustainable Development Goals (SDG6): ensuring availability and sustainable management of water and sanitation for all. The second conference, held at Caesar's Palace in Las Vegas, was the annual meeting of the Colorado River Water Users Association (CRWUA), where the implications of low Colorado River flows and storage were discussed.

Key take-aways from both conferences were similar; we must consider all water sources, include climate change with our multiple supply issues, and account for different geographic levels in our search for pathways to solutions. For me, however, a major difference between the conferences was in the feelings they inspired. Let me briefly write about each.

The UN Groundwater Summit, held December 6-8, 2022, consisted of three full days of sessions. The key focus was on how groundwater will contribute to achieving SDG6. Knowing that many readers do not follow SDG issues closely, I provide the sub-targets for SDG6, most of which have 2030 as the achievement date:

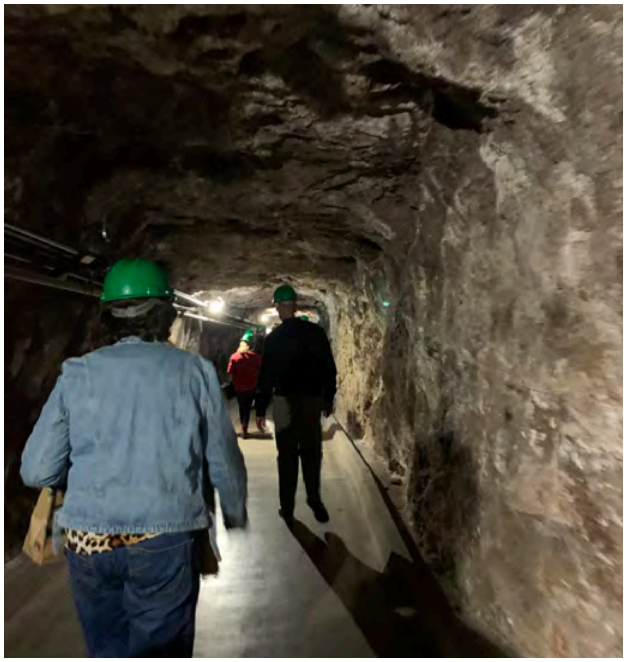
1. Achieve universal and equitable access to safe and affordable drinking water for all;
2. Achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations;
3. Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally;
4. Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity;
5. Implement integrated water resources management at all levels, including through transboundary cooperation as appropriate; and
6. By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes [and support capacity building in developing countries and local communities by 2030].

These are indeed worthy goals, for which indicators have been developed to monitor progress. The progress toward some goals, such as water use efficiency, is difficult to quantify. After a day that included three tracks of pre-sessions on topics relevant to groundwater and SDG6, the first day of plenary session focused on five foundational elements for achieving the targets: (1) data and information, (2) capacity development, (3) innovation, (4) finance, and (5) governance. These are universal elements to addressing wicked water problems. The final day focused on regional challenges and solutions, including those of Africa and transboundary aquifers, reminding us to consider geographic scale in generating solutions. This last day also had a session devoted to strengthening the science-policy-practice interface and another focused on a recently formed global Groundwater Youth Forum. Youth Forum member and UArizona graduate student Joseph Fickett and I served as reporters for the session on transboundary aquifers. (Joseph graduated a week after the conference with an MS degree in Water, Society, and Policy.) There was commonality in the messaging by governmental representatives and other experts in their presentations and commentary. Messages related to quantifying and/or characterizing the challenges, identifying the players who must be involved in identifying and implementing solutions, and removing obstacles to forging the pathways toward achieving the goals. An overall summary of the conference is expected to be released before the March 2023 UN Water Conference. A key objective of the UN Groundwater Summit was to develop strong messaging on the role of groundwater quantity and quality in meeting global water needs. The March conference, which will be held at the UN in New York City, will be only the second UN Water Conference to be convened. The first was held in 1977 in Argentina.

Youth Forum member and UArizona graduate student Joseph Fickett and WRRC Director Sharon B. Megdal participate in Transboundary Aquifers session.

This year's well-attended CRWUA annual conference had the theme, "The Colorado River Compact – 100 years & beyond." I expect most there would have appreciated a more celebratory mood at the Colorado River Compact centennial, but river conditions did not allow for celebration. The first-day colloquia were on "Messaging in a More Water-Challenged World" and "Adapting to the New Normal: Trying Technology and Tools." The morning sessions on the first full day included varied perspectives from the Colorado River Basin, and the afternoon's concurrent sessions focused on funding, trade-offs and turbulence, collaborative options, and how companies are adapting to a drier future; clearly not cheerful topics. The final morning of the conference featured the messages of federal officials from Mexico and the US. No one could avoid talking about the seriously challenging river conditions. It was impossible to overstate how much work is required to address the current threats to water supply and power generation. There is no time to lose. At the conference, an end-of-January deadline was established by Bureau of Reclamation Commissioner Camille Calimlim Touton for the seven basin states (Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming) to come up with a plan to reduce water deliveries by millions of acre feet—substantially greater reductions than the Tier 2a deliveries that became effective January 1, 2023. If no plan is presented, unilateral federal action was promised. Though when a prior deadline was missed in August 2022, the Department of Interior did not announce unilateral action, it is clear that action must be taken in 2023 to have a chance at maintaining reliable water and hydropower deliveries. Whether the parties to state-level deliberations can come to agreement to feed into a basin-level agreement in the short time available remains to be seen. Though a series of storms is hammering the West as I write this, the reader must remember two truths: (1) one good winter will not provide relief from years of low Colorado River flows and reduced storage; and (2) in past years, run-off from precipitation has been much lower than expected due to high springtime temperatures and dry soil conditions. (See Jim Prairie's excellent CRWUA presentation, which can be found starting at about two minutes into

the session **video**, with the slides available **here**.) Reclamation's ongoing formal consultations on changing dam operations and redoing the shortage sharing regulations continue, as do related consultations with Native Nations. The variety and intensity of necessary efforts are daunting. Reclamation Deputy Commissioner of Operations David Palumbo made a point about policy I heard mentioned in later hallway conversations. Palumbo noted that, as with the concept of hydrologic non-stationarity (made famous by the 2008 Milly et al. **paper**, "Stationarity Is Dead: Whither Water Management?"), policy can no longer be considered stationary. New policies are necessary to address an unprecedented situation.



Inside Hoover Dam. Photo: Sharon B. Megdal

Though the sessions were informative and stimulating, I am glad I was able to take an organized side tour at each conference. A visit to the Paris Sewer Museum, which explains the system of collecting Paris' wastewater, reminded me that good engineering can endure for years. Similarly, a visit to Hoover Dam provided evidence of the amazing engineering that resulted in construction of the colossal dam, which became operational over 85 years ago. However, while Paris' wastewater flows abundantly, low water levels at Hoover Dam's intake towers starkly remind us of the implications for water deliveries and power generation.

Lake Mead and Hoover Dam. Photo: Sharon B. Megdal

The sense of serious purpose in facing the critical issues at both conferences was palpable. Though people seemed to understand that the SDG6 target and sub-targets will not be fully achieved, they also expressed an understanding that tenacity and hard work can result in significant progress toward relief from the dire individual and community consequences that come with lack of access to water and sanitation. The sentiment at CRWUA was urgency; the hard work of reducing water deliveries to avoid an impending large-scale calamity is needed now. Of course, there will be burdens associated with reducing water deliveries, but there is no choice. Yet, along with the somber messaging at CRWUA, we should remember that we have options. Some have access to other water sources, and efforts are underway to augment supplies. In addition, there are opportunities on the demand side of the equation to adapt by reducing water consumption.

Over the years, in many of my lectures, I have pointed to the half-full glass of water and noted that the portion of the glass I focus on depends on whether my mood is optimistic or pessimistic. When addressing wicked water problems, I prefer to focus on the half-full portion, though the Colorado River storage system, admittedly, is now only about one-quarter full. My reasoning is that we will need optimism, globally and regionally, to get us through the difficulties associated with finding pathways to solutions for our wicked water problems.

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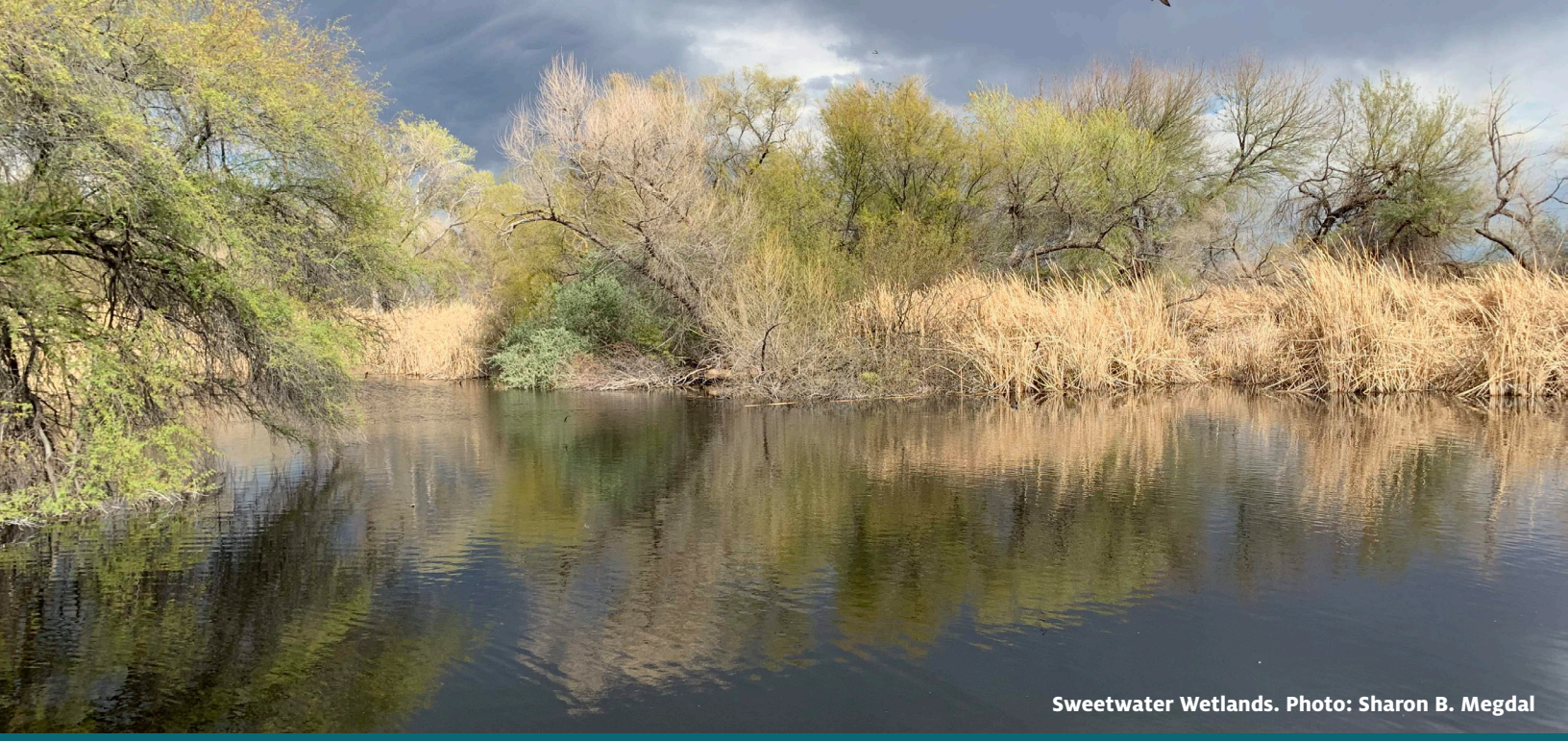


Sweetwater Wetlands. Photo: Sharon B. Megdal

Reflections: A Cloudy Day at Sweetwater Wetlands

by Sharon B. Megdal
02/24/2023

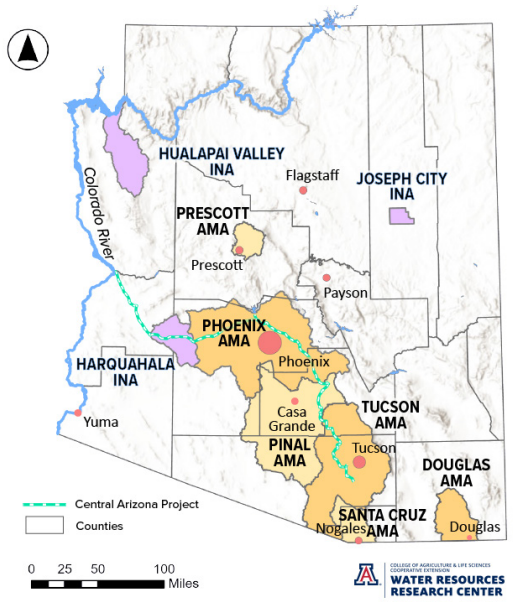
Graduate students in my "Water Policy in Arizona and Semi-arid Regions" class visited the **Sweetwater Wetlands** on Saturday, February 11, 2023. We were joined there by Professor David Quanrud and students from his "Wildland Water Quality" class. A visit to the wetlands is always a helpful addition to classroom discussions and readings. There we can see how treated wastewater is recharged and reclaimed for reuse and benefits the environment. Open to the public, it is a hidden gem and worth a visit. We visited the Wetlands on a cloudy, somewhat gloomy morning. Clouds often contribute to interesting photos, and the reflections of the clouds in the water led me to write this essay.

These can be considered gloomy times when it comes to water. Bluntly stated, the Colorado River system, which has supplied over 35% of Arizona's annual water use, is in crisis. Regardless of what you call it — long-term drought, climate change, or aridification — annual Colorado River flows over the past 20+ years have been lower, and sometimes much lower, than the long-term average. On top of that, allocations to the Lower Basin states of Arizona, California, and Nevada exceed what could be expected of the Colorado River even in better times. Despite this, we have not reduced our use of Colorado River water to be in balance with what Mother Nature provides. Instead, we have been living off our water supply savings by drawing down Lake Mead, the largest surface water reservoir in the United States. Our savings are now depleted, and the prospects for replenishing the reservoir any time soon are low. The immediate collective goal is to avoid a crash of the system; that is, to avoid losing the ability of the system to generate hydropower and deliver water downstream of Hoover Dam. Achieving this goal will require significant cuts in water deliveries to prevent water storage in Lake Mead and Lake Powell, the other large Colorado River reservoir, from declining much more. That the seven basin states have been unable to come to agreement as to how to spread the burden of large water cuts is not surprising. Unprecedented and painful actions are required. However, we do not have the luxury of time, even with better-than-average precipitation this winter. Action must be taken. Legal wrangling, which is a concern but may be difficult to avoid, will not produce water. **The Colorado River is not waiting**.

Unfortunately, this is not the only water challenge Arizona faces. Groundwater, another major Arizona water supply, is also highly stressed. Groundwater, which is relied upon to meet over 40% of Arizona's annual water needs, has been used in amounts that exceed what is being replenished. Groundwater overdraft led to adoption of the 1980 Groundwater Management Act, yet it continues both within the Active Management Areas (AMAs), which are subject to groundwater management, and outside them, where there is no effective groundwater management.

Overdraft led the Arizona Department of Water Resources (ADWR) to halt certifications of assured water supply for groundwater-dependent development in two rapidly growing areas — the Pinal AMA and the Lower Hassayampa Sub-basin (Buckeye area) of the Phoenix AMA. In December 2022, ADWR declared the Hualapai Valley Groundwater Basin in Northwestern Arizona a new Irrigation Non-expansion Area (INA), meaning irrigated acreage cannot expand over what was historically irrigated. And though voters in the Willcox area rejected formation of an AMA there, voters in southeastern Cochise County approved formation of a new AMA for the Douglas Basin.

Note that estimates of dependence on Colorado River water and groundwater are statewide averages. Reliance on water sources varies across Arizona; therefore, the water situation varies across communities and regions. (Water source dependence is pictured on **an inset** to the WRRC's water map poster.) Nevertheless, it's fair to say that water challenges pervade Arizona.



Active Management Areas (AMAs) and Irrigation Non-expansion Areas (INAs).

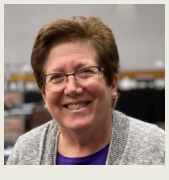
The level of awareness of these challenges is increasing. People in Arizona, along with researchers, students, and media from across the world, want to know about the solutions. They are asking what they as individuals, along with what their communities, can do. They want to know what options are being considered by whom. This is a hopeful sign, as broad involvement in examining the implications of alternative pathways to solutions is critical.

Though clouds remain, there are options to pursue. Recently, I had the opportunity to be interviewed on **Science Friday**. I was asked by host Ira Flatow about possible solutions. In the limited time I had, I mentioned several, many of which I have **previously written about**: conservation, more efficient use of water, water reuse, other water augmentation such as desalination, moving water, marketing and other mutually agreeable exchanges, rainwater and stormwater capture, and changes to how we design our buildings and communities. Ira asked me about the cost of some of these options. Indeed, costs for implementation of the solutions can be very high, and the water users must pay. Water pricing, not mentioned in the radio interview list, is a key determinant of water use and a huge topic of its own. Options such as desalination or moving water to Arizona from a far-away basin may be expensive and/or seem far-fetched, but many agree that they should be evaluated. What is critical to making sound decisions and investments is to evaluate the many options in terms of water yield (the extent to which they reduce the imbalance in supply and demand), costs, time frame, regulatory hurdles, and public acceptance. Careful analysis must be conducted and broadly shared. Public acceptability is very important. As water users, we all have a voice in this, and we all are decision-maker-influencers, meaning we can influence the associated political debates.

At the end of the interview, Ira asked: Was I feeling optimistic that we are up to the challenge? Though I have sometimes been criticized for sounding too optimistic, I noted that I believe we must be optimistic collectively to bring all the people together to develop the pathways to solutions. If we have a pessimistic mindset, it will be difficult to do the hard work required of so many.

Sweetwater Wetlands Field Trip. February 11, 2023.

Back to the Saturday morning at Sweetwater. Though it was a somewhat gloomy morning, clouds bring us much-needed precipitation. Indeed, that Saturday morning filled with clouds was a good morning. Being surrounded by bright students who will help shape our future contributes to my feeling optimistic that we will get the hard work done.



Sharon B. Megdal, Ph.D.
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Science Friday Feature on Western Water Infrastructure

Reflections: Today Is World Water Day!

by Sharon B. Megdal
03/22/2023

Greetings from New York City and Happy **World Water Day**! Today is the official start of the **UN 2023 Water Conference**, the first water conference convened by the United Nations in almost 50 years. Thousands of participants have gathered to commit to strong actions to address water issues at all scales across the globe. It is recognized that advancing achievement of **Sustainable Development Goal 6** — clean water and sanitation for all — requires actions on the part of each one of us.

Registration for the conference was not open to individuals. Instead, NGOs, universities, and others had to apply for accreditation to participate. UArizona's accreditation enabled the participation of eight registered delegates, who all arrived in New York City eager to participate. The UArizona delegation members include Colorado River Indian Tribes Chairwoman Amelia Flores, Gila River Indian Community Governor Stephen Roe Lewis, UArizona Professor and Director of the Udall Center for Studies in Public Policy Andrea K. Gerlak, UArizona graduate student Wilzave Quiles Guzmán, Colorado River Basin Water & Tribes Initiative Co-Directors Matt McKinney and Daryl Vigil, UArizona alumna Elia Tapia, and yours truly. It is great to be at the conference with UArizona colleagues and partners, including former UArizona Extension Agent Josh Moore, who now works as Farms Manager for his home community, the Colorado River Indian Tribes.

Prior to the formal three-day conference, several of us participated in the all-day March 21 **Water Diplomacy Symposium**, where the discussion focused heavily on the need for inclusive and equitable consultation and engagement. We explored issues related to Indigenous communities, gender, income, and age, with a very strong focus on shared waters. Empowering ourselves was an important theme, whether it be through sharing of data and information, perspectives, and/or practices. Dialogue through the breaks was robust, and many new friendships were made. The Women in Water Diplomacy Network was the key convener. The network's signature clip will be worn by many throughout the UN Water Conference.

Women in Water Diplomacy Network Clip

World Water Day activities officially started for me at midnight, when I delivered via Zoom the keynote lecture, "Taking action to change the ways we use, consume, and manage water," for the Water Research Center at Sultan Qaboos University.

My World Water Day continued with the afternoon side event session at the UN, **The Role of Indigenous People in Governing Shared Waters**, which was co-convened by the Water & Tribes Initiative | Colorado River Basin and the WRRC. We were honored that U.S. Department of Interior Secretary Deb Haaland delivered inspirational comments to lead off the session. Observing that water security depends on good water stewardship, she noted that a more equitable water future depends on respect, integrating Indigenous knowledge, and putting words into action. Indeed, the featured speakers from the Colorado River Basin and other parts of the world inspired attendees to recognize that working through respectful partnerships is essential.

Of course, there is great excitement associated with the conference and related events, which are occurring at the UN and all over New York City. Though everyone realizes that action is necessary and commitment statements are being developed, only time will tell if the commitments to action translate into improved water and sanitation conditions.

I'll end this Reflections — more to follow via the WRRC's ***Weekly Wave*** newsletter and through our **March 28 webinar** about the conference experience — with how I ended my lecture for Sultan Qaboos University's celebration of World Water Day: Let's all act to improve!

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The University of Arizona

Near Nogales International Wastewater Treatment Plant, Rio Rico, AZ. Photo: Sharon B. Megdal

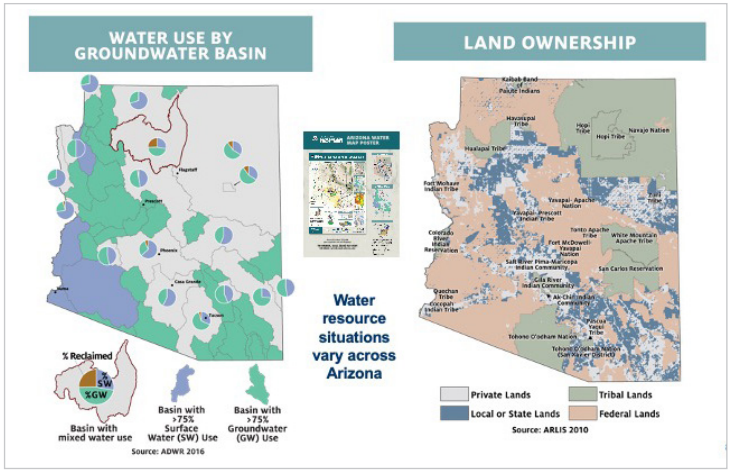
Reflections: On a Busy Spring

by Sharon B. Megdal
07/07/2023

It is July, more than three months since my last *Reflections*, which was written from the UN Water Conference on World Water Day. The reason for the gap: an overabundance of work-related activities. Teaching, project work, engagement and speaking activities, media interviews, and more have kept me very busy.

Informing audiences of many kinds about our water situation has always been meaningful for me. Interest in understanding the complicated and uncertain implications to Arizona of low Colorado River flows has never been higher. Groundwater issues are of heightened interest as well. Whether the audience consists of students in my graduate course "Water Policy in Arizona and Semi-arid Regions," community groups, conference/workshop attendees (including international), and/or the media, it's always necessary to provide sufficient context and nuance. Though I have been complimented for explaining complex water issues concisely, I find it increasingly difficult to deliver quick summaries and explanations. Uneven impacts across geographic regions, across jurisdictions, and across and among water using sectors make generalizations impossible. Two examples drive this home.

The first relates to the impacts of Colorado River cutbacks. Statements like "Arizona's priority is junior to that of California" and "deliveries of Colorado River water to Arizona agriculture have been cut" must be corrected. While it is true that Central Arizona Project (CAP) water is junior to California's Colorado River water deliveries, not all Colorado River water used by Arizona entities and jurisdictions, including Native Nations, is junior to California's. Moreover, within the Central Arizona Project's three-county service area (Maricopa, Pinal, and Pima Counties), different water-using groups have been assigned different priorities, with agricultural CAP water deliveries generally assigned low priority. Outside of the CAP service area, agriculture may have high priority water rights. Many audiences, including news media from across the world, need assistance in understanding these complexities. More than ever, I am spending considerable time providing background. Showing maps can help, so I often use maps of water use and land ownership from the WRRC's **Water Map Poster** to drive home the point that situations vary considerably across Arizona.



Selected maps from the WRRC Arizona Water Map Poster

The second example relates to the early June release by the Arizona Department of Water Resources (ADWR)

of its new groundwater model for the Phoenix Active Management Area (AMA). ADWR's online **Phoenix AMA Groundwater Supply Updates** page states: "In keeping with these findings of unmet demand [for groundwater], the State will not approve new determinations of Assured Water Supply within the Phoenix AMA based on groundwater supplies. Developments within existing Certificates or Designations of Assured Water Supply may continue, but communities or developers seeking new Assured Water Supply determinations will need to do so based on alternative water sources." Unpacking this statement requires a great deal of background knowledge. In addition, it is critical to recognize that ADWR's pronouncement, with its unprecedented and serious implications, has uneven application across the many cities and towns in the Phoenix AMA, depending on the local water source(s) and Assured Water Supply status. When media representatives indicate that they only need 10 minutes of my time for an interview on this type of complex topic, I suggest more time will be needed — because it is.

These are just two examples of the complicated water matters that more people of more varied backgrounds want to understand. Further, our constantly changing circumstances make my educational and engagement activities ever more challenging!

My research projects likewise connect to surface water and groundwater challenges. I am working on the Arizona portion of a multi-state **USDA-funded project** that considers the long-term situation of irrigated agriculture in the Southwest. The Arizona team's focus is on the Pinal Active Management Area, where water use remains predominantly agricultural. Farmers there have experienced large cutbacks in surface water supply. Even before the Phoenix AMA model report was released, ADWR's Pinal AMA groundwater model revealed a significant deficit of groundwater availability in that AMA when compared with projected groundwater use. The agricultural sector's responses to surface water supply cutbacks—substitution of groundwater and land fallowing—have negative implications for the groundwater deficit and agricultural sustainability. Complexities abound. With decisions to be made over the short, intermediate, and long terms, identifying potential future scenarios is challenging.

Up to now, our work on characterizing the groundwater situation for selected aquifers along the Arizona-Sonora border through the **Transboundary Aquifer Assessment Program** has focused mostly on the hydrogeologic system's physical aspects. Looking forward, we intend to characterize socioeconomic aspects of water use as well. Especially difficult to predict in a transboundary setting, the impacts of changing groundwater conditions due to changing climate on communities largely or fully dependent on groundwater require elucidation.

I often say that everything I do professionally is interrelated, and this is certainly true when it comes to my current board, commission, and council memberships. I serve as one of two University of Arizona representatives to the six-person Board of Governors for the Kasser Joint Institute for Food, Water, and Energy Security. University of Arizona researchers have been working with researchers based in Israel's Arava Valley to advance the application of aquaponics and agrivoltaics in regions facing food, water, and/or energy insecurity. Over the past six months, I have served as one of 10 members of University of Arizona President Robbins' Advisory Commission on the Future of Agriculture and Food Production in a Drying Climate. The Commission's report, which is nearing completion after six months of work, identifies threats and potential solutions to maintaining and increasing food production in Arizona and other arid regions. Looking forward, it highlights opportunities to expand existing efforts and develop new programs and partnerships to address the serious global challenge of producing more food with less water. Finally, I have the honor of serving on Governor Hobbs' Water Policy Council, which was established by **Executive Order**. The charge to the **Governor's Water Policy Council** (GWPC) is "to analyze and recommend updates, revisions and additions to the GMA [1980 Groundwater Management Act] and related water legislation, which shall include, without limitation, analysis and recommendations for groundwater management outside current Active Management Areas." To meet Governor Hobbs' end-of-year deadline for recommendations, GWPC members divided into two committees. The first is focusing on the **Assured Water Supply Program**. The second committee, on which I serve, is focusing on rural groundwater, which is largely unregulated. For the work of these committees, time is of the essence.

As I reflect on how quickly the first half of 2023 has gone by and the increasing intensity of the efforts of so many to work on solutions to our unprecedented water challenges, I suspect that the rest of 2023 will go by in a flash. Though the amount of work is daunting, I look forward to it!

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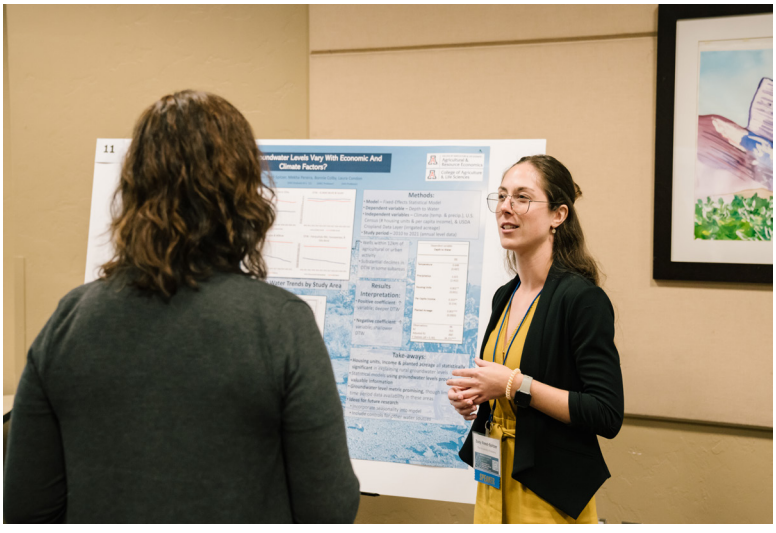
Conference Panel on Adapting Policy. Photo: Clayton B. Lyon

Reflections: On Annual Conference Key Themes – and Questions About 2024

by Sharon B. Megdal
08/04/2023

The WRRC's 2023 Annual Conference, held in mid-July, tackled this key question: What can we do to address Arizona's water challenges? We developed the agenda differently in that we solicited abstracts for presentation. We did not want to presume we knew the solutions to be featured. Combining proposed solutions with some invited presentations resulted in a packed two-day agenda filled with a variety of speakers and solutions.

As I sit looking at the Pacific Ocean during my annual escape from Tucson's summer heat, the role of seawater desalination in meeting water demands comes to mind. Particularly in freshwater-scarce regions like Israel and United Arab Emirates, desalinated seawater is critical to meeting water needs. Though mentioned at the conference, discussion of how seawater might fit into Arizona's solution set was limited. Perhaps this should not be surprising. After all, Arizona does not border a sea or ocean. And seawater desalination is only one of many options. Over the two days of robust presentations and discussions, it was apparent that many solutions to addressing the numerous challenges must be pursued simultaneously. There is no single solution.


Conference poster presenter Zoey Reed-Spitzer. Photo: Clayton B. Lyon

We were honored to have University of Arizona President Robert C. Robbins open the conference, mentioning the forthcoming report of his Commission on the Future of Agriculture and Food Production in a Drying Climate. Sessions covered proposed solutions for a broad range of challenges, including water quality, information gaps, improving farming practices, managing groundwater, utilizing stormwater, adapting policy, growing the water workforce, technological innovation, and financing opportunities offered

through the Water Infrastructure Financing Authority of Arizona. Speakers also provided information and insights on responses to the Colorado River shortage, Tribal consultation and solutions, portfolio-based approaches to meeting water demands, and Arizona State University's water innovation initiative. In addition, more than a dozen presenters participated in the second day's poster-networking session. The full agenda, along with recordings of oral presentations, has been posted on the **WRRC 2023 Annual Conference web page**.

Networking with sponsors. Photo: Clayton B. Lyon

Aside from specific solutions, I picked up on two key themes that permeated speakers' descriptions of programs and processes for moving forward: partnerships and inclusivity. Concepts related to partnerships rang through the two days. Many spoke to the cooperation and consultation required to get feasible solutions on the table and the buy-in needed for implementation. Inclusive consultation and involvement are key, but inclusivity was highlighted in a different context as well. Several speakers mentioned the need to reach out to those not typically or historically part of the conversation and to make sure programs and resources reached underserved communities and individuals. Speakers underscored that we are in this together. It will take individual and collective actions to address the challenges and adapt as conditions change. Solutions will need to be thoroughly vetted through inclusive processes and considerations, and it is important that we do not leave people or communities behind.

It is gratifying that we received much positive feedback about the conference, including praise for the opportunity it afforded to hear diverse perspectives and to engage in informal discussions. Yet, we all realize there is much work to do as we continue contributing to the dialogue through our ongoing applied research, community and individual engagement programs, and education efforts. And there is the 2024 Annual Conference to plan. It is in the context of our conference planning that I'd like to ask you about next year's conference, whether or not you attended this year's conference and/or **past conferences**. Would you like to see next year's conference focus again on solutions, with a call for abstracts? Or is there a different topic we should address? Please send your thoughts to me at **smegdal@arizona.edu** and, if not already subscribed, sign up for the **Weekly Wave**, WRRC's e-news digest, to hear about our plans and programs.

Would you like to see next year's conference focus again on solutions, with a call for abstracts? Or is there a different topic we should address? Please send your thoughts to me at smegdal@arizona.edu

We partner with many to deliver our annual conference, the WRRC's signature event. I thank our presenters, sponsors, conference advisory committee, and in-person and Zoom attendees from so many communities, states, and countries for participating. I thank the staff, students, and volunteers who are essential to delivering a smooth experience. I thank all who engage with us and look forward to continued engagement in working toward solutions to the water challenges of Arizona and beyond!

Sharon B. Megdal, Ph.D.
Director, Water Resources Research Center
The University of Arizona

Scan this QR code to check out all Reflections

(L to R) Aana Edmondson, Camille Calimlim Touton, Lorelei Cloud, Daryl Vigil, Sharon Megdal, Michelle Brown-Yazzie, Erina Watene, Leslie "Phil" Duncan

Reflections: Respect, Responsibility, Reciprocity, and Relationship

by Sharon B. Megdal
09/01/2023

I recently returned from attending **Stockholm World Water Week** (WWW), the annual international water conference organized by the Stockholm International Water Institute (SIWI). Always an excellent conference, this one stood out for its heightened focus on Indigenous water knowledge, experiences, and communities. There had been some inclusion of Indigenous voices in last year's WWW. In fact, it was there that I met Australian hydrologist Brad Moggridge, who gave a **WRRC webinar** in early 2023. However, noting the limited Indigenous presence in 2022, some colleagues engaged in some cross-continental brainstorming on session ideas, resulting in multiple Indigenous-focused session proposals that were accepted for the 2023 program. The Colorado River Basin was featured in the session "Indigenous Voices in Water Governance," which was co-convened by the Water & Tribes Initiative | Colorado River Basin, the Lincoln Institute of Land Policy, and the WRRC. More about our session in a moment.

The conference's Monday opening session keynote by Dr. Milika Sobey, an Indigenous Fijian marine scientist, set the stage. In her eloquent remarks, Dr. Sobey spoke about the connectivity between people and nature and the need to look at the marine system holistically. She pointed to the benefit of combining scientific rigor with traditional practices, a concept similar to **two-eyed seeing**. The **Vanua** core values she articulated – respect, responsibility, reciprocity, and relationship – were foundational to later discussions. Connecting the need for innovation to this year's WWW theme, "Seeds of Change: Innovative Solutions for a Water-Wise World," Dr. Sobey reminded the audience that management is of people and their actions, rather than of the water. We can attest to that in the Colorado River Basin!

Milika Sobey

Our Tuesday afternoon session fit in well with Dr. Sobey's four Rs, respect, responsibility, reciprocity, and relationship. Our session lived up to its description: *This session will bring to the WWW stage tribal leaders in the hydrologically stressed Colorado*

River Basin, Australia, and New Zealand, along with a key federal official from the United States. Collectively, Native Nations in the United States hold rights to a substantial portion of Colorado River water, but some await quantification of water rights and/or construction of infrastructure to deliver water. With an estimated 40 million people relying on Colorado River water, the challenges are significant. This session on Indigenous water governance will focus on the local and larger scale issues associated with climate change and demand-supply imbalance. Elevating indigenous voices will forge new ways of thinking and acting together as a community. This session will highlight innovations in water governance and management, along with new approaches to consultation and inclusion. It will create opportunities for exchange with other Indigenous peoples at the session and throughout World Water Week.

Inger Axiö Albinsson

We started the session with an acknowledgement to the Sami people and the Sami lands of Stockholm by Inger Axiö Albinsson of the Stockholm Sami Association. Although many are now accustomed to land acknowledgements that express respect and recognition of the Tribal lands on which we live and work, this was a new experience for Ms. Albinsson, who spoke from the heart. From the Colorado River Basin, Daryl Vigil (Co-Director, Water & Tribes Initiative), Camille Calimlim Touton (Commissioner, U.S. Bureau of Reclamation), Michelle Brown-Yazzie (Assistant Attorney General, Navajo Nation Department of Justice), and Lorelei Cloud (Vice Chairman, Southern Ute Tribe) shared their experiences and knowledge, along with their water challenges. Leslie "Phil" Duncan (University of Canberra), Erina Watane (Waikato River Authority), and Aana Edmondson (Sami Youth Organization) added their insights. There was time for audience questions and closing comments. The feedback about the session was positive; there was enthusiastic response to the sharing by and learning from the speakers.

The enthusiasm for sharing and the richness of interactions were nothing short of amazing. Unfortunately, because I arrived a day late due to a cancelled flight, I had to miss a special day organized by the Sami Association of Stockholm for Sunday, August 20. It was clear that strong bonds were established during this day of learning about the history and current issues of the Sami. Friendships and warm collegiality strengthened across the days. There was crossover of speakers in the sessions. There was eagerness to continue the dialogues. There was breaking of bread. There was constant welcomeness. On Tuesday, the Australian Embassy and the Australian Water Partnership hosted a reception for First Nations and Indigenous delegates and friends of Australian Water Partners for Development. There, the Māori delegation completed the evening program with their speech and Waiata (singing) which is their traditional practice, something that they were kind enough to do again the following evening at the casual dinner many of us attended. That beautiful evening marked the end of my visit due to another flight cancellation. I left Stockholm early so as not to be stranded in Europe at a time when much awaited my attention back in Tucson.

Māori Waiata (singing)

A key take-away for me is a reminder on the importance of *respect* and listening to learn, along with the importance of building *relationships*. That way we can benefit from *reciprocity*, that is, exchange for mutual benefit. Whether in times of water crisis or not, this is our *responsibility*.

Sharon B. Megdal, Ph.D.
Director, Water Resources Research Center
The University of Arizona

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Reflections: Testifying on Reauthorization of the Transboundary Aquifer Assessment Program

Images: Subcommittee on Water, Wildlife and Fisheries legislative hearing, Oct. 25, 2023

by Sharon B. Megdal
10/27/2023

On October 25, 2023, I had the honor of presenting testimony on H.R. 5874 at the U.S. House of Representatives Committee on Natural Resources, Subcommittee on Water, Wildlife and Fisheries. H.R. 5874, introduced by Arizona District 6 Representative Juan Ciscomani, amends the United States-Mexico Transboundary Aquifer Assessment Act by reauthorizing the United States-Mexico transboundary aquifer assessment program. In addition, the bill, co-sponsored by New Mexico District 1 Representative Melanie Stansbury, modifies a restriction on designation of additional transboundary aquifers along the border shared by Arizona and the state of Sonora, Mexico.

The subcommittee heard several bills. First, House subcommittee members, along with the bills' sponsors, had the opportunity to offer remarks. Then each of the invited witnesses had five minutes to comment on one or more of the bills, after which the witnesses were available to answer questions. Prior to the hearing, I submitted written testimony, from which I drew my five minutes of strictly timed oral testimony.

In his remarks at the **subcommittee legislative hearing**, Representative Ciscomani noted that water security is on the top of Arizonans' minds and underscored the importance of groundwater to communities along the border, many of which are rural and underserved. He highlighted the transboundary aquifer assessment program's role in assisting communities shape their water futures.

Representative Jim Kolbe (1942–2022), who represented Southern Arizona in Congress from 1985 to 2007, was the House sponsor of the bill to establish a transboundary aquifer assessment program. Representative Kolbe invited me to testify in May 2006 on H.R. 469, which was identical to the Senate bill introduced by Senators Jeff Bingaman of New Mexico and Jon Kyl of Arizona. Representative Raúl Grijalva (District 7), who has represented Arizona's border communities since 2003 and serves as House Natural Resources Committee Ranking Member, has likewise advanced the program.

I reflected on my first experience delivering oral testimony to a congressional subcommittee in my early 2007 essay, **Front-Row View of Federal Water Lawmaking Shows Process Works**. This latest opportunity to offer testimony on the program prompted me to reflect on the value of the program. What follows is the essence of my submitted written H.R. 5874 testimony. I omit the opening and closing remarks of thanks and the screenshot of the bulletin on the Binational Study of the Transboundary San Pedro Aquifer that was appended to my written testimony. It contains a summary of what this program has accomplished and where it is heading. I am proud to have worked on this cooperative binational program since its inception. I hope you'll read on to become familiar with the Transboundary Aquifer Assessment Program and how the partners are working strategically to foster understanding of the characteristics of shared aquifers. I invite you to email me comments and/or questions at **smegdal@arizona.edu**.

Directly from the testimony of Sharon B. Megdal with respect to H.R. 5874 dated October 25, 2023:

Background

Like elsewhere in the Southwest – and the Nation – water security and reliability are critical concerns along the border shared by the United States and Mexico. Along the border, groundwater is a particularly important source of water for many communities, and it is the only source for some. Due to its invisibility, assessment of groundwater quantity and quality are needed. Characterizing groundwater conditions and aquifer properties will enable communities along the border to understand their water supply conditions and the implications of their water utilization. Assessments enable more informed decision making by water users, water managers, and policy makers at multiple levels.

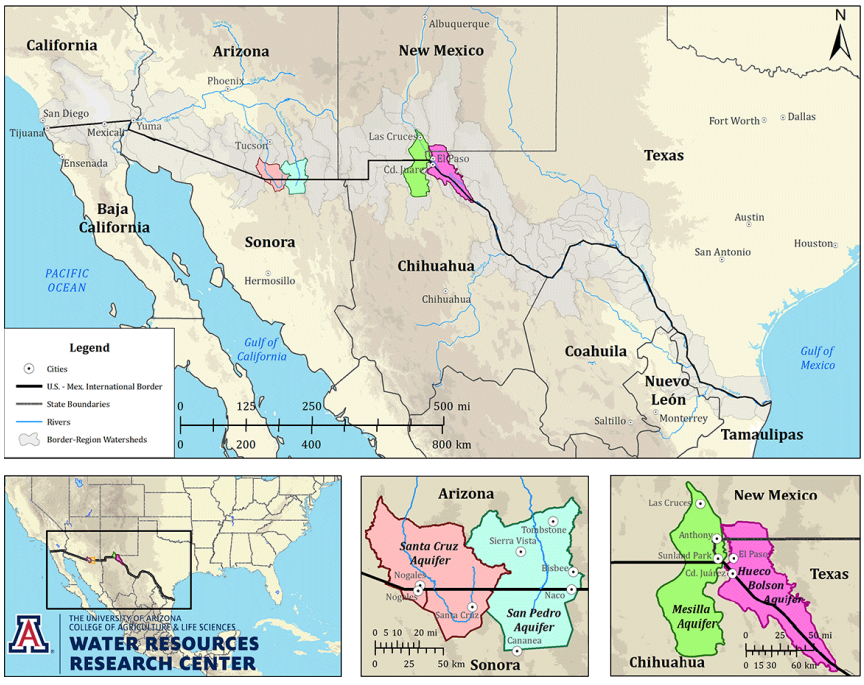
The original legislation authorizing the Transboundary Aquifer Assessment Program, codified as P.L. 109-448, became law in late 2006. It authorized the Secretary of the Interior, through the U.S. Geologic Survey (USGS), to collaborate with the states of Arizona, New Mexico and Texas, the country of Mexico, and others to characterize priority transboundary aquifers. The Act established a partnership between the USGS and the federally authorized water resources research institutes per the Water Resources Research Act of 1964, as amended, for the participating states. The University of Arizona Water Resources Research Center, for which I serve as Director, is the federally authorized water institute for Arizona, with the New Mexico Water Resources Research Institute at New Mexico State University and the Texas Water Resources Institute at Texas A&M University being the other two participating university partners. I had the honor or providing testimony at the May 2006 House hearing on the original authorization, H.R. 469 at the time, and I have been involved in implementing the program ever since its approval. This testimony reflects this involvement, along with perspectives gained from my professional academic and non-academic work on groundwater policy and management that extends beyond 30 years.

Aquifers contain the groundwater on which many communities across the country depend. Because groundwater is not visible or accessible like river water, assessments are necessary to characterize the water quantity and quality of the resource, including the rate at which groundwater is being depleted and recharged. Many communities along our shared border with Mexico rely on groundwater. Current research has established that close to 30 aquifers along this border can be considered transboundary. The national frameworks of the United States and Mexico for managing groundwater are quite different. How states and communities within the United States manage groundwater varies considerably. The Transboundary Aquifer Assessment Program authorized by P.L. 109-448 has enabled collaborative research on groundwater and the aquifers that hold it, along with binational dialogue, which has contributed considerably to developing a common understanding of this critically important water resource. With sound, verifiable information in hand, water users, water managers, and policy makers are better equipped to make decisions to support the long-term viability of their economies and communities along the border.

An Overview of Transboundary Aquifer Assessment Program Efforts to Date

The Transboundary Aquifer Assessment Program has focused on the four priority aquifers specified in P.L. 109-448, which are shown on the map on the right. The map can be accessed at **https://webapps.usgs.gov/taap/index.html**.

Given the program's focus on internationally shared aquifers, the



International Boundary and Water Commission (IBWC) has played a key coordination role for efforts carried out binationally. The IBWC is the binational body responsible for implementing the 1944 Water Treaty for the "Utilization of waters of the Colorado and Tijuana Rivers and of the Rio Grande." It is the key diplomatic mechanism for working on water matters along the border. The IBWC's 2009 three-page "Joint Report of the Principal Engineers Regarding the Joint Cooperative Process United States-Mexico for the Transboundary Aquifer Assessment Program" established the binational cooperative framework that has guided the collaborative binational efforts to date. The six Principles of Agreement are as follows. 1. Activities described under this agreement should be beneficial to both countries. 2. Aquifers to be jointly studied, as well as the scope of the studies or activities to be done on each aquifer, should be agreed upon within the framework of the IBWC. 3. The activities should respect the legal framework and jurisdictional requirements of each country. 4. No provisions set forth in this agreement will limit what either country can do independently in its own territory. 5. Nothing in this agreement may contravene what has been stipulated in the Boundary and Water Treaties between the two countries. 6. The information generated from these projects is solely for the purpose of expanding knowledge of the aquifers and should not be used by one country to require that the other country modify its water management and use.

The USGS website on the Transboundary Aquifer Assessment Program (TAAP) (**https://webapps.usgs.gov/taap/index.html**) provides information about TAAP studies and products, many of which have been carried out on the US side of the transboundary aquifers. The USGS site lists these key TAAP objectives:

- Develop binational information and shared databases on groundwater quantity and quality;
- Identify and delineate transboundary aquifers of importance;
- Develop binational criteria for determination of priority transboundary aquifers;
- Assess the extent, availability, and movement of water in transboundary aquifers and the interaction with surface water;
- Develop and improve groundwater-flow information for binational aquifers to facilitate water-resource assessment and planning;
- Analyze trends in groundwater quality, including salinity and nutrients;
- Apply new data, models, and information to evaluate strategies to protect water quality and enhance supplies; and
- Provide useful information to decision makers, including assessments of groundwater management institutions and policies.

Teams have been working on meeting these objectives through many investigations, reports, presentations, and dialogues. A noteworthy dialogue extending across the border region was the 2019 border groundwater summit convened by IBWC. Ongoing dialogue has been fostered by meetings of technical project teams and less formal dialogues, such as the Permanent Forum of Binational Waters (**https://www.binationalwaters.org/**), which includes significant coverage of groundwater.

One of the earlier binational reports is the 2011 report, Hydrogeological Activities in the Conejos-Medanos/Mesilla Basin Aquifer, Chihuahua, Phase I, which was facilitated by IBWC. The 2016 Binational Study of the Transboundary San Pedro Aquifer ("San Pedro report") was co-produced by the International Boundary and Water Commission, USGS, the University of Arizona, the University of Sonora, and CONAGUA (Mexico's National Water Agency). Along with the 2011 study, this first fully bilingual, binational study of a transboundary aquifer can be accessed online at the USGS TAAP website.

The San Pedro report includes compilation of much existing information and harmonization of maps to provide visual representation of the data and information. Instead of having maps that end on the respective national borders, which had been the case, this report includes binational maps that show the nature of the aquifer system that spans the border. All information, including maps, went through careful review by U.S. and Mexican experts and is published in both English and Spanish. While much of the content is highly technical, the importance of groundwater to supporting the economies of the border communities is underscored in the report's concluding section. A six-page, bilingual bulletin on the San Pedro report (appended to this Testimony) demonstrates efforts to present the information to broad audiences. The report and bulletin can be accessed at **https://wrrc.arizona.edu/programs/taap-transboundary-aquifer-assessment-program/taap-official-binational-reports**.

The process of developing the binationally endorsed San Pedro study involved constant interactions of the binational technical team. The mutually respectful approach enabled seamless transition to the development

of a similarly structured binational report for the transboundary Santa Cruz aquifer system, which is nearing completion. The Santa Cruz aquifer system provides the groundwater for the "Ambos Nogales" region, an important border region for transportation of produce from Mexico to the United States and other products. Nogales, Sonora, which is much larger in population than Nogales, Arizona, is home to many maquiladora factories. The Arizona TAAP team has developed a water balance modeling framework and performed a series of water balance analyses, which show decline in groundwater levels and over-drafting of the aquifers. The modeling approach can be used to study impact of various water management decisions.

These and additional studies of the aquifers that support population and economic centers along the border, such as the El Paso-Ciudad Juarez area, increase understanding of the uncertainties associated with changing precipitation patterns and increased pumping. They contribute to more informed water management decisions. However, additional transboundary assessment, particularly groundwater modeling, is needed. In some areas, no modeling has been done. In other regions, updated, binationally developed numerical models would provide more accurate representation of the implications of pumping and recharge on groundwater supplies.

Assessments are performed aquifer-by-aquifer or community-by-community because the hydrologic, geologic, recharge, and other conditions vary by aquifer. Groundwater is withdrawn to support municipal, industrial and agricultural uses, and groundwater supports natural riparian systems. Groundwater extraction is often occurring at rates that exceed naturally occurring recharge. Recharge rates are dependent on a host of factors, including the connected surface water flows, which themselves involve significant variability.

Many TAAP products can be found at **https://webapps.usgs.gov/taap/products.html**. Published in 2023, the book version of the special issue of the journal *Water* entitled "Advances in Transboundary Aquifer Assessment," which was guest edited by USGS scientist Dr. Anne-Marie Matherne and me, includes several recent TAAP-funded analyses. The free PDF version of the book can be accessed at **https://www.mdpi.com/books/book/7794**. Most publications are freely accessed. The University of Arizona Water Resources Research Center maintains websites that catalog reports and publications in English (**https://wrrc.arizona.edu/programs/taap-transboundary-aquifer-assessment-program**) and Spanish (**https://wrrc.arizona.edu/programs/programa-de-evaluacion-de-acuiferos-transfronterizos-taap**). New Mexico State University's TAAP activities and products can be accessed at **https://taap.nmwrri.nmsu.edu/**. Texas A&M has a transboundary water portal, from which information about TAAP can be found. See **https://transboundary.tamu.edu/taap/**. Additional references can be provided on request.

Through Fiscal Year 2023, a total of $10 million has been appropriated for the Transboundary Aquifer Assessment Program. The authorizing legislation specified that 50% of any appropriated funding remains with the USGS, with the other 50% distributed to the participating Water Resources Research Institutes, though the legislation does not specify how the funding is distributed across the states. According to my records, funding has occurred as shown in the table on the right. The University of Arizona Water Resources Research Center has received one-sixth of the amounts noted on the right.

Federal TAAP Appropriations through FY2023

FY2008	$~500,000
FY2009	$500,000
FY2010	$1,000,000
FY2016	$1,000,000
FY2017	$1,000,000
FY2018	$1,000,000
FY2019	$1,000,000
FY2020	$1,000,000
FY2021	$1,000,000
FY2022	$1,000,000
FY2023	$1,000,000
TOTAL	**$10,000,000**

The collaborative work continues. The USGS and the Water Resources Research Institutes have prioritized five over-arching tasks for the five-year period beginning with Fiscal Year 2023:

1. Stakeholder Engagement and Capacity Building
2. Socio-Economic Context, Governance, and Policy [Note: Although USGS does not preform research related to water policy, personnel at the partner universities do engage in policy analyses.]
3. Binational Groundwater Atlas: Data Management, Mapping, and Visualization
4. Aquifer prioritization and vulnerability assessment
5. Hydrologic Studies to Understand Water Availability Challenges Facing Transboundary Aquifers – Stressors from Population, Industry, Agriculture, Drought, and Climate Variability

The extent to which each is accomplished will depend on funding availability. The U.S. team is actively engaged in discussions with Mexico regarding their participation, particularly with Atlas preparation and hydrologic modeling and data compilation. The five-year plan notes that substantial time and effort are required for binational reports. Fortunately, the international relationships are good and the framework for cooperation has been established. Some of the international work of TAAP team members has been to underscore the strong binational water cooperation we have at our country's southern border. Although cross-border work requires substantial time, the partners can build upon past experiences with carrying out multi-agency reviews and translation of reports to identify opportunities to streamline these processes going forward. There is commitment to work together across the USGS and the university-based water institutes and across the international border.

The Proposed Amendments included in H.R. 5874

Although the Transboundary Aquifer Assessment Program has accomplished a lot with the funding made available, there is still much work to be done. The partnerships established through TAAP have provided a very strong foundation for additional work. The processes and collaborations are in place for continuing and expanding these efforts.

In addition to the extension of the authorization period, H.R. 5874 includes a provision to enable the designation of additional priority aquifers along the Arizona-Sonora border. The original law envisioned the specification of additional priority aquifers along New Mexico's and Texas' border regions. However, in 2006, some water entities wanted to keep the very western, Colorado River portion of Arizona's border region outside of the Transboundary Aquifer Assessment Program. Between the time of the May 2006 hearing and the final passage of the legislation, language prohibiting designation of any additional priority aquifers along the Arizona-Sonora border was added. Section 2 (a) of H.R. 5874 would refine that prohibition by limiting it to the "Yuma groundwater basin designated by the order of the Director of the Arizona Department of Water Resources dated June 21, 1984". This change would enable other transboundary aquifers along the border, except the Yuma groundwater basin, to be eligible for study as part of the Transboundary Aquifer Assessment Program.

As someone who has worked on this program since its inception, I can attest to the productive collaboration of all involved to provide needed analyses and insights. Reauthorization will reinvigorate and reinforce the robust effort to bolster water security for our border communities and economies.

Legislative Hearing | Water, Wildlife and Fisheries Subcommittee

October 25, 2023

Full Video

Representative Juan Ciscomani Remarks

Dr. Sharon B. Megdal Remarks

Sharon B. Megdal, Ph.D.
Director, Water Resources Research Center
The University of Arizona

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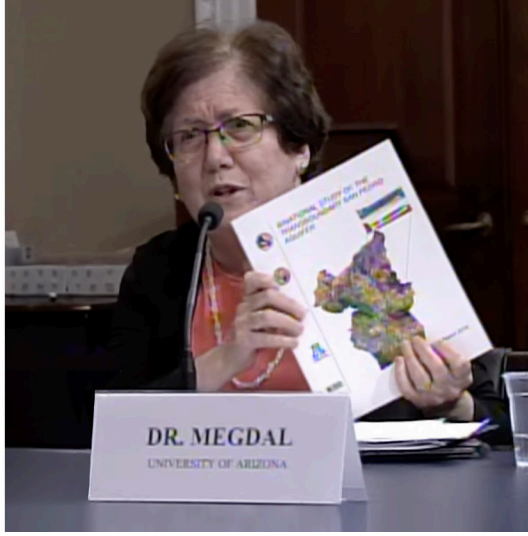
Reflexiones: Testificando durante la Reautorización del Programa de Evaluación de Acuíferos Transfronterizos



Imágenes: Audiencia Legislativa de la Subcomisión de Agua, Vida Salvaje y Pesca, octubre 25, 2023

Escrito por Sharon B. Megdal
27/10/23

El 25 de octubre de 2023 tuve el honor de presentar mi testimonio sobre la Resolución de la Cámara de Representantes H.R. 5874 en el Comité de Recursos Naturales de la Cámara de Representantes de los Estados Unidos, Subcomité de Agua, Vida Silvestre y Pesca. La H.R 5874, introducida por el representante del Distrito 6 de Arizona, Juan Ciscomani, modifica la Ley de Evaluación de Acuíferos Transfronterizos de los Estados Unidos y México y reautoriza el Programa de Evaluación de Acuíferos Transfronterizos de los Estados Unidos y México. Además, la propuesta de ley, copatrocinada por la representante del Distrito 1 de Nuevo México Melanie Stansbury, modifica una restricción en la designación de acuíferos transfronterizos adicionales a lo largo de la frontera compartida por Arizona y el estado de Sonora, México.

El subcomité escuchó varios proyectos de ley. En primer lugar, los miembros del subcomité de la Cámara, junto con los patrocinadores de los proyectos de ley, tuvieron la oportunidad de hacer comentarios. Luego, cada uno de los testigos invitados tuvo cinco minutos para comentar uno o más de los proyectos de ley, después los testigos estuvieron disponibles para responder preguntas. Previo a la audiencia, presenté un testimonio escrito, del cual extraje mis cinco minutos de testimonio oral estrictamente cronometrado.

En sus comentarios durante la audiencia **legislativa del subcomité**, el representante Ciscomani señaló que la seguridad hídrica está en la mente de los Arizonenses y subrayó la importancia del agua subterránea para las comunidades a lo largo de la frontera, muchas de las cuales son rurales y poco atendidas. Destacó el papel del programa de evaluación de acuíferos transfronterizos para apoyar a estas comunidades a dar forma a su futuro hídrico.

El representante Jim Kolbe (1942-2022), que representó al sur de Arizona en el Congreso desde 1985 hasta 2007, fue el promotor en la Cámara de Representantes del proyecto de ley para establecer un programa de evaluación de acuíferos transfronterizos. El representante Kolbe me invitó a testificar en mayo de 2006 sobre la H.R. 469, que era idéntica al proyecto de ley del Senado presentado por los senadores Jeff Bingaman, de Nuevo México y Jon Kyl de Arizona. El representante Raúl Grijalva (Distrito 7), quien ha representado a las comunidades fronterizas de Arizona desde 2003 y se desempeña como Miembro de Rango del Comité de Recursos Naturales de la Cámara de Representantes, también ha impulsado el programa.

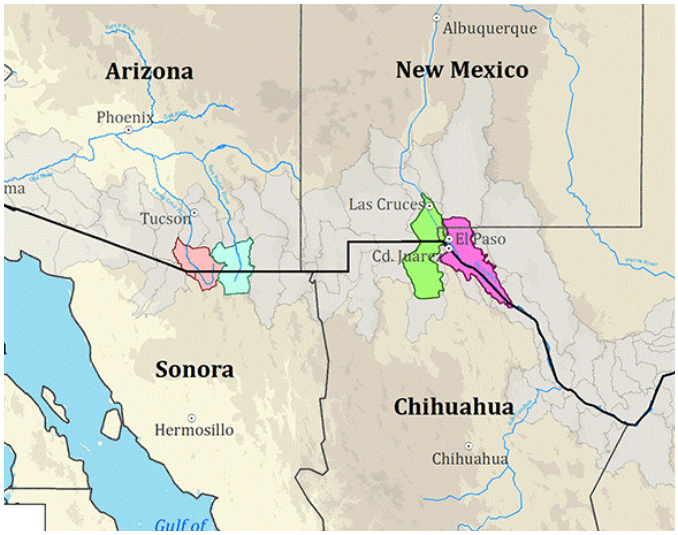
Escribí sobre mi primera experiencia al presentar mi testimonio oral ante un subcomité del Congreso en mi ensayo de principios de 2007, **Front-Row View of Federal Water Lawmaking Shows Process Works** (Vista privilegiada de la creación de leyes federales sobre el agua demuestra que el proceso funciona). Esta última oportunidad de ofrecer testimonio sobre el programa me llevó a reflexionar sobre el valor del mismo. Lo siguiente es la esencia de mi testimonio escrito sobre la H.R. 5874. He omitido las palabras de agradecimiento iniciales y finales, así como la captura de pantalla del boletín sobre el Estudio Binacional del Acuífero Transfronterizo San Pedro que se adjuntó a mi testimonio escrito el cual contiene un resumen de lo que este programa ha logrado y hacia dónde se dirige. Me enorgullece haber trabajado en este programa binacional de cooperación desde sus inicios. Espero que continúen leyendo para familiarizarse con el Programa de Evaluación de Acuíferos Transfronterizos y con el modo en que los colaboradores trabajan estratégicamente para fomentar la comprensión de las características de los acuíferos compartidos. Los invito a que me envíen por correo electrónico comentarios y/o preguntas a **smegdal@arizona.edu**.

Directamente del testimonio de Sharon B. Megdal con respeto a la H.R 5874 con fecha del 25 de octubre de 2023:

Antecedentes

Al igual que en otras partes del suroeste y en el resto de la Nación, la seguridad y confiabilidad hídrica son preocupaciones fundamentales a lo largo de la frontera que comparten los Estados Unidos y México. A través de la frontera, el agua subterránea es una fuente especialmente importante para muchas comunidades y constituye la única fuente de agua para algunas de ellas. Debido a su invisibilidad, es necesario evaluar la cantidad y calidad del agua subterránea. La caracterización de las condiciones del agua subterránea y de las propiedades de los acuíferos permitirá a las comunidades fronterizas comprender las condiciones del suministro de agua y las implicaciones de su utilización. Las evaluaciones promueven la toma informada de decisiones por parte de los usuarios, los administradores del agua y los responsables de la formulación de políticas en múltiples niveles.

La legislación original que autoriza el Programa de Evaluación de Acuíferos Transfronterizos, codificada como P.L. 109-448, se convirtió en ley a finales de 2006. Autorizaba al Secretario de Interior, a través del Servicio Geológico de los Estados Unidos (USGS), a colaborar con los estados de Arizona, Nuevo México y Texas, el país de México y otros para caracterizar los acuíferos transfronterizos de interés. La ley estableció una asociación entre el USGS y los institutos de investigación de recursos hídricos autorizados federalmente según la ley de Investigación de Recursos Hídricos de 1964, en su versión enmendada, para los estados participantes. El Centro de Investigación de Recursos Hídricos de la Universidad de Arizona, del cual soy directora, es el instituto hídrico autorizado a nivel federal para Arizona, con el Instituto de Investigación de Recursos Hídricos de Nuevo México, en la Universidad Estatal de Nuevo México y el Instituto de Recursos Hídricos de Texas, en la Universidad de Texas A&M, siendo las otras dos universidades participantes. Tuve el honor de dar testimonio en la audiencia de mayo de 2006 sobre la autorización original, H.R. 469 en ese momento, y he estado involucrada en la implementación del participación, junto con las perspectivas obtenidas de mi trabajo profesional académico y no académico sobre la política y la gestión de las aguas subterráneas que se extiende más allá de los 30 años.



Los acuíferos albergan el agua subterránea de la cual dependen muchas comunidades en todo el país. Dado que el agua subterránea no es visible ni accesible como el agua de los ríos, es necesario llevar a cabo evaluaciones para caracterizar la cantidad y calidad del recurso, incluyendo la tasa a la cual se está agotando y recargando. Muchas comunidades a lo largo de nuestra frontera compartida con México dependen de las aguas subterráneas. Las investigaciones actuales han establecido que cerca de 30 acuíferos a lo largo de esta frontera pueden considerarse transfronterizos. Los marcos nacionales de Estados Unidos y México para la gestión de las aguas subterráneas son muy diferentes. La forma en que los estados y las comunidades dentro de los Estados Unidos gestionan el agua subterránea varía considerablemente. El Programa de Evaluación de Acuíferos Transfronterizos autorizado por la Ley Pública P.L. 109-448 ha permitido la investigación colaborativa sobre las aguas subterráneas y los acuíferos que las contienen, junto con el diálogo binacional, lo que ha contribuido considerablemente a desarrollar una comprensión común de este recurso hídrico de importancia crítica. Con información sólida y verificable, los usuarios y administradores del agua, así como los responsables políticos están mejor equipados para tomar decisiones que apoyen la viabilidad a largo plazo de sus economías y comunidades a lo largo de la frontera.

Un Repaso de los Esfuerzos del Programa de Evaluación de Acuíferos Transfronterizos hasta la fecha

El Programa de Evaluación de Acuíferos Transfronterizos se ha centrado en los cuatro acuíferos de interés especificados en la P.L. 109-448, que se muestran en el mapa de la derecha. El mapa puede ser consultado en **https://webapps.usgs.gov/taap/index.html**.

Dado que el programa se centra en los acuíferos compartidos internacionalmente, la Comisión Internacional de Límites y Aguas (CILA) ha desempeñado un papel importante en la coordinación de los esfuerzos realizados binacionalmente. La CILA es el organismo binacional responsable de la implementación del Tratado de 1944 para la «Utilización de las aguas de los ríos Colorado y Tijuana y del Río Grande.» Es el mecanismo diplomático clave para trabajar en asuntos hídricos a lo largo de la frontera. El «Informe Común de los Ingenieros Principales sobre el Proceso Conjunto de Cooperación México-Estados Unidos para el Programa de Evaluación de Acuíferos Transfronterizos» de 2009 de la CILA, de tres páginas, estableció el marco de cooperación binacional que ha guiado los esfuerzos binacionales colaborativos hasta la fecha. Los seis Principios de Acuerdo son los siguientes. 1. Las actividades descritas en este acuerdo deberán ser de beneficio para ambos países. 2. Los acuíferos a estudiar conjuntamente, así como los alcances de los estudios o actividades a realizar en cada acuífero, deben definirse conjuntamente en el marco de la CILA. 3. Las actividades deberán respetar los marcos legales y requerimientos de jurisdicción en cada país. 4. Las disposiciones establecidas en este acuerdo no limitarán lo que cualquiera de los dos países determine de manera independiente en su territorio. 5. Ninguno de los elementos presentes en este acuerdo podrá contravenir lo estipulado en los Tratados de Límites y Aguas entre los dos países. 6. La información generada a partir de estos proyectos es con el único propósito de ampliar los conocimientos de los acuíferos y no debe ser utilizada por un país para exigir al otro que modifique el manejo y uso del agua.

El sitio web del USGS sobre el Programa de Evaluación de Acuíferos Transfronterizos (TAAP) (**https://webapps.usgs.gov/taap/index.html**) ofrece información sobre los estudios y productos del TAAP, muchos de los cuales se han llevado a cabo en el lado estadounidense de los acuíferos transfronterizos. El sitio del USGS enumera los siguientes objetivos clave del TAAP:

- Desarrollar información binacional y bases de datos compartidas sobre la cantidad y calidad de las aguas subterráneas;
- Identificar y delimitar los acuíferos transfronterizos de importancia;
- Desarrollar criterios binacionales para la determinación de acuíferos transfronterizos de interés;
- Evaluar la extensión, disponibilidad y movimiento del agua en los acuíferos transfronterizos y su interacción con las aguas superficiales;
- Desarrollar y mejorar la información sobre el flujo de agua subterránea para los acuíferos binacionales con el fin de facilitar la evaluación y planificación de los recursos hídricos;
- Analizar las tendencias de calidad de agua subterránea, incluyendo la salinidad y los nutrientes;
- Aplicar nuevos datos, modelos e información para evaluar estrategias que protejan la calidad del agua y mejoren el abastecimiento y los suministros; y
- Proporcionar información útil para los responsables de la toma de decisiones, incluyendo evaluaciones de las instituciones y políticas de gestión de agua subterránea.

Los equipos han trabajado para cumplir estos objetivos a través de numerosas investigaciones, informes, presentaciones y diálogos. Un diálogo digno de mención que se extendió por toda la región fronteriza fue la cumbre sobre aguas subterráneas fronterizas de 2019 convocada por la CILA. El diálogo continuo se ha fomentado a través de reuniones de equipos de proyectos técnicos y también diálogos menos formales, como el Foro Permanente de Aguas Binacionales (**https://www.binationalwaters.org/**), que proporciona una cobertura significativa sobre las aguas subterráneas.

Uno de los primeros informes binacionales es el de 2011, Actividades hidrogeológicas en el acuífero de la Cuenca Mesilla/Conejos-Medanos, Chihuahua, Fase I, que fue facilitado por la CILA. El estudio binacional de 2016 sobre el Acuífero Transfronterizo del San Pedro («informe del San Pedro») fue coproducido por la Comisión Internacional de Límites y Aguas, el USGS, la Universidad de Arizona, la Universidad de Sonora y CONAGUA (Comisión Nacional del Agua de México). Junto con el estudio de 2011, este primer estudio completamente bilingüe y binacional de un acuífero transfronterizo puede consultarse en línea en el sitio web del TAAP del USGS.

El informe del San Pedro incluye la recopilación de gran parte de la información existente y la armonización de mapas para ofrecer una representación visual de los datos y la información. En lugar de contar con mapas que terminan en las respectivas fronteras nacionales, como había sido el caso, este informe incluye mapas binacionales que muestran la naturaleza del sistema acuífero que atraviesa la frontera. Toda la información,

generada, incluyendo los mapas, ha sido cuidadosamente revisada por expertos estadounidenses y mexicanos y está publicada tanto en inglés como en español. Aunque gran parte del contenido es técnico, en la sección final del informe se resalta la importancia de las aguas subterráneas para sostener las economías de las comunidades fronterizas. Un boletín bilingüe de seis páginas sobre el informe del San Pedro (adjunto a este testimonio) demuestra los esfuerzos realizados para presentar la información a un público amplio. El informe y el boletín pueden consultarse en **https://wrrc.arizona.edu/programs/taap-transboundary-aquifer-assessment-program/taap-official-binational-reports**.

El proceso desarrollo del estudio del San Pedro, respaldado binacionalmente, involucró interacciones constantes del equipo técnico binacional. El enfoque mutuamente respetuoso permitió una transición sin problemas hacia el desarrollo de un informe binacional de estructura similar para el sistema acuífero transfronterizo Santa Cruz, que está casi terminado. El sistema acuífero Santa Cruz provee el agua subterránea para la región de «Ambos Nogales», una importante región fronteriza para el transporte de productos agrícolas de México a los Estados Unidos y otros productos. Nogales, Sonora, que es mucho más grande en población que Nogales, Arizona, es el hogar de muchas fábricas maquiladoras. El equipo del TAAP de Arizona ha desarrollado un marco de modelación del balance hídrico para la zona y ha realizado una serie de análisis, que muestran un descenso de los niveles de agua subterránea y un exceso de extracción de los acuíferos. El método de modelación puede utilizarse para estudiar el impacto de diversas decisiones de manejo de agua.

Estos y otros estudios de los acuíferos que sustentan a las poblaciones y centros económicos a lo largo de la frontera, como la zona de El Paso-Ciudad Juárez, aumentan la comprensión de la incertidumbre asociada a los cambiantes patrones de precipitación y al aumento del bombeo y contribuyen a tomar decisiones más informadas sobre la gestión del agua. Sin embargo, se necesitan evaluaciones transfronterizas adicionales, en particular modelos de agua subterránea. En algunas zonas no se ha desarrollado ningún modelo. En otras regiones, los modelos numéricos actualizados y desarrollados binacionalmente facilitan una representación más precisa del impacto del bombeo y la recarga en las reservas de agua subterránea.

Las evaluaciones se desarrollan acuífero por acuífero o comunidad por comunidad porque las condiciones hidrológicas, geológicas, de recarga, entre otras, varían según el acuífero. El agua subterránea se extrae para usos municipales, industriales y agrícolas, y respalda a los sistemas ribereños naturales. La extracción de agua subterránea se produce a menudo a tasas que superan la recarga natural. Las tasas de recarga dependen de varios factores, incluyendo los flujos de agua superficial, que varían significativamente.

Muchos de los productos TAAP pueden encontrarse en **https://webapps.usgs.gov/taap/products.html**. Publicado en 2023, la versión en libro de la Edición Especial de la revista *Water* titulada «Advances in Transboundary Aquifer Assessment» (Avances en la evaluación de acuíferos transfronterizos), editada por la Dra. Anne-Marie Matherne, científica del USGS, y por mí, incluye varios análisis recientes financiados por el TAAP. La versión PDF gratuita del libro puede consultarse en **https://www.mdpi.com/books/book/7794**. La mayoría de las publicaciones son de acceso libre. El Centro de Investigación de Recursos Hídricos de la Universidad de Arizona mantiene sitios web que catalogan informes y publicaciones en inglés (https://wrrc.arizona.edu/programs/taap-transboundary-aquifer-assessment-program) y español (**https://wrrc.arizona.edu/programs/programa-de-evaluacion-de-acuiferos-transfronterizos-taap**). Las actividades y productos del TAAP de la Universidad Estatal de Nuevo México pueden consultarse en **https://taap.nmwrri.nmsu.edu/**. Texas A&M tiene un portal sobre aguas transfronterizas, en el que se puede encontrar información sobre el TAAP. Vea **https://transboundary.tamu.edu/taap/**. Previa solicitud, pueden facilitarse referencias adicionales.

Asignaciones Federales para TAAP hasta el año fiscal 2023

FY2008	$~500,000
FY2009	$500,000
FY2010	$1,000,000
FY2016	$1,000,000
FY2017	$1,000,000
FY2018	$1,000,000
FY2019	$1,000,000
FY2020	$1,000,000
FY2021	$1,000,000
FY2022	$1,000,000
FY2023	$1,000,000
TOTAL	**$10,000,000**

Hasta el año fiscal 2023, se ha asignado un total de 10 millones de dólares para el Programa de Evaluación de Acuíferos Transfronterizos. La legislación que lo autoriza especifica que el 50% del financiamiento permanece con el USGS y el otro 50% se distribuye a los Institutos de Investigación de Recursos Hídricos participantes, aunque la legislación no especifica cómo se distribuyen los fondos entre los estados. Según mis registros, el financiamiento ha ocurrido como se indica en la tabla de la derecha. El Centro de Investigación de Recursos Hídricos ha recibido una sexta parte de las cantidades indicadas a la derecha.

El trabajo colaborativo continúa. El USGS y los Institutos de Investigación de Recursos Hídricos han priorizado cinco tareas generales para el período de cinco años a partir del año fiscal 2023:

1. Participación de las partes interesadas y desarrollo de capacidades
2. Contexto socioeconómico, gobernanza y política [Nota: Aunque el USGS no realiza investigaciones relacionadas con la política hídrica, el personal de las universidades asociadas si realiza este análisis]
3. Atlas binacional de aguas subterráneas: Gestión de datos, cartografía y visualización
4. Priorización de acuíferos y evaluación de la vulnerabilidad
5. Estudios hidrológicos para comprender los retos de disponibilidad de agua en los acuíferos transfronterizos- Factores de estrés derivados de la población, la industria, la agricultura, la sequía y la variabilidad climática.

El alcance de cada una de estas tareas dependerá de la disponibilidad de fondos. El equipo de E.U.A. mantiene conversaciones con México sobre su participación, en particular en la preparación del Atlas y la elaboración de modelos hidrológicos y la recopilación de datos. El plan quinquenal señala que los informes binacionales requieren tiempo y esfuerzos considerables. Afortunadamente, las relaciones internacionales son buenas y se ha establecido el marco para la cooperación. Parte del trabajo internacional de los miembros del equipo del TAAP ha consistido en resaltar la sólida cooperación binacional en materia de agua que tenemos en la frontera sur de nuestro país. Aunque el trabajo transfronterizo requiere mucho tiempo, los colaboradores pueden aprovechar las experiencias pasadas en la realización de revisiones multinstitucionales y la traducción de informes para identificar oportunidades para agilizar estos procesos en el futuro. Existe un compromiso de colaboración entre el USGS y los institutos universitarios de investigación hídrica, así como a través de la frontera internacional.

Las enmiendas propuestas incluidas en la H.R 5874

Aunque el Programa de Evaluación de Acuíferos Transfronterizos ha logrado mucho con los fondos disponibles, todavía queda mucho trabajo por hacer. Las relaciones establecidas a través del TAAP proporcionaron una base muy sólida para el desarrollo trabajo adicional. Se han establecido procesos y colaboraciones para continuar y expandir estos esfuerzos.

Audiencia legislativa | Subcomisión de Agua, Vida Salvaje y Pesca

Octubre 25, 2023

- **Video completo**
- **Comentarios del representante Juan Ciscomani**
- **Comentarios de la Dra. Sharon B. Megdal**

Además de la ampliación del periodo de autorización, la H.R. 5874 incluye una disposición para permitir la designación de acuíferos de interés adicionales a lo largo de la frontera entre Arizona y Sonora. La ley original preveía la especificación de acuíferos prioritarios adicionales a lo largo de las regiones fronterizas de Nuevo México y Texas. Sin embargo, en 2006, algunas entidades hídricas quisiero mantener la parte más occidental de la región fronteriza de Arizona, la del río Colorado, fuera del Programa de Evaluación de Acuíferos Transfronterizos. Entre el momento de la audiencia de mayo de 2006 y el pasaje final de la legislación, se añadió un texto que prohibía designación de cualquier acuífero de interés adicional a lo largo de la frontera entre Arizona y Sonora. La sección 2 (a) de la H.R. 5874 afinará esa prohibición por limitar a la «cuenca de aguas subterráneas de Yuma designada por orden del director del Departamento de Recursos Hídricos de Arizona con fecha del 21 de junio de 1984». Este cambio permitiría que otros acuíferos transfronterizos a lo largo de la frontera, excepto la cuenca de aguas subterráneas de Yuma, puedan ser objeto de estudio dentro del marco del Programa de Evaluación de Acuíferos Transfronterizos.

Como alguien que ha trabajado en este programa desde sus inicios, puedo dar fe de la productiva colaboración de todos los implicados para proporcionar los análisis y perspectivas necesarios. La reautorización revigorizará y reforzará el esfuerzo sólido para fortalecer la seguridad hídrica de nuestras comunidades y economías fronterizas.

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Escanee este código QR para revisar todas las Reflexiones.