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COOPERATIVE EXTENSION
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ARIZONA WATER RESOURCE

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Feature

Intern Offers Reflections on Lower Santa Cruz River Basin Study

by Bailey Kennett, Research Analyst, WRRC

Photo: Terry Moody courtesy of the Sonoran Institute

When I first saw the email about an internship opportunity with U.S. Bureau of Reclamation's Lower Santa Cruz River Basin Study, I didn't give it much attention. The announcement called for a student to work on a multi-year Reclamation planning study, and stated that primary tasks involved note-taking at stakeholder meetings – neither of which were all that appealing to me. I was looking for something more exciting, some project where I could channel all the passion for water I had built over the years and was continuing to build through my graduate classes. I was looking for a platform to get the community fired up about the urgency of climate change and the critical importance of sustaining ever-threatened water supplies. Little did I know at the time that the Basin Study was just that opportunity.

On the surface, regional water planning is not very thrilling. It is often long and slow and bureaucracy-ridden. And as hard as it may be for us water wonks to understand, most people don't find talk of groundwater flow models and rates of evapotranspiration all that exciting – go figure?! So, how then, is the Lower Santa Cruz River Basin Study such an innovative and motivating project, one that all of Tucson should get behind? Let me explain.

Climate change is happening, and it's happening in Tucson. In the Southwest United States, the average annual temperature has increased about 1.6°F since 1901, with 2001 to 2010 being the warmest and fourth driest decade since that time. Arizona has been experiencing sustained drought for well over a decade, while the 2001-2010 average Colorado River streamflow (a major source of Tucson's drinking water supply) was 16 percent lower than last century's average. Looking forward, temperatures throughout the state are projected to increase 3.5 to 8.5°F by 2100, while Colorado River flow projections show decreases in the range of 9 to 29 percent by 2060. Considering these very real threats to regional water supplies, the Basin Study is taking a risk-based approach and facing the implications of these projections head on. By exploring worst case scenarios, the study encourages preparedness for climatic extremes, not just projected averages.

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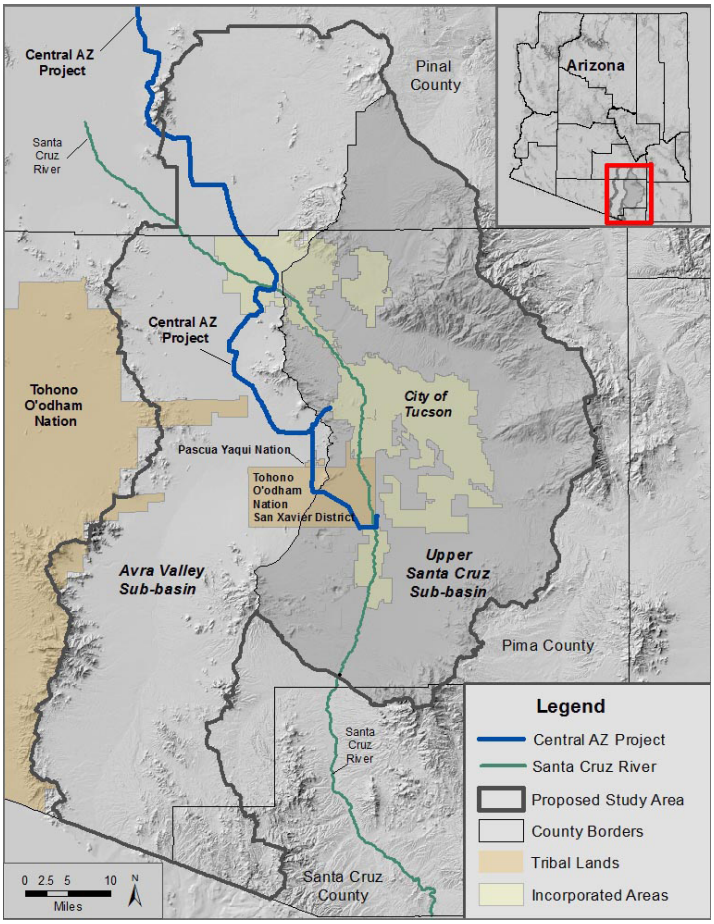


Lower Santa Cruz River Basin Study Area
Source: U.S. Bureau of Reclamation

The Lower Santa Cruz River Basin Study is a three-year planning effort that relies on cutting edge science and local and federal expertise to understand how climate change and various socio-economic factors will impact regional water supply and demand, today through 2060. If demands are projected to outpace supply in any areas, or for any specific users within the Tucson groundwater basin, the study team will recommend strategies to mitigate these imbalances, as well as adaptation strategies to improve overall regional water reliability. Representatives from agriculture, mining, tribal communities, and environmental organizations are working alongside water providers and scientists to ensure that all of our local water needs are accounted for as we plan for the future. This collaboration of diverse, and sometimes divergent, stakeholders speaks to Tucson's strong commitment to water stewardship and should be considered a real win in and of itself.

As a participant in all project meetings, I can confidently say that the Basin Study team is not just checking boxes on a federal checklist; they're digging in deep and thinking outside of the box to make sure that this effort results in usable information that has the potential to make a real difference in the region. First, the study is utilizing an innovative, relatively new global climate model downscaling technique in an attempt to accurately reflect local characteristics and climate patterns. The study team will then use a variety of socio-economic and hydrologic models to develop scenarios of plausible future conditions and get an idea of where to expect water imbalances through the year 2060. A unique characteristic of this Basin Study – something the study team strongly advocated for in the initial project phases – is that it will explicitly consider environmental water needs. The study will explore how riparian ecosystems will be affected by changing climate and water supply conditions, then will develop potential adaptations to address these impacts.

The Lower Santa Cruz River Basin Study's risk-based planning approach, use of innovative climate modeling, and consideration of environmental impacts are all precedent-setting measures that have the potential to influence future Reclamation Basin Studies. The thought of Tucson paving the way for more progressive and holistic water planning motivates me to dig into these challenges with all that I've got.

If you believe that innovation, collaboration, and flexibility are our best tools to tackle the very real threats of climate change – get on board with the Basin Study! Whether you're interested in staying up-to-date on study processes and products or participating more regularly and actively as a Stakeholder Advisor, there are definite opportunities to stay informed and get involved. Your voice is what makes the Basin Study reflective of the needs and desires of the community, and your feedback has real potential to influence decision makers within and beyond Arizona. In this way, the Lower Santa Cruz River Basin Study presents a unique platform for sustained environmental engagement and provides a very practical means to address the seemingly overwhelming challenges of climate change.

Feature

Saving Water Can Put Money in The Bank!

by Anthony Batchelder, Graduate Student, University of Arizona Department of Agricultural Economics

Conserving water and using it efficiently. Can there really be money in that? Communities are often motivated to conserve water for hydrological and environmental benefits such as groundwater recharge or environmental restoration, including reintroduction of animal populations, yet the economic benefits of water conservation and improvements in water use efficiency can be a potent motivator. Many economic benefits can be achieved from conserving water and being more efficient with its use. Consider the various industries involved in certain water conservation strategies, including storm runoff retention (which contributes to

Irrigation with recycled water

aquifer recharge), passive and active rainwater harvesting, and re-use of treated wastewater. If communities are pro-active and utilize more of these systems, the economic benefit would be an increase in jobs within these industries, as products need to be produced and facilities need to be maintained. In addition, the labor needed to implement these strategies would require local contractors, which would also benefit the local economy.

A lack of water conservation can also have economic costs. The Pacific Institute reported that the inability to use hydroelectric power and the increased dependence on fossil fuel plants in California caused an increase in electricity costs of over $2 billion from October 2011-September 2015. This amounted to a 1.3-percent increase in costs to the average household. With conservation and more efficient water use, communities can increase the river flow and increase their ability to use hydroelectric power, which is one of the cheapest energy sources according to the Pacific Institute, and cleaner than the alternative, natural gas. Conservation and efficient use of water can have an impact on consumers and the economy via jobs and cheaper, cleaner energy.

The economic benefits of water conservation can also be observed within the agricultural industry, which accounts for approximately 80 percent of the nation's consumptive water use. Many people in the agricultural industry already understand these benefits. The Imperial Irrigation District in California saw water use drop by 20 percent in the first decade of the 2000s, and simultaneously saw an increase in farm incomes of 30 percent.

To inspire conservation from the agricultural industry and incentivize increased water efficiency, opportunities have been created for farmers to trade their water as they did in the two cases of Oregon's Whychus Creek and Scott River Water Trust. In Oregon, one farming family was able to transfer some of their water from their farm back to in-stream flow, for which they received $400,000 from environmental groups. This allowed the family to purchase a more efficient irrigation system, which in turn generated water savings in the same amount that was transferred as part of the agreement. These transfers of water from agriculture to in-stream flow have helped restore fish populations and have also provided farmers the resources to purchase more efficient irrigation systems, allowing them to conserve water and receive compensation for keeping their water in-stream.

In the communities surrounding the Scott River in Siskiyou County in northern California, the salmon fishing industry was shut down in 2008 owing to a lack of sufficient flow in the Scott River. The fishery closure caused the California salmon industry to lose $255 million annually in 2008 and 2009, and the survival of the river's entire adult salmon population was at risk. Environmentalists worked together with local farmers to decrease agricultural diversions, which provided a sufficient amount of water in-stream to allow the adult Coho salmon population to regenerate: adult salmon numbers grew from 62 in 2008 to 340 in 2011. As the salmon population continues to grow, the opportunity for economic recovery of the salmon industry also increases. If proactive conservation had been implemented, the negative economic impact on California's salmon industry could have been avoided.


A droplet saved can be dollars earned

It is important for communities to recognize that costs may be incurred by failing to conserve and efficiently use water, but with pro-active water conservation and efficient water use comes the opportunity for economic benefits and growth. Conservation and efficient water use can have strong positive economic impacts, and the examples discussed in this article are only a few of the possibilities.

Studies Confirm Conservation Lowers Water Rates

According to new research from two Arizona communities, water conservation helps keep water rates lower than they would otherwise be. The Alliance for Water Efficiency released the studies by the Town of Gilbert and the City of Tucson on costs avoided by conservation and water efficiency. The Tucson Avoided Cost Analysis clearly and convincingly debunks the myth that conservation drives up water rates by examining the overall impact of water efficiency on water and wastewater rates. Water and wastewater rates in Tucson are at least 17percent lower today than they would have had to be without the various water conservation and efficiency actions Tucsonans have implemented. Gilbert's results showed a similar effect. Gilbert, which avoided nearly $341million in investment costs for new water resources and water and wastewater treatment, estimated that a residential unit's system development fee is $7,700 lower today than it would have been. The reports are available at http://www.allianceforwaterefficiency.org/Avoided-Cost-Report.aspx

Special Feature

Research Projects Focus on Water Reuse

Two water quality research projects, funded through the Water Resources Research Center, reported their results in May. The WRRC receives funding from annual appropriations to the U.S. Geological Survey to support the national Water Resources Research Institutes program. Some of this funding is allocated each year to research projects proposed by faculty at Arizona's three state universities. A wide range of projects has been funded over the years, emphasizing the mandated program goals of improving water supply reliability and quality, exploring new ideas to address water problems, and expanding understanding of water and water-related phenomena.

In the project year that ended this spring, projects led by University of Arizona researchers Channah Rock (Recycled water use for agriculture: on-farm demonstration and evaluation research) and Robert Arnold and David Quanrud (Sunlight-driven reactive oxygen species production for natural attenuation of wastewater trace organic compounds) were selected for support.

The Rock project concerned the use of recycled water for agricultural irrigation and its potential for bioaccumulation of emerging contaminants, antibiotics, and antibiotic resistant bacteria. Recent drought pressures in the West have forced some growers to cut water use by 25 percent, which has spurred a consideration of recycled wastewater for crop irrigation. Recycled water has the advantage of being a constant and reliable water source and its use on a volume basis is growing at an estimated 15 percent per year.

The long-term goal of this project was to assess industry perceptions of the risk to consumers from the use of recycled irrigation water in agriculture and to develop industry-based tools and guidelines. It asks the question whether the risk of exposure to organic contaminants found in recycled agricultural irrigation water represents a barrier to its use. Tools and guidelines are intended to facilitate the making of informed decisions by produce growers and related stakeholders about the utilization of recycled water.

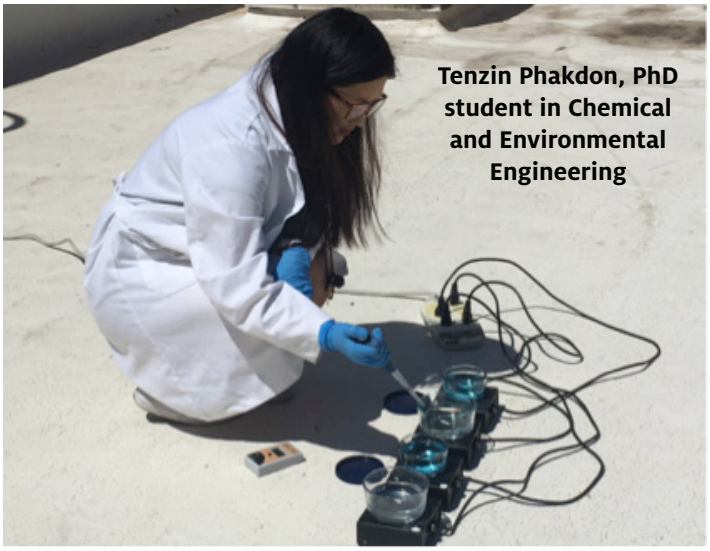
Two focus groups were convened: a citizen panel of representatives with knowledge in a variety of fields and a panel of agricultural professionals (growers, producers, food safety managers, and irrigation districts). Both groups were asked to evaluate issues and concerns related to perceptions of recycled water and other nontraditional water sources. They were presented with information on costs and benefits related to public acceptance, health and safety concerns, and environmental considerations and were asked to consider

Focus group meeting, Yuma, AZ

these costs and benefits in their evaluations. Grower participation was encouraged through flyers, word of mouth, and efforts by University of Arizona Cooperative Extension to promote the program through newspaper, email, and flyers distributed at grower events. The results of the focus groups formed the foundation for the development of tools and guidelines.

Feedback from stakeholders indicated that on-line tools, web-based grower Apps, and short videos are often preferred methods of communication. A web-based interactive water information tool was developed covering topics such as nontraditional water sources, water availability, water quality, food safety, and Best Management Practices. In addition, a series of short instructional videos reviewing concepts of nontraditional water sources as well as risk assessment was developed with support from the Yuma Center of Excellence for Desert Agriculture.

Overall, the Arizona agricultural industry is concerned about consumer perceptions of recycled water and its use for agricultural irrigation. These perceptions necessarily affect how growers respond to the need for conservation and utilization of recycled water. Broad dissemination of reliable information on the risks is essential for wise decisions.



Tenzin Phakdon, PhD student in Chemical and Environmental Engineering

In their study, investigators Arnold and Quanrud noted, like Rock, that the need for water conservation in the American Southwest means that wastewater reuse is being considered, and cost-effective treatment that minimizes safety risks remains an important research goal.

For almost two decades, it has been known that treated wastewater contains low concentrations of many organics that enter sewage through human activity. Examples include a variety of pharmaceuticals and industrial chemicals. Many of these trace contaminants decrease in concentration over time and distance traveled in surface water. The mechanisms for contaminant loss or transformation are seldom known, however. One candidate is sunlight-driven reactions, either of direct photolysis, in which light energy causes chemical conversion, or indirect photolysis, in which light energizes a chemical intermediate or "sensitizer". The sensitizer reacts with a contaminant or starts a chain reaction that results in degradation or elimination of a contaminant. An example of a sensitizer is singlet oxygen, an energized form of the normal oxygen molecule. The importance of singlet oxygen to indirect photolysis was fully acknowledged only recently.

Better understanding of this chemistry may allow us to use photolytic reactions to destroy residual organic compounds in municipal wastewater, minimizing both ecological and human exposures. The project research was designed first, to establish the mechanism of photolytic transformation of a common class of contaminants in treated wastewater and then, to simulate that mechanism mathematically for a simplified situation.

The experimental setup consisted of a light source and reactor. The target compound and sensitizer were dissolved in either treated wastewater obtained from Pima County or pure water. Experimental results indicated that light energy and molecular oxygen were necessary for photo-degradation of the target contaminant. When light was absent or when oxygen was stripped from solution, no reaction was observed. The reaction was also missing when treated wastewater was replaced by pure water. Results support a mechanism in which light activates a compound or compounds in wastewater (sensitizer), which convert molecular oxygen to singlet oxygen, which then reacts with the target. Since no reaction occurs without oxygen, it is clear that the active sensitizer in treated wastewater does not react directly with the target contaminant. In addition to these experimental results, the reaction mechanism was successfully simulated mathematically.

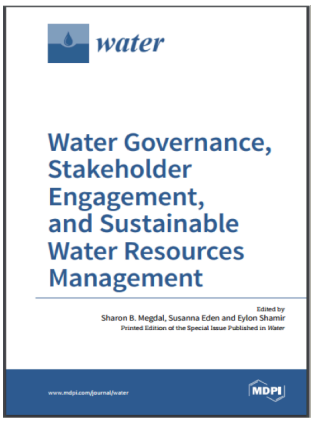
With additional work it will be possible to discover the nature of the sensitizer(s) in treated wastewater and to identify the range of wavelengths in simulated sunlight that are responsible for initiating photolytic reactions. With this knowledge, trace contaminants that survive conventional wastewater treatment may be better managed through engineered, photolytic treatment.

Resources

Water Governance, Stakeholder Engagement, and Sustainable Water Resources Management

Sharon B. Megdal, Susanna Eden, and Eylon Shamir, editors

MDPI, 2017



The Special Issue of the journal Water titled "Water Governance, Stakeholder Engagement, and Sustainable Water Resources Management" has been published in book form. The Special Issue was edited by WRRC Director Sharon B. Megdal, Susanna Eden, WRRC Assistant Director, and Eylon Shamir, Hydrologic Research Center. A collection of 20 articles by experts in numerous fields related to water governance and management, the book offers research from a range of perspectives, geographic scales, and locations around the world. It focuses on the relationship of water governance practices and stakeholder engagement approaches to the development, evaluation, and adoption of solutions for sustainable water management. Reprints are freely accessible and printed copies may be purchased on the MDPI Books platform at http://www.mdpi.com/books/pdfview/book/327.

Price of Water 2017: Four Percent Increase in 30 Large U.S. Cities

by Brett Walton

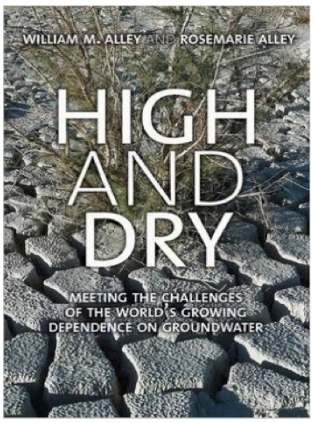
Circle of Blue, May 18, 2017

In May, the Circle of Blue, a water news source, released the results of its annual survey of water pricing in U.S. cities. The survey looks at 30 large cities. Instead of trying to compare average household bills the study authors tracked the annual change in prices for three residential consumption scenarios: a family of four using 150, 100 or 50 gallons per person per day. They found that the average cost of residential drinking water service in the 100 gallons per person per day scenario increased four percent, the smallest annual increase since the first survey in 2010. The survey analysis notes that water utilities across the country are changing the way they charge for water to meet the simultaneous challenges of earning enough to cover costs and keeping water affordable for the poor, in an era of conservation and declining per capita sales. The changes in rates over time for each city surveyed can be viewed on the Circle of Blue web site at http://www.circleofblue.org/2017/water-management/pricing/price-water-2017-four-percent-increase-30-large-u-s-cities/.

High And Dry: Meeting the Challenges of the World's Growing Dependence on Groundwater

by William M. Alley and Rosemarie Alley

Yale University Press, 2017



Because groundwater is largely unseen, the topic has been neglected by writers addressing a non-scientific audience. This is a shame, as groundwater is a vital resource that is shrinking due to pressures from a growing global demand and widespread contamination. Many more people from policy makers to the public at large need to be informed about groundwater, its nature, uses, and problems, as well as what can be done to solve them. This book fills that need with an engaging collection of stories from around the world in which the authors highlight the complex scientific, socioeconomic, and environmental issues associated with groundwater use and management. William M. Alley, an eminent groundwater expert, with his collaborator, science writer Rosemarie Alley, has produced a comprehensive and accessible introduction to the subject.

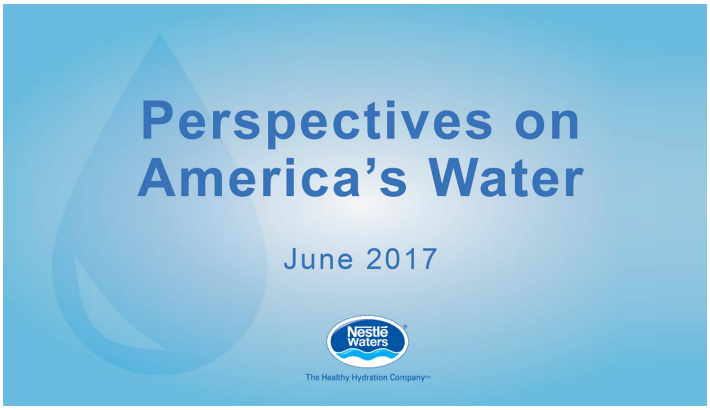
Energy-Water Policy Database

Office of Energy Policy and Systems Analysis, U.S. Department of Energy, 2017

U.S. Department of Energy (DOE), Office of Energy Policy and Systems Analysis (EPSA) is Beta testing a database of U.S. water policies and programs affecting energy systems. This draft database contains more than 1,700 policy entries, such as water quality standards affecting energy systems and surface and groundwater rights relating to power generation. The database can be searched using a number of filters including state, jurisdiction, and policy type. Users can download the entire database in spreadsheet format. The EPSA Office is inviting comments and feedback on this draft version of the database. https://energywaterpolicy.org/#

Perspectives on America's Water

Nestle Water, June 2017

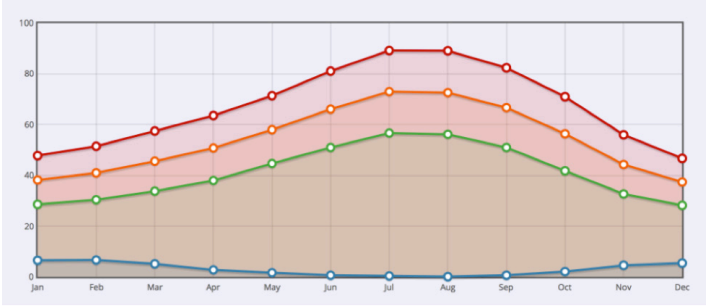


Perspectives on America's Water, released in June 2017 by Nestlé Waters, is a unique national study that asked 4,381 American consumers in 17 states across the country and 375 experts in water, health, environment, and infrastructure about their perceptions of water safety, threats, and infrastructure needs. Consumers were representative of the national general population. Study authors found that clean drinking water is considered the most essential natural resource by more people than clean air or energy. The majority of consumers and experts agreed that water problems are a major problem in the United States. They also agreed that the United States needs a significant water infrastructure overhaul—59 percent of consumers and 58 percent of experts. All the results can be found at https://www.nestle-watersna.com/content/documents/pdfs/perspectives_on_americas_water-june2017.pdf.

1981-2010 Climate Normals – Climographs

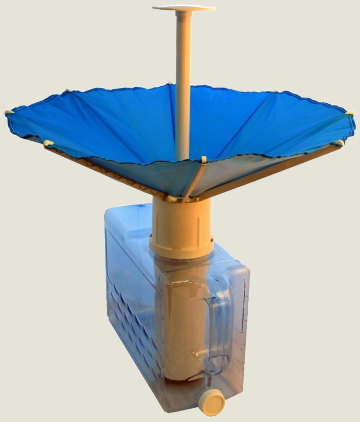
Climate.gov, National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration – or NOAA – now provides graphs and tables of temperature and precipitation data representing the "normal" climate for weather stations across the United States. Simple graphs of Climate Normal data can be used to visualize the climate of a particular location at three time intervals: season, month, or day, and a few stations show hourly normals. The graphs



are constructed from 30 years of observed weather data collected from each station. The current Climate Normals reflect the years 1981-2010. According to these data, the normal maximum temperature for the University of Arizona in Tucson in July is 101.7º F, compared to 106.1º F for the Phoenix airport.

https://www.climate.gov/maps-data/dataset/1981-2010-climate-normals-climographs



Device Helps Save Shower Water

The AWR does not usually include information on commercial products, but we thought readers might be interested in this low-tech device for saving water while you wait for the shower water to warm up. The upside-down umbrella collects water in a handy plastic container. Interested readers can find this product, called the Shower Flower, at http://www.nrgideas.com/revolutionary-new-product-the-shower-flower/.

Guest View

Shouldn't Ag Water Conservation Be Used For..... Agriculture?

by Paul Brierley, Executive Director, Yuma Center of Excellence for Desert Agriculture

Originally appeared in The Voice blog, Arizona Farm Bureau, April 19, 2017

Water is a hot topic in the desert southwest, and agriculture uses a lot of it. Are there ways for agriculture to save water? If so, what should it be used for, and how would agriculture and rural communities be impacted?

I was recently asked to be on a panel of water experts looking at alternatives to permanent fallowing of agricultural lands, or "buy and dry" as some call it. Today I want to share with you some of my thoughts on agricultural water conservation and the impacts it could have on production agriculture.

People say agriculture should conserve water to meet the needs of urban and environmental water users. Conserving water is a great thing to do, but I take exception to the premise that the purpose of Ag water conservation is to supply the needs of *other* water users. Why is that always the assumption?

The United Nations says the world needs to produce 70% more food by the year 2050. Given this, doesn't it make sense that any agricultural water savings should be used by agriculture to produce even *more* food?

Fallowing, irrigation efficiency, deficit irrigation, and switching to low-water-use crops are commonly suggested. These are all good ideas and definitely have their place. But they have real-world consequences that must be considered before assuming they are an easy answer to water shortages.

Desert agriculture is a model for irrigation efficiency, already producing much more food with less water than 30 years ago. Concrete lining of ditches, laser leveling of fields, high-flow turnouts, gated pipe, furrow irrigation, sprinklers, and drip irrigation are all methods of conserving water. Each technique is appropriate in certain situations and must be economically justifiable.

Is fallowing the solution? It sounds good on the surface: Pay the farmer what he would have made and we're good, right? Wrong! There is a huge infrastructure that goes along with Ag production. What about the employees that don't get hired? The seed and chemical companies whose products are no longer needed? The retail sector that has fewer customers? The local government that collects less sales tax? And what about the downstream user who no longer benefits from return flows or aquifer recharge? And the irrigation district that has fixed costs spread over a smaller customer base?

Then there's this: fallowing doesn't actually conserve water! It just transfers the water *somewhere else* for *someone else* to use. If that somewhere else is out of the basin, then there are no return flows or aquifer recharging, so the actual savings are less by about half.

And maybe the farmer doesn't want to fallow his fields! How would you feel if someone said your profession is considered of secondary importance and we'll pay you to stop doing it?

What if it is *temporary* fallowing? Well, if it's voluntary that can make sense in case of short-term drought. But is it really temporary? If it is used to build homes and create jobs somewhere else, those uses will never be given up, and that water is gone from agriculture forever.

What about issues like dust and weeds during fallowing? And what about when the land returns to production — will it need extra water applied to leach salts that accumulated during fallowing? This would minimize actual water savings.

How about switching to low water use crops? Realize that the farmer is already planting what he thinks is going to bring the most profit. Crop selection is based on many factors, and low water use crops may not return enough on investment to justify growing them, even with the water savings.

What about deficit irrigation, using less water than the crop needs? In most cases, less water = lower production, which hurts the bottom line. Remember, the first rule of sustainable production is that the farmer has to be able to make a living or it's not sustainable.

So, what do we do about Ag water? Well, we need to find new ways to squeeze every possible bit of production out of whatever water *does* go on the crops. At the Yuma Center of Excellence for Desert Agriculture, we are figuring out ways to maximize production, getting "the most crop per drop!" Whether it's saving water, avoiding plant disease, or applying technology, we are helping farmers to produce more food with fewer inputs. This is better for the farmer, better for the environment, and better for a hungry world!

NOTE: The University of Arizona's Yuma Center of Excellence for Desert Agriculture is a public-private partnership between the College of Agriculture & Life Sciences and the Desert Agriculture production industry.

TAAP Stakeholder Engagement Forum in Sierra Vista, AZ

Public Policy Review

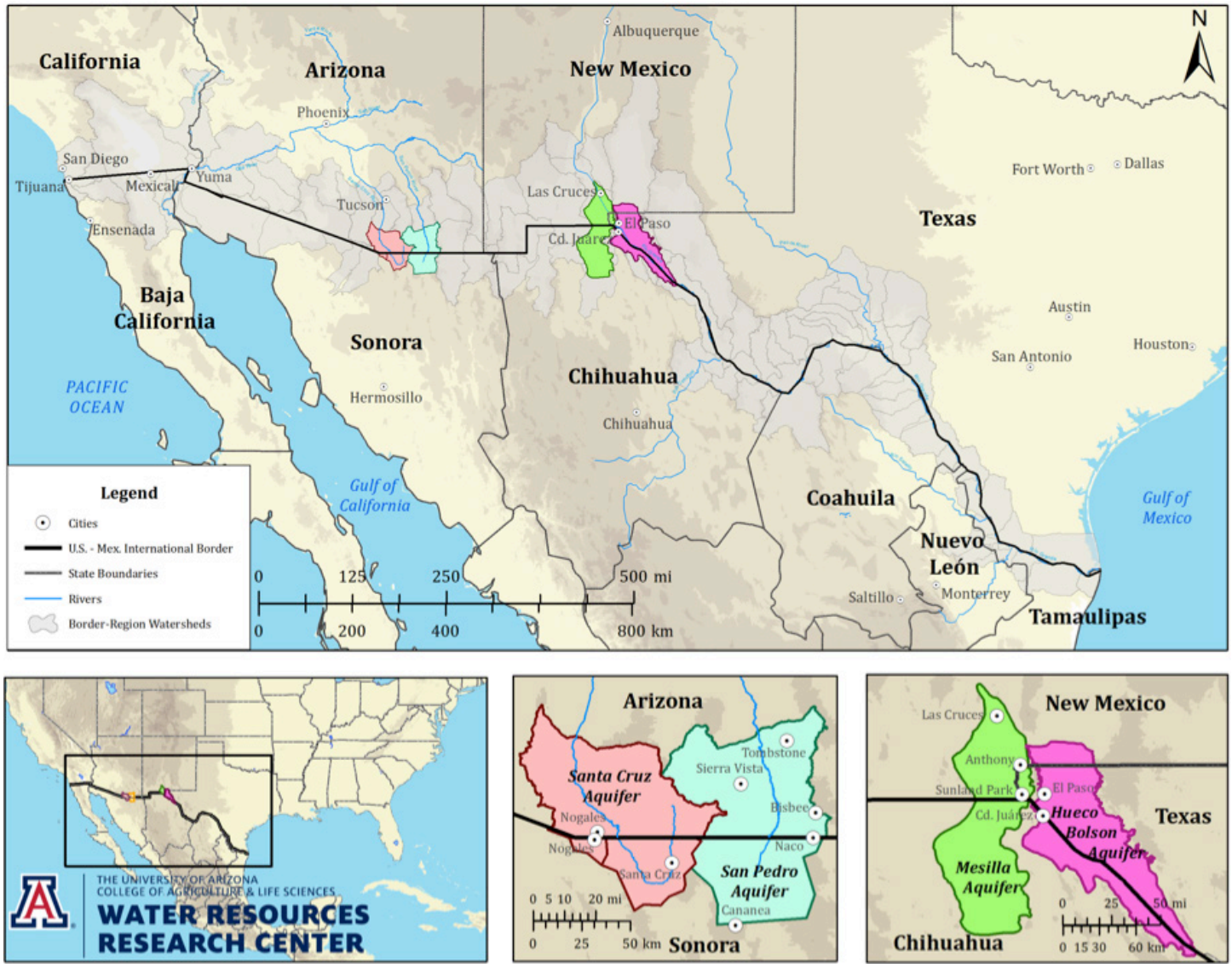
The Cooperative Framework for the Transboundary Aquifer Assessment Program: A Model for Collaborative Transborder Studies

Sharon B. Megdal

Being part of the team working on the Transboundary Aquifer Assessment Program (TAAP) continues to be gratifying. The International Boundary and Water Commission's (IBWC) recent publication of the *Binational Study of the Transboundary San Pedro Aquifer* (San Pedro Study) marked a milestone. This publication is noteworthy in that it is a first-ever binationally prepared, fully bilingual aquifer assessment, and because it was subject to peer review on both sides of the border. Also noteworthy is the framework for cooperation that has guided the team's multi-disciplinary and trans-disciplinary collaborative assessment work. Signed on August 19, 2009, IBWC's "Joint Report of the Principle Engineers Regarding the Joint Cooperative Process United States-Mexico for the Transboundary Aquifer Assessment Program" (Cooperative Framework) took considerable time to develop. The successful ongoing collaboration confirms the value of the time spent at the front-end to develop the Cooperative Framework. The team was able to persevere despite uncertain and very limited funding and the challenges of working in different languages and across an international border. I believe strongly that the Cooperative Framework can serve as a model for both transboundary water studies across the globe, whether or not focused on groundwater.

By way of background, TAAP got its start on the U.S. side with the signing of U.S. Public Law 109-448, the Transboundary Aquifer Assessment Act, in late 2006. I had the honor of serving as the sole non-federal witness at the May 2006 House of Representatives subcommittee hearing on the proposed legislation. The Act articulated U.S. interest in engaging in binational aquifer assessments of specified priority aquifers. While the Act indicated that IBWC would be consulted "as appropriate", it soon became clear that IBWC involvement would be central to development of the type of assessment authorized by the Act. (For more information on the IBWC, including the Commissioners and staff for the U.S. and Mexican sections, see ibwc.gov and cila.sre.gob.mx/cilanorte.)

The Cooperative Framework establishes that the binational program will be called the Transboundary Aquifer Assessment Program and that the IBWC will serve as the Binational Coordinating Agency. It confirms that the U.S. and Mexican sections are aware of the value of developing an understanding of the aquifers used by both countries. The Cooperative Framework acknowledges the need to develop a team of binational experts to assess aquifers, exchange data, and if necessary, develop new datasets. The document states that the "IBWC, under this joint cooperative process, will provide the framework for coordination of binational assessment activities conducted by U.S. and Mexican agencies, universities, and others participating in the program," … "to improve the knowledge base of transboundary aquifers between the United States and Mexico". Additional key provisions include assuring that both countries concur on transboundary aquifer assessment activities and specifying binational technical advisory committees for each identified transboundary aquifer. The IBWC was named as the official repository for binational project reports to be published in Spanish and English. Importantly, IBWC is responsible for developing a joint program and for determining whether a



Transboundary Aquifer Assessment Program Aquifers of Focus
Source: Water Resources Research Center

proposed aquifer study is in the interest of both countries. The IBWC also coordinates with agencies for both countries in defining the scope of the assessment and facilitating agreement on work plans. However, the Cooperative Framework specifies that "each country will be responsible for any costs on projects conducted in its territory, in addition to selecting the participants and consultants to carry out the studies in that country. Each country may contribute to costs for work done in the other country, and the IBWC will coordinate any flow of funds across the border." The six principles of agreement, which appear toward the end of the three-page document, make it clear that each country is free to undertake its own studies when such are limited to one side of the border.

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.

There is much global interest in governance and management of transboundary groundwater. The international legal

community and others have for some time been advocating for UN adoption of the 2008 Draft Articles on the Law of Transboundary Aquifers (Draft Articles). I pointed out that the Cooperative Framework is consistent with two important provisions of the Draft Articles in my first international presentation on TAAP at Stockholm's World Water Week on August 20, 2009, (the day after the signing of the Cooperative Framework) and again as recently as the 2017 World Water Congress in late May. Both "Article 7, §2: General Obligation to Cooperate" and "Article 8, §2: Regular exchange of data and information" speak to the desirability of cooperative study.

A common understanding of aquifer conditions is a first step in efforts to explore binational governance and management. Disagreement about groundwater conditions is likely to lead to different perspectives on approaches to groundwater management. Because it is beyond the scope of TAAP responsibility, the expert team has been silent on the prospects for binational groundwater management along the U.S.-Mexico border. Instead, the TAAP team has focused on expanding shared knowledge and understanding. Since 2009, the Cooperative Framework has facilitated successful completion of the San Pedro Study, with completion of a similar study for the transboundary Santa Cruz aquifer in progress. In addition, binational efforts are continuing for the other TAAP aquifers, as shown on the map of TAAP transboundary aquifers. The basic elements of the Cooperative Framework can serve as a model for others engaged in transborder studies. The Cooperative Framework, a link to the San Pedro Report, and other information on TAAP history and activities, particularly for the Arizona-Sonora transboundary aquifers, can be found at wrrc.arizona.edu/TAAP.

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