



COLLEGE OF AGRICULTURE & LIFE SCIENCES  
COOPERATIVE EXTENSION

# WATER RESOURCES RESEARCH CENTER

# ARIZONA WATER RESOURCE

## The Water Resources Research Center Quarterly Newsletter

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### WATER CONFERENCE HIGHLIGHTS ARIZONA'S IRRIGATED AGRICULTURE

by Susanna Eden, WRRC

Photos: Lynn Ketchum - College of Agriculture and Life Sciences

"We do the best that we can with what we have, in the time we have, in the place we are." This modest aphorism offered by Terry Button of Ramona Farms captures the spirit of service that was evident throughout the WRRC's annual conference, "Irrigated Agriculture in Arizona: A Fresh Perspective." Farmers and the people who work with them presented their perspectives, sharing their knowledge and experience with the 325 people gathered to learn about water issues faced by Arizona's agricultural industry.

Ramona Farms specializes in traditional foods that are nutritious and renew links with cultural and family roots. Inspired by the example and wisdom of Ramona's father, who foresaw her future in farming on Gila River lands, the Buttons went through tough times and brought themselves from "horse and buggy" farming to a modern operation with the help of university-based knowledge.

Through the conference, the University of Arizona demonstrated again its commitment to supporting a broad understanding of issues important to the state. Shane Burgess, UA Vice President and Dean of the College of Agriculture and Life Sciences, and Jeff Silvertooth, Director of Arizona Cooperative Extension, both pointed out that the University of Arizona is well-placed to study problems of arid regions. Burgess further emphasized the value of water management in deserts and the water efficiency of Arizona's agriculture. "Water is a practical problem we work with people to solve," said Silvertooth.

The agriculture sector, which accounts for approximately 70 percent of the water used in Arizona, is feeling the pressure of impending shortages and growing demands by other water-using sectors. More than one speaker refuted the idea that agricultural water represents a reservoir that can be drawn on as the solution to shortages in other sectors.

On the contrary, speakers repeatedly invoked the importance of agriculture to the state, nation, and world. Cheap food production, which in the United States takes less than 10 percent of household income, has provided the foundation on

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Vice President and Dean Shane Burgess addresses WRRRC conference attendees.



which our society has developed, fueling prosperity, leisure, and freedom, according to Mark Killian, Director of the Arizona Department of Agriculture. His words were echoed by Tom Davis, President of the Agribusiness and Water Council of Arizona, who said, “We enjoy a strong middle class because we have had 75 years of cheap food, energy, and water. What might happen if that changes?”

Killian emphasized the high quality of Arizona’s crops and called it our moral imperative to feed the world. The requirements for productive agriculture are land with good soils, sunlight, and water. Arizona is rich in two of these. Following up on Burgess’s opening observation that water turns sunlight into life, he noted that the judicious use of water has given Arizona some of the most productive agriculture in the country. According to Noel Gollehon, a senior economist at the USDA Natural Resources Conservation Service, Arizona “punches above its weight” in land efficiency with a rank of 17th among states in cultivated acres and a rank of 10th in agricultural sales.

Kevin Rogers, farmer and President of the Arizona Farm Bureau, pointed out, “The public is going to have something to say about what we do about water.” He called for agriculture to advocate with the public about what it does. “They seem to be troubled that we’re shipping our water in products and don’t understand that’s what the country does.” In Arizona, agriculture is a \$17 billion industry with national and global impacts.

With world population projected to grow to 9.1 billion people by 2050, overall food production would have to increase by about 70 percent to keep up with demand. Most of this increase—90 percent—is expected to come through higher yields and increased cropping intensity, according to the United Nations Food and Agricultural Organization. This is where investment and innovation in irrigated agriculture will contribute to food security.

There have been tremendous water efficiency gains in irrigated agriculture over the past decade, Noel Gollehon reported. More efficient management and technology have reduced irrigation

water use nationally from 25 inches per acre to 19 inches per acre between 1969 and 2012, an efficiency gain of 24 percent. Ron Rayner, farmer and Partner at A-Tumbling-T Ranches, highlighted a two-fold increase in production while using less water, and credits innovations in management and technology with the improvement.

Paul Brown, Associate Director of Arizona Cooperative Extension, summarized Arizona agriculture’s gains in water efficiency for the conference. While irrigation in Arizona is still dominated by gravity systems, it has become more efficient through several techniques like shortening irrigation runs and changing the flow rate down the furrow. Water use in Yuma is down about 18 percent in the last 40 years. There is a move toward sprinklers, especially “solid set” sprinkler systems for plant establishment, where 50 to 75 percent reductions in water use are possible. Away from Yuma, agriculture has seen increases in laser leveling and large increases in center pivot sprinklers, especially in southeast Arizona. Area farmers also have rapidly increased their use of drip irrigation where tree nuts are grown. Additional water savings are possible through irrigation timing based on crop evapotranspiration, and this technology is growing slowly.

Colorado River Indian Tribes Council Secretary Amelia Flores introduces panel on fallowing.



NRCS Senior Economist Noel Gollehon gives morning keynote at WRRC conference.



An example of farming innovation and efficiency was offered by Arnott Duncan of Duncan Family Farms, which specializes in all organic greens and herbs. His focus is producing a quality of product and the farms use techniques designed to grow more and better product with high efficiency. These include portable drip irrigation systems set up for specific crops, as well as soil lubrication for dead-level harvesting, and use of organic matter to enhance light soils for crops with shallow roots. He is investigating high-tech automated microwave and cellular systems and sanitation systems at the farm level for use of recycled water.

However, as Gollehon observed, efficiency does not always mean conservation. Efficient production may simply use the same amount of water to produce more. If conservation is the goal, other measures should be used.

Fallowing is one agricultural water conservation measure that has received a lot of attention. In a panel on the subject, David Bradshaw, Assistant Water Manager with Imperial Irrigation District, Meghan Scott, attorney for BARD Water District, and Jack Seiler, farmer and Trustee for Palo Verde Irrigation District, described fallowing arrangements, how they work and how well. Components of fallowing programs include voluntary enrollment and limits on the amount of land that can be fallowed in a district. In the project described by Scott, it was explicitly stated that participation in no way affects water rights. In addition, the programs should contain mitigation actions to buffer communities dependent on the farm economy from losses. In general, farmers seem to like to see the secure income fallowing provides in hard times and banks understand the value of these arrangements. Bradshaw cautioned, however, that implementing fallowing for water conservation is complicated, and Scott added that measuring success in water savings is a problem.

Despite these largely positive examples, Dan Keppen, Executive Director of the Family Farm Alliance, indicated that the immediate reaction of farmers to the idea of fallowing for water conservation is usually negative, although some folks are forced into it by economics. The idea has to be approached sensitively to acknowledge the value of farming. “Agriculture will not be the reservoir to meet water demands,” said Keppen.

In Central Arizona, agricultural entities are facing the potential for major cut backs in their supplies of Central Arizona Project (CAP) water and are planning for meeting this challenge. With shortages on the horizon, water users are looking for ways to collaborate on problem-solving without sacrificing their fundamental interests. Central Arizona irrigators are at the table for negotiations regarding the Colorado River Basin Drought Contingency Plan and will continue to participate in efforts to keep water in Lake Mead to forestall a shortage declaration. However, many, like Dan Thelander, Partner of Tempe Farming Company, and Brian Betcher, General Manager of Maricopa-Stanfield Irrigation and Drainage District, are wary of the provision that CAP water for Central Arizona agriculture would drop to zero if Lake Mead falls to 1,075 feet above sea level. Betcher’s voice was one that questioned the fairness of the situation that Central Arizona agriculture should absorb system losses.

Betcher described Central Arizona’s irrigated agriculture as scientific and integrated — “These guys know what they’re doing,” he said. Betcher noted that irrigators use highly efficient low head systems, have changed their crops, and have begun fallowing marginal lands. Ultimately, though, a cut in CAP water means a return to groundwater use to meet the needs of the district’s members. He highlighted the question of how much groundwater can and should they pump, which the district is facing in its planning for the future.

Dan Thelander noted that the choices for agriculture in a water shortage are problematic. Farmers can install expensive irrigation systems, experiment with low water use crops, and switch to high-value crops. Though all of these choices have their drawbacks, Thelander sees some promising options including use of high organic material on soils to reduce water use while providing other benefits to the plants. In addition, growing guayule, a source for rubber, would respond to existing demand for this low-water use crop.

Jason Hauter, attorney and Gila River Indian Community (GRIC) member, spoke from a different perspective about the potential role of GRIC in assisting with the Drought Contingency Plan and other needs related to shortages on the Colorado River. They pledged 450,000 acre-feet over 2-year period for Lake Mead. The GRIC has the largest single contract for CAP water (311,800 acre-feet per year) as part of its quantified right to 653,500 acre-feet of water. Community goals for the use of their water require flexibility, so they are not interested in 100-year leases. Instead, they will be focusing on short-term arrangements. According to Hauter, the GRIC don’t have a water supply issue; they have a water cost issue related to the cost of CAP delivery.

Beyond Central Arizona there are other issues arising around maintaining groundwater supplies. Central Arizona has both CAP access and groundwater management restrictions for the protection of groundwater supplies, which other areas of the state lack. Clint Chandler, Assistant Director, Water Planning and Permitting Division of the Arizona Department of Water Resources (ADWR), described Governor Ducey's Water Initiative, a planning process searching for stakeholder-driven solutions, which has prioritized attention to three "planning areas", the West Basin, Northwest Basin, and Cochise planning districts.

In these areas, as Chandler noted, "existing management tools may not be appropriate." Active Management Areas and Irrigation Non-Expansion Areas are the two current possible tools, and they both prohibit irrigation of new lands. These would squash the budding wine industry, which shows so much promise for economic development in rural areas.

A tag team of John Hart, farmer and Vice President of the Cochise County Farm Bureau, and Richard Searle, Cochise County pistachio grower and rancher, talked about efforts in the Wilcox area and Sulfur Springs Valley to address problems of falling water levels and small wells going dry. Subsidence and earth fissures are causing problems. "We have been chasing water for 100 years," said Searle. The agricultural crash in the early 1980s put a lot of farmers out of business, following which the water table came back up somewhat. This demonstrated that the aquifer does receive recharge, estimated at about 20,000 to 40,000 acre-feet. But in the 1990s agriculture came back. Now area residents are seeing an influx of deep wells for trees being dug by developers mostly from California. "It is not an affluent area," observed Hart; Searle added, "The anger level is going up."

Hart and Searle tried to come up with a third way by getting people together to work out their differences. What they came up with would allow water to move around within the basin, but put a cap on how much could be pumped. It did not reduce water use, but no new uses would be allowed unless moved from another part of the basin. There was an exemption for small domestic wells.

The group made progress as long as there was a threat of an AMA being formed, but agreement dissipated after that ended. When they brought their "Groundwater Conservation Area" proposal to the Legislature, they were told that they didn't have enough support.



Arizona State Conservationist Keisha Tatem speaks on the role of NRCS in irrigated agriculture.



Some of the 325 conference attendees during a WRRC conference session.

Things are not quite as volatile in Mohave County as described by Mark Clark, Manager of Mohave Valley Irrigation District and Bullhead City Councilman, but Mohave County has worries in some areas about the future. The Hualapai Basin could double its water use in the next 10 years. None of the available tools are proactive: petitioners were turned down for an AMA or an INA because they couldn't demonstrate current drawdown. However, residents are still hopeful that something can be worked out.

There is less optimism in the Cochise area. Hart offered the opinion that without a crisis change is unlikely. Searle suggested that the state lacks the will to solve the problem for such a small population. "If nothing is done, economics may drive the decisions," added Searle. Doug Dunham, ADWR legislative liaison, said the department is trying to help rural Arizona find tools for coping with groundwater issues. He asked that the parties give the state a chance. Time is needed to get the right answer. Improvements in the regional discussions give hope.

Past successes in solving water management challenges at the state level also give hope. The prime example is the story of the state's 1980 Groundwater Management Act. The film, *Groundwater: To Enact a Law for the Common Good*, produced by Kathleen Ferris and Michael Schiffer, went behind the scenes on how the law came to be through conflict, threat, leadership, and compromise. Difficult negotiations resulted in a bill that spread the pain of losses for the sake of responsible groundwater management. In the end, farmers, along with everyone else in the most populous and water stressed parts of the state, had to accept limits on their water use but, as Rayner stated, at the same time their right to water was recognized.

John Sullivan, retired Deputy General Manager of the Salt River Project, spoke about GMA's impact in the Phoenix AMA, where it encouraged lining ditches, laser leveling, best management practices that encourage efficiency, use of reclaimed water, and water banking through Groundwater Savings Facilities.

For the future, there is a need for continued collaboration because some things remain to be done. Partnerships are seen as key instigators for creating solutions. Keisha Tatem, the USDA-NRCS State Conservationist, emphasized their desire to leverage local partners for accomplishing common goals.

Betcher noted that the irrigation district is partnering with the Environmental Defense Fund on a study of options for sustainable groundwater use, and Hauter ended his talk on GRIC's water use by reminding the audience that they are looking for partnership opportunities.

Davis referred to the "Groundwater" film for his conference take-away message: "Sometimes unsolvable things can be

solved by reasonable minds if they have no other choice." For her summary of the day's lessons, Sharon Megdal referred to earlier comments made by Sullivan calling for attention, perseverance, effort, and time for achieving solutions. She added "tension"—not crisis—but enough tension to create conditions for collaborative problem-solving. 

## Feature

### Nexus of Food-Energy-Water Challenges Resource Management

by R. Andres Sanchez, WRRC Graduate Outreach Assistant

The challenges of climate change, population growth, and water scarcity have highlighted the need to develop a better understanding of the interactions among food, energy, and water (FEW) systems. There is a FEW nexus in which energy, water, and agriculture are intertwined aspects of resource security. Food production through the agricultural industry is critical for food security and depends on inputs of water and energy. Energy is required to supply and treat water for agriculture, municipal, and industrial uses, whereas water is used for human and industrial consumption, crop irrigation, and energy production. Thus, constraints in one area can significantly impact the others.

In the past, each component of the FEW system has been managed and regulated independently, disregarding the existing linkages among these resources. The increasing demand for fresh water, energy, and food under the pressures of climate change and population growth have increased the need for integrated management that accounts for the complexity and dynamic interrelationships of the FEW nexus. Such an approach aims for cross-sector coordination instead of sector specific optima to avoid unintended side-effects and negative sectoral trade-offs.

Arizona's current water use varies between seven and eight million-acre feet per year. Agriculture is by far the largest user of water in Arizona, accounting for about 70 percent of withdrawals. Arizona's climate allows year-round agricultural production, self-supplying most of its demand for animal feed, livestock, and other food products and also supplying major regional cities, including Los Angeles, San Diego, El Paso, and Las Vegas.

A study conducted by researchers at the School of Sustainable Engineering and the Built Environment at Arizona State University found that irrigation requirements, crop yield,

and energy use are sensitive to temperature change. Thus, the entire FEW system is vulnerable to a warming climate. Farmers with low profit margins and crops that use the most water, like alfalfa and cotton, may be more affected by these changes. Farmers could cope with the impacts of climate change without significant investments by changing their crop choices, planting dates, and irrigation timing. A larger investment is required for technological adaptations, which will be important to improvements in energy and water efficiencies. The United States Department of Agriculture in its 2013 Farm and Irrigation Survey reported that only 471 Arizona farms use drip, trickle, and low flow micro sprinklers, while 1,640 farms use traditional sprinkler systems and 3,005 use gravity systems. These numbers show that there is still room for improvement in water efficiency through increased use of more efficient irrigation techniques.

The FEW nexus is emerging as a topic of interdisciplinary research. In this regard, the National Science Foundation (NSF) has awarded several projects aiming to develop a better understanding of the FEW nexus. Researchers at Northern Arizona University have received funding from NSF to create the first detailed mapping of the FEW system of the United States. This project aims to integrate the multiple components of the FEW system, such as regional trade, river basins and aquifers, irrigation districts, crop belts, states, tribes, counties and cities, power grids, and climate gradients, to produce a more comprehensive understanding of their dynamics and interactions.

A multidisciplinary group of researchers at Arizona State University is working on a project to engage stakeholders in the Phoenix Active Management Area to develop a bottom-up model of the FEW nexus. They are utilizing modeling tools for each component of the FEW nexus and developing a tool, called a knowledge interchange broker, to enable the models to talk to each other. The aim is to create a FEW model for stakeholder and policy engagement.

Understanding how the FEW system works as a whole would provide a foundation for future water and energy savings and would help policy and decision makers allocate and prioritize resources in an integrated manner across the food, energy, and water sectors. 

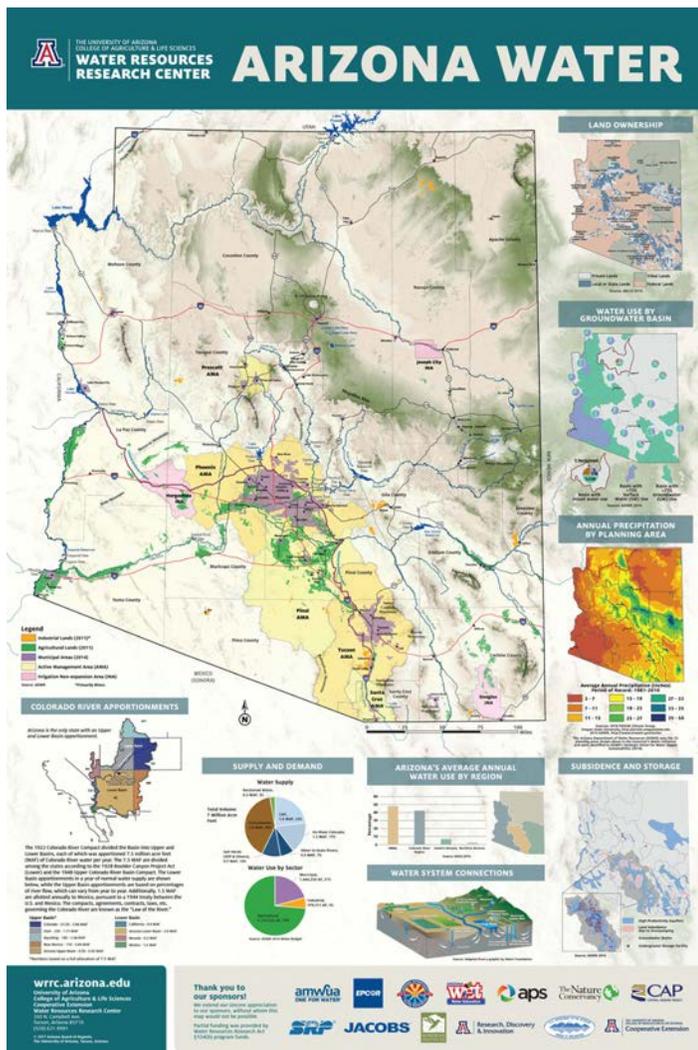
# Special Feature

## Arizona Water Map Poster: The Production of a Stakeholder-Driven Map

By Ashley Hullinger, WRRC Research Analyst

**Question:** What kind of effort and time go into the making of the WRRC Arizona Water Map?

**Answer:** More than you might expect! In terms of effort, four WRRC personnel completed research and tasks at varying stages of map development and relied upon the volunteer hours of dozens of supporters. Approximately one year and six months later, we are all proud of the outcome.



management and planning unique to our state. While WRRC-internal conversations started a few months before, the map was propelled forward by the formation of the Arizona Water Map Technical Advisory Committee (TAC), convened on the basis of GIS expertise, experience with Arizona water resources data, and involvement in previous Arizona Water Map development. The TAC included representatives from the Arizona Department of Environmental Quality, Arizona Department of Water Resources, Central Arizona Project, Salt River Project, U.S. Bureau of Reclamation, University of Arizona, Water Infrastructure Finance Authority of Arizona, and Water Resources Research Center.

The first stakeholder meeting and an online survey were conducted in October 2015, posing questions about the usefulness of past maps and possible areas of improvement. A plan of attack was formed. The first step was to compile all of the suggestions and feedback from the meeting and survey to ask three pointed questions of the WRRC External Advisory Committee in November of 2015:

1. Which of the three previous Arizona water maps is most visually appealing? Why?
2. Is the question, "Are we going to run out of water?" a valid and useful organizing theme for this map?
3. What would you consider to be the 7-10 most important Arizona water features to include on a static map of the state?

Responses were tabulated, and with an array of responses in hand, the WRRC and TAC put the map through multiple stages of design and review. The TAC provided vital guidance and expertise throughout the map development process, which was then taken back to the WRRC drawing board for synthesis. Notable updates and changes to the final map included:

- Stronger emphasis on water supply and demand in Arizona, among different water using sectors and regions
- Inclusion of ADWR's 22 planning areas used in their statewide planning initiative released in the 2014 Strategic Vision
- Updated data
- Updated appearance to reflect modern design technique
- Emphasis on groundwater usage
- Highlighted population density
- New map on recharge and subsidence
- New natural terrain background using Esri's multi-directional hillshade, which presents mountains, plateaus, valleys and canyons using an algorithm that computes hillshade from six different directions (as opposed to one direction in a default hillshade)

From brainstorming to final reviews, the power of the stakeholder-driven process was harnessed to ensure that the fourth version of the Water Map accurately reflects the current state of water resources in Arizona, as well as a culture of

We look forward to sharing the latest map throughout the state, continuing a tradition of providing reliable and concise visual representation of Arizona's water resources.

Throughout the course of map development we welcomed the support of sponsors and partners, to whom we are extremely grateful. Their logos are displayed at the bottom of the map, and they include the Arizona Department of Water Resources, Arizona Municipal Water Users Association, Arizona Public Service, Arizona Project WET, Arizona Cooperative Extension, Central Arizona Project, EPCOR Water, Jacobs Engineering, Salt River Project, Sonoran Institute,

The Nature Conservancy, U.S. Bureau of Reclamation, University of Arizona Research, Discovery & Innovation, and Water Resources Research Act §104(b) program.

Beginning in May, maps will be on sale at the Water Resources Research Center and can be ordered by emailing us a [wrrc@email.arizona.edu](mailto:wrrc@email.arizona.edu) or calling 520-621-9591. Contact us now to preorder. 

## News Briefs

### Student Poster Prizes Awarded at 2017 WRRC Conference



At the March 28th conference, "Irrigated Agriculture in Arizona: A Fresh Perspective," prizes were awarded for the best student posters. The poster exhibit included 14 posters on projects related to water management, quality, and irrigated agriculture. Of these, 11 were presented by students. While all the posters generated animated discussion during the event, three posters won top honors. First place went to graduate student Ravindra Dwivedi, Department of Hydrology and Atmospheric Sciences, for his poster, *Catchment-scale Groundwater Recharge and Vegetation Water Use Efficiency*. Juli Simons' poster, *Self-Sterilizing Irrigation Pipelines*, took second place. Simons is a graduate student in the Department of Soil, Water and Environmental Science. *Innovative Water & Risk Trading Between Agriculture, Cities, Tribes & Conservation Interests* by Suhina Deol, graduate student in the Department of Agricultural and Resource Economics, received third place honors. Poster sessions co-sponsors, Southern Arizona Water Users Association and Water Asset Management, provided funding for the prizes.

### Apache Junction Receives Water Project of the Year Award

The Water Infrastructure Finance Authority (WIFA) of Arizona selected the Superstition Area Water Plant, which is operated by the Apache Junction Water Utilities Community Facilities District, as the recipient of the 2016 Drinking Water Project of the Year Award. The Superstition Area Water Plant was designed and built to treat 1.5 million gallons of water per day. WIFA's Project of the Year awards recognize exemplary project management and commitment to public health through the improvement of drinking water and wastewater infrastructure.

### Conference Lunch Celebrates Local Foods

Lunch at the WRRC's 2017 annual conference, "Irrigated Agriculture in Arizona: A Fresh Perspective," was a celebration of Tucson's designation as a UNESCO City of Gastronomy, the first such designation in the United States. Dr. Jonathan Mabry, Historic Preservation Officer and Archaeologist for the City of Tucson, spoke about Tucson's qualifications for the designation. Mabry, who was the lead author of the application to UNESCO, presented a tour of Tucson's 4,000-year history of food production. Since 1993, archeological projects conducted in the floodplain of the Santa Cruz River have found irrigation canals that go back 3,500 years and uncovered an early farming village culture that flourished



long before the Hohokam of the Phoenix area. In addition, Tucson has a 300-year tradition of vineyards, orchards and cattle ranching dating back to the Spanish period and currently has more foods listed on a worldwide list of regionally unique foods grown within 100 miles than any other city in North America. The designation is expected to encourage growth in tourism and related economic development.

As a special treat for the conference lunch, BKW Farms and master baker Don Guerra of Barrio Bread supplied each table with a basket of bread made from locally grown grain. The Wong family, owners of BKW Farms, grew the wheat—White Sonora, Khorasan, Hard Red, and Durum—Guerra used in his bread. This partnership illustrated the emergence of a unique local food culture in the Tucson region.

## Goodyear and SRP Agree on Water Wheeling Deal

The City of Goodyear will finally be able to use its more than 17,000 acre-feet of water annually from CAP and a lease with the Gila River Indian Community, thanks to a unique agreement with the Salt River Project (SRP). Goodyear relies entirely on groundwater to meet its municipal water needs because it does not currently have the infrastructure necessary to use its annual CAP allocation. According to the agreement, SRP will wheel the water to Goodyear by taking delivery at the SRP-CAP Interconnect Facility near Granite Reef Dam and then transporting it through SRP's conveyance system. Goodyear will pay SRP for the use of the interconnect facility and conveyance system. In addition, Goodyear will construct a water treatment plant and pipeline to connect the plant to the SRP system. Water deliveries to SRP shareholders from the Salt and Verde Rivers will not be affected. This partnership will increase Goodyear's flexibility in planning for its future water demands, as well as create an opportunity for SRP to collaborate in regional water solutions.

## USGS Studies Hualapai Basin Groundwater Declines

The City of Kingman and Mohave County are sponsoring a study of water use in the Hualapai Basin by the United States Geological Survey. The three-year study will cost \$450,000, with the bill shared by the city and county. The study will be similar to one performed in the San Pedro Basin in Southern Arizona, using a groundwater flow model and groundwater monitoring through gravity network measurements from stations placed in the Hualapai Basin. The two-phase project will start with monitoring and end with modeling different scenarios of increased recharge and withdrawal of the basin to develop a picture of future groundwater levels. It is hoped that the new information will support decision making regarding potential water use regulation for the basin.

## Rodney Lewis Appointed to CAWCD Board



Rodney Lewis (center) accepts appointment to CAWCD board.

Governor Doug Ducey announced the appointment of water rights attorney and Gila River Indian Community member Rodney Lewis to the 15-member Central Arizona Water Conservation District (CAWCD) Board of Directors. Governor Ducey noted Lewis's long and distinguished service and experience as a valuable asset in the search for solutions to the complex issues faced by the CAWCD. Lewis, a graduate of the UCLA law school, served as the General Counsel for the Gila River Indian Community beginning in 1978 and led the Community's negotiations with the federal government, the State of Arizona, and more than 30 non-Indian parties that resulted in the Arizona Water Settlements Act of 2004. He was the first member of an Arizona Indian Tribe to gain admission to the Arizona State Bar, and in 1980, he was the first member of an Indian Tribe to win a case before the United States Supreme Court. He also worked toward the Crow Nation Water Settlement of 2010 and the Pechanga Water Settlement of 2016. Lewis was inducted into the Maricopa County Bar's Hall of Fame in 2009.

## New Agreement Creates Partnership for Drought Resiliency

A cooperative agreement signed by the Gila River Indian Community, the Arizona Department of Water Resources, the City of Phoenix, and the Walton Family Foundation will support continued planning to address water level declines in Lake Mead. The agreement will allow Arizona parties to continue negotiating a comprehensive plan known as the Drought Contingency Plan Plus or DCP Plus. The partners seek to establish mechanisms for working together for the long-term protection of the Colorado River and Lake Mead.

## Big Chino Sub-basin Groundwater Flow Modeling Study Undertaken

The City of Prescott, Town of Prescott Valley, and Salt River Project have partnered in an initiative to create a refined groundwater model for the Big Chino Sub-basin. The model's purpose is to assess the hydrogeologic connection of sub-basin groundwater with the Upper Verde River and

potential effects of plans to pump approximately 8,000 acre-feet of groundwater annually from sub-basin. In addition, hydrologic data collected over the past decade and continuing into the future will be augmented by information from newly installed groundwater and surface water monitoring stations. The 2010 US Geological Survey Northern Arizona Regional Groundwater Flow Model (NAGARFM), which encompassed

the study area, was at too large a scale to be used for the needed level of detailed analysis to support decision-making. The refined modeling, to be carried out by Golder Associates, Inc. of Tucson, will be scaled to answer questions related to the effects of pumping in the Big Chino Sub-basin and what might be done to mitigate these effects if necessary. The \$1.1 million effort is scheduled to be completed by 2020.

## Resources

### Aquacrop-OS

UN Food and Agriculture Organization 2017

<http://aquacropos.com/>



In response to the need for increasing efficiency and productivity of agricultural water use, the Food and Agriculture Organization of the United Nations (FAO) has launched the AquaCrop-OpenSource (AquaCrop-OS) website, which is an open source tool to use in agricultural water management. Traditionally, the crop yield and water supply relationship has been determined based on empirical production functions and/or crop simulation models that are either developed for a specific location or require highly detailed input data. To address these limitations, the FAO developed the original AquaCrop in 2009, a multi-crop model that requires a small number of parameters and has been successfully applied to a wide range of environmental and agronomic settings. However, this model cannot be combined or integrated easily with other software tools. An international group of researchers from the University of Nebraska, FAO, the University of Manchester, and Imperial College, London developed the new AquaCrop-OS, with source code and documentation freely available for non-commercial purposes. It also can be run across multiple languages and operating systems. With AquaCrop-OS users can assess the effects of agricultural water use on basin hydrology and find solutions to issues of food security in water-scare areas.

### EPA Green Infrastructure and Climate Change Case Study Report

U.S. Environmental Protection Agency, Office of Wastewater Management, August 2016 EPA 832-R-16-004

[https://www.epa.gov/sites/production/files/2016-08/documents/gi\\_climate\\_charrettes\\_final\\_508\\_2.pdf](https://www.epa.gov/sites/production/files/2016-08/documents/gi_climate_charrettes_final_508_2.pdf)



The four cities of Albuquerque, Grand Rapids, Los Angeles, and New Orleans participated in 2015 in a U.S. Environmental Protection Agency program designed to explore how green infrastructure could help them become more resilient to climate change. The EPA organized intensive planning sessions in which representatives of each city from a variety of disciplines worked with a set of concepts that guided their planning.

These concepts included identifying the multiple benefits of green infrastructure practices; collaborating across city agencies to maximize benefits; unifying solutions across multiple disciplines; and achieving efficiencies in project implementation. Each city focused on their most pressing climate change issues given the level of green infrastructure they had already implemented. Lessons learned and recommendations are summarized in the publication "Green Infrastructure and Climate Change Collaborating to Improve Community Resiliency," which is intended to serve as a guide for communities wanting to prepare for and manage the effects of climate change.

### National Water and Climate Center Interactive Map 3.0

USDA Natural Resources Conservation Service, National Water and Climate Center 2017

[https://www.wcc.nrcs.usda.gov/snow/snow\\_map.html](https://www.wcc.nrcs.usda.gov/snow/snow_map.html)



The NRCS National Water and Climate Center has released a Beta version of an interactive map displaying current and historical measurements for snow, rain, and streamflow for the western United States. New features include more detailed and in-depth analyses of seasonal peak snowpack. The map reveals

regional trends in snow water equivalent and snow depth. Clicking on a station displays information about the station type and location, as well as statistics on most recent values and values over the life of the station. Users are encouraged to evaluate the map features during the Beta testing phase and provide feedback.

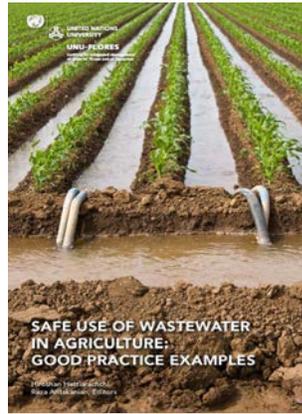
## Safe Use of Wastewater in Agriculture: Good Practice Examples

Hiroshan Hettiarachchi Reza Ardakanian, Editors

United Nations University Institute for Integrated Management of Material Fluxes and of Resources, 2017

<http://collections.unu.edu/eserv/UNU:5764/SafeUseOfWastewaterInAgriculture.pdf>

The United Nations University Institute for Integrated Management of Material Fluxes and of Resources (UNU-FLORES) published *Safe Use of Wastewater in Agriculture: Good Practice Examples*, a book-length collection of case studies. This publication aims to address the technical, institutional, and policy challenges of safe wastewater reuse, as well as



providing a better understanding of its opportunities and potential risks. Wastewater has been recognized as a crucial resource for future water security. However, many developing countries and countries in transition lack the necessary scientific criteria for ensuring safe reuse. In response to this need, the UNU-FLORES identified case studies from around the world exemplifying the practice

of wastewater use in agriculture across the globe. These cases were discussed at a workshop attended by representatives from 15 countries in Lima, Peru, in February 2016. The resulting book includes 17 case studies selected from Latin America, Asia, and Africa addressing three different dimensions of the topic: Technological Advances, Health and Environmental Aspects, and Policy and Implementation Issues. The new book is a resource for those interested in learning from existing good practice on using wastewater in agriculture.

## Student Spotlight

### Jake Golden, Water, Society, and Policy



Jake Golden is a first-year master's student at the University of Arizona in Water, Society, and Policy and a Gates Millennium Scholar. He received his Bachelor's degrees in International Relations and History from the University of Arkansas in Fayetteville.

Jake has worked in a variety of places from the Federal Bureau of Investigation to a national manufacturing company, Raven Lining Systems.

He worked for eleven months at the FBI in Oklahoma City, OK and Fayetteville, AR on cyber and drug enforcement programs. After studying abroad in Besançon, France, Jake went on to pursue two minors in Sustainability and French. At Raven Lining Systems, he provided support to the social media team and aided in writing case studies.

Passionate about water issues and sustainable management, Jake hopes to find solutions for greater national water security in the U.S. As a member of the Cherokee Nation, water security and natural resource sovereignty are top priorities in his research.

At the WRRC, Jake works as a Graduate Assistant on a variety of tasks including support for the Annual WRRC Conference. Expected to graduate in May 2018, he wants to work on tribal water issues or international water management issues. 



## Public Policy Review

### A Spring Full of Productive Activity!

by Sharon B. Megdal

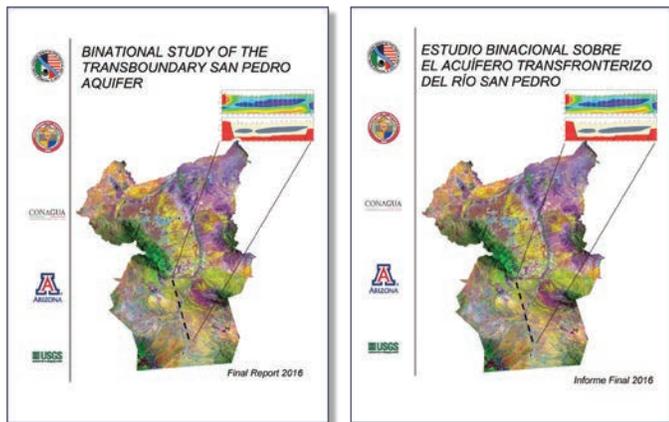
Spring semester is always a busy time of year. I teach my graduate Arizona Water Policy class and convene a seminar class for the Master's program in Water, Society, and Policy. Students are completing theses, projects, and examinations as they ready for graduation. The Water Resources Research Center recently held its Annual Conference, which it has done every year since 2003.

While I am confident that students enjoy their classroom learning opportunities, getting out in the field is – at least for me – a course highlight. Early in March, visitors from Sonora, Mexico joined my class for our annual field trip to Tucson Water's recharge and wetlands sites and Central Arizona Project's Twin Peaks Pumping Plant, with a great outdoor lunch at the White Stallion Ranch in Marana hosted by BKW Farms.

The WRRC's Annual Conference provides another mechanism for exploration. We were pleased with and thankful for the strong interest in this year's topic, "Irrigated Agriculture in Arizona – A Fresh Perspective", and the contributions of all of our speakers, moderators, sponsors, and attendees. Although we could not take well over 300 people into the field to learn about irrigation practices and cropping patterns in Arizona, we sincerely hope that attendees at our March 28, 2017 conference found the presentations and commentary we brought to them informative and interesting. The WRRC's Annual Conference is designed to address a topic of statewide importance and bring together participants

from throughout Arizona and beyond to share information and to learn. This year's participants came from about 35 Arizona communities and from eight other states in the US, Washington, DC and Sonora, Mexico. The conference benefitted tremendously from the input and assistance of an engaged conference advisory committee. For attendees and non-attendees, we have posted the presentation videos and, when available, power point slides: <https://wrrc.arizona.edu/conferences/2017/agenda>. Please take a look. And please mark your calendars for next year's conference! Our 2018 Annual Conference on "The Business of Water" will be held on March 28 at the University of Arizona Memorial Student Union. We received very positive feedback on this topic, which is broadly construed to include water financing, water rates, public-private partnerships, water commodification and marketing, and more. Let me know your thoughts about topics and perspectives to include by emailing me at [smegdal@email.arizona.edu](mailto:smegdal@email.arizona.edu).

This has been a busy semester for research project work as well. In particular, work continues on various aspects of the binational Transboundary Aquifer Assessment Program (TAAP). Late in 2016 we announced the official release of the Binational Study of the Transboundary San Pedro Aquifer, a key product of the binational TAAP. The International Boundary and Water Commission posted the peer-reviewed report in English ([https://www.ibwc.gov/Files/San\\_Pedro\\_Binational\\_Report\\_En\\_01122017.pdf](https://www.ibwc.gov/Files/San_Pedro_Binational_Report_En_01122017.pdf)) and Spanish ([https://www.ibwc.gov/Files/San\\_Pedro\\_Binational\\_Report\\_ESP\\_Final\\_2016.pdf](https://www.ibwc.gov/Files/San_Pedro_Binational_Report_ESP_Final_2016.pdf)). We continue to work on completing a similar report for the transboundary Santa Cruz aquifer. WRRC research analyst Jacob Petersen-Perlman and I have written an invited book chapter explaining how the TAAP effort is consistent with the information sharing goals of the United Nations International Law Commission's Draft Articles



**Covers in English and Spanish of the Binational Study of the Transboundary San Pedro Aquifer.**

on the Law of Transboundary Aquifers. Graduate student Elia Tapia, whose excellent translation and GIS mapping skills are reflected in the published San Pedro Study, is working on expanding our understanding of the relationship between precipitation and groundwater utilization patterns at the border. We will soon release a synopsis of the San Pedro Study in both English and Spanish and our binational team will speak to the many facets of this study effort at the May international World Water Congress in Cancún, Mexico and

the June national conference of the Universities Council on Water Resources in Ft. Collins, Colorado. At the World Water Congress, a multi-part special session considering shared waters of North America will feature participants from all regions involved in TAAP. They will speak to the program's scientific and modeling accomplishments, along with some of the institutional and legal considerations. There I will discuss the importance of the 2009 Joint Report of the Principle Engineers Regarding the *Joint Cooperative Process United States-Mexico for the Transboundary Aquifer Assessment Program*, which has guided this important binational collaborative effort. The robust cooperative process for the Arizona-Sonora portion of the TAAP involves the U.S. and Mexican Sections of the International Boundary and Water Commission, U.S. Geological Survey, Comisión Nacional del Agua (CONAGUA), University of Sonora, and University of Arizona. It can serve as a model for federal-university partnerships and binational studies that go well beyond aquifer assessment. More information about the TAAP, particularly the Arizona-Sonora portion of the program, can be found at <https://wrrc.arizona.edu/TAAP>.

I look forward to the culmination of Spring semester activities. And of course, the work will continue, which I look forward to as well! 🌍



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