



East Fork, Black River, Apache-Sitgreaves National Forest.  
Source: Kerry Schwartz

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## Publications

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# Water Resources Protection Spurs Forest Restoration Actions

by Marie-Blanche Roudaut, WRRC Graduate Outreach Assistant  
and Susanna Eden, WRRC

Arizona's forests need help. The dense, over-stocked forests in Arizona are not natural and create an environment conducive to insect and disease outbreaks, high-intensity wildfires, and unsustainable conditions for forest ecosystems. Years of fire suppression and drought have produced a situation where mega-fires become the norm. Arizona has witnessed an increase in the size, severity, and frequency of wildfires during the past 14 years. The two largest fires in Arizona's history, the 2002 Rodeo-Chediski Fire and the 2011 Wallow Fire burnt respectively 468,000 and 538,000 acres. The Schultz Fire in 2010, which burned the east side of San Francisco Peak, was not only destructive, but also resulted in devastating post-fire flooding and loss of life.

Arizona's forests are critical to the state water supply. Most of Arizona's surface water resources are supplied by high-elevation forested watersheds, which capture rain and snow that feed downstream surface waters. Forest lands provide the majority of the water for the Salt and Verde Rivers, which are vital water supplies for users in the greater Phoenix metropolitan Area.

Fortunately forests are receiving increased attention as understanding grows about threats to water and other resources from past mismanagement. This

*Forests continued on page 2*

# Research Projects Tackle Reclaimed Water Issues

Concerns about the quality of reclaimed water are getting research attention in two very different projects selected for funding by the University of Arizona Water Resources Research Center. The WRRC provides research grants up to \$10,000 each under the Water Resources Research Act, Section 104(b) with funding from the U.S. Geological Survey. The 104(b) program's major goals are to foster research on water and related issues of importance to the state and region and to encourage the entry of students and young scientists into the field of water resources.

The first project, proposed by Robert Arnold, UA Professor of Chemical and Environmental Engineering, and David Quanrud, Associate Research Scientist in the School of Natural Resources and the Environment, investigates the natural

*Research continued on page 6*

recent attention is fostering programs that restore forest health to reduce these threats. Many municipalities are investing in forest restoration projects with the goal of returning forests to a more natural state that is more resilient to drought, fire, and insect infestations. The estimated cost of forest treatment and restoration projects aimed at minimizing the harmful effects of wildfires is estimated to cost \$500 to \$1,000 per acre. This investment could save Arizona hundreds of millions of dollars in wildfire suppression costs and damages.

Arizona Forward, an organization that brings business and civic leaders together over issues of environmental sustainability and economic vitality, published “Threat to Forest Health puts Arizona at Risk” to highlight the urgent need for forest treatment and restoration. The primer was unveiled in early October 2015 to 300 community leaders attending Salt River Project’s two-day “Healthy Forests, Vibrant Economy” forum on how to accelerate forest restoration in Arizona. The document proposes actions that could mitigate the impact of wildfires and threats to water quality.

Healthy forests are characterized by small groves of trees with large spaces between them filled with grass and wildflowers. Ideally, each individual tree has adequate access to water, sunshine, and nutrients. Overgrown forests support far too many trees per acre that compete for water and nutrients. For example, a healthy ponderosa pine forest has about 20-50 trees per acre. In contrast, the unhealthy forests commonly seen in Arizona contain over 1,000 trees per acre, with the ground between them covered with a thick layer of pine needles and very little grass or wildflowers.

A forest with widely spaced trees has a significantly lower risk of catastrophic wildfires and is instead more prone to low-intensity ground fires that rejuvenate soils and control vegetation density. In addition, healthy forests have greater resistance to bark beetle infestations that have devastated large areas of Arizona’s ponderosa pine forests. Healthy forests also support more diverse wildlife and plant species that are vital for the entire forest ecosystem.

When wildfires burn through a dense, unhealthy forest, they burn extremely hot and can be catastrophic in size and intensity. After such catastrophic fires, soils are scorched and are unable to retain or absorb rain, increasing the risk

of dangerous flooding. In addition, the amplified runoff washes down burned slopes carrying significant amounts of ash, sediments, and debris into streams, destroying fish habitats and riparian areas. The sediment carried by such flows into reservoirs reduces the reservoir storage capacity and increases the cost for cities to treat the water to potable water standards.

In the Phoenix metropolitan area, increased sediment loading and decreased water quality resulting from intense wildfires in the Salt and Verde River watersheds directly led to an increase in operational costs for city water treatment plants. Proactive forest restoration projects could prevent municipalities from spending millions of dollars for slope stabilization, reservoir dredging, and additional water treatment to mitigate the impacts of wildfires.

The Northern Arizona Forest Fund (NAFF) was created in 2014 to help connect businesses, residents, and other stakeholders in the Phoenix Metropolitan Area with projects that improve forest and watershed health. NAFF provides an opportunity to invest in projects in the Salt and Verde watersheds, and the fund receives significant financial contributions from a variety of investors, including cities, businesses, and civic organizations. For example, the City of Scottsdale is investing \$120,000 over three years in the NAFF. Contributions to the NAFF are collected and administered by the National Forest Foundation.

The National Forest Foundation was created by Congress in 1993 to engage the American public in the restoration and public enjoyment of its national forests and grasslands. The official nonprofit partner of the Forest Service, it engages in community-based and national programs to promote the health of national forests. It also administers gifts of funds and land for the benefit of the national forests.

Each year, the National Forest Foundation in collaboration with the U.S. Forest Service identifies priority projects aimed at improving the health and resilience of National Forest lands in the Verde and Salt River watersheds. The NAFF’s six 2015-2016 funded projects were officially announced at the third annual “Healthy Forests, Vibrant Economy” forum in Scottsdale, October 7 and 8, 2015. They include the Stoneman Lake Watershed Health and Habitat Protection Project, located in the ponderosa pine forests along the Mogollon Rim in the Coconino National Forest, near Sedona and the

McCracken Woodland Health and Habitat Improvement Project, located within the pinyon-juniper woodlands of the Kaibab National Forest, south of Williams. Other projects deal with degradation of Oak Creek, sedimentation in the Verde River, and riparian protection of Black River. Another erosion control project is located at a popular trail east of Superior. In addition to reducing the risk of catastrophic wildfire, thereby decreasing erosion and sedimentation into streams, rivers, and important reservoirs, these projects will also improve wildlife habitat and enhance recreational opportunities.

The U.S. Forest Service has embarked on a 20-year initiative to restore forests in collaboration with nearly 50 stakeholder groups, including local, county, and state governments, environmental groups, organizations, institutions, and industry representatives. The Four Forest Restoration Initiative (4FRI) is an unprecedented effort to restore the health and ecological function of 2.4 million acres of ponderosa pine forest across the Mogollon Rim within the Kaibab, Coconino, Apache-Sitgreaves and Tonto National Forests. Several types of restoration strategies are used depending on the terrain and the goal of the treatment. Mastication and thinning are both used to eliminate shrubs and small trees, for fire reduction purposes, on slopes no steeper than 40 percent. The shrubs and small trees are shredded into chips to be left on site or removed as fuelwood. Mastication and thinning are sometimes followed by prescribed surface fires. These low- to moderate-intensity fires are used to reduce high fuel loads, thin overcrowded forests, release nitrogen and other nutrients into the soil, and encourage germination of various plant species. It is a particularly useful tool in rugged terrain with steep slopes.

A key component of 4FRI is the involvement of local private industry in conducting the restorative treatments that are paid for by the sale of the timber products. The Forest Service contracts out the work through stewardship contracts, which allow private industry to use the timber and biomass resulting from restorative treatments for products such as lumber, wood pellets, and biomass power. With this system, the restorative treatments not only pay for themselves, but also strengthen local economies by re-establishing a strong forest product industry. 

## UA Opens West Center—New Water Research Facility

The University of Arizona has opened the new WEST (Water & Energy Sustainable Technology) Center, a \$5.5 million facility where industry, government, and academia collaborate to advance sustainable solutions at the nexus of water and energy. Located in Agua Nueva, Pima County's new water reclamation facility, the state-of-the-art facility will take advantage of its location at the treatment plant, with its adjacent reclaimed water recharge basins and constructed wetlands, to develop, evaluate, and demonstrate new water treatment and energy technologies. A working partnership involving Pima County, Tucson Water, numerous industrial partners, and the UA, the center provides an ideal work environment for researchers from the UA's College of Agriculture and Life Sciences and College of Engineering. As a public-private partnership, the center aims to advance and commercialize energy efficient solutions for water safety and security. Goals include supporting better technology transfer between public institutions and private industry, providing training for technicians, utility personnel, and students, and creating additional jobs and economic development in the region.

## Arizona Town Hall Takes on Water

The Arizona Town Hall on Water, "Keeping Arizona's Water Glass Full," was held November 16-18, 2015 in Mesa, Arizona. Approximately 175 participants spent three days in working sessions answering a series of key questions about Arizona's water resources. This statewide forum brought diverse Arizonans together for an exchange of ideas and perspectives, making for lively discussions both during the sessions and the many opportunities for informal conversation. In advance of the Town Hall, participants received a background report prepared by author-editors from the University of Arizona, Arizona State University, and Northern Arizona University to inform dialogue. At the Town Hall, subgroups of about 25 people were presented with questions about influences on water use and challenges to its management. Other questions triggered exploration of ideas for securing a water future that balances economic vitality with other quality of life goals for communities throughout Arizona, including tribal communities. Financing was a major topic, which linked with water pricing and communicating the value of water to water users. Finally working group participants were tasked with establishing priorities and recommending specific actions. Diligent recorders compiled consensus drafts for each work session and reconciled and combined the consensus drafts from the various subgroups into a single document. In a spirited plenary session on the last morning, the draft report was amended based on suggestions from the subgroups. Resulting recommendations can be viewed at <http://wrrc.arizona.edu/az-town-hall-2015>. The background report is also available on the same page.

## New Carlsbad, CA Desal Plant Opens

Operations have commenced at the largest and most technologically advanced seawater desalination plant in the United States. The Claude "Bud" Lewis Carlsbad Desalination Plant is

a 50-million-gallon per day seawater desalination plant located in Carlsbad, California, adjacent to the Encina Power Station. On December 14, the plant was dedicated by more than 600 elected officials, community leaders, and project partners. By the date of the dedication the plant had already produced 1.5 billion gallons of desalinated water for San Diego County. A 30-year Water Purchase Agreement is in place between the San Diego County Water Authority and Poseidon Water which built the plant, for the entire output of the plant. By tapping the largest reservoir in the world—the Pacific Ocean—the plant is helping to minimize the region's vulnerability to the statewide drought.

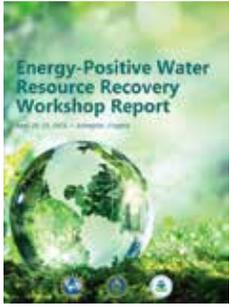
## National Natural Resource Investment Center Created

U.S. Secretary of the Interior Sally Jewell announced on December 15 the establishment of a Natural Resource Investment Center that will work closely with the private sector and others to identify innovative ideas and financing options for projects that increase investment in critical water infrastructure, conserve scarce Western water resources, and protect habitat. The Center is part of President Obama's Build America Investment Initiative, which calls on federal agencies to find new ways to increase investment in 21<sup>st</sup>-century infrastructure projects. The Center will start to outline specific conservation projects and partnerships early next year. It plans to model its activities in part on existing successful initiatives, such as voluntary water transfer mechanisms, innovative financing, and creative public-private partnerships. The Center will harness the expertise of multiple Department of Interior units, including the Bureau of Reclamation, U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, Bureau of Indian Affairs, and U.S. Geological Survey and will tap into private sector experience to deliver on its objectives.

## White House Water Summit Announced

On March 22, 2016, in conjunction with the United Nations World Water Day, a White House Water Summit will be held to raise awareness of water issues and potential solutions in the United States. The Summit aims to provide a catalyst for ideas and actions in innovative science and technology to help build a sustainable and secure water future. The summit will bring together representatives from Federal, State, regional, local, and tribal levels, and from other stakeholder groups. In the run-up to the summit the White House has issued a call to action to address key water issues, such as drought and flooding, water availability and quality, water-use efficiency, water security, ecosystem requirements, and more. The public is invited to announce innovations in fundamental research; data, monitoring, modeling, and forecasting; technology development, demonstration, deployment, and scale-up; citizen science; entrepreneurship; and creation and dissemination of science-based tools and resources to inform decision making. Information on announced innovations may become part of the material generated in preparation for the summit. An on-line form for participation is located at <https://www.whitehouse.gov/webform/share-your-input-activities-and-actions-build-sustainable-water-future>.

## Energy Positive Water Resource Recovery Workshop Report



Prepared by Energetics Incorporated for an Interagency Working Group from the National Science Foundation, U.S. Department of Energy, and U.S. Environmental Protection Agency, April 2015

On April 28–29, 2015 the U.S. Department of Energy, U.S. Environmental Protection Agency, and National Science Foundation jointly hosted the Energy-Positive Water Resource Recovery (EPWRR) Workshop to envision a transition from the wastewater treatment facilities of today to a new generation of facilities. Stakeholders from industry, academia, national laboratories, and government met at NSF headquarters in Arlington, Virginia, to discuss barriers to the development and deployment of water resource recovery facilities of the future. The workshop report presents a synopsis of the perspectives and ideas generated by the experts who attended the workshop.

Continuing to reliably transport and treat wastewater and deliver clean drinking water will require massive investments, about \$600 billion over the next 20 years. This need offers an opportunity to rethink the design and functionality of water management infrastructure. The workshop report identifies options that build on existing industry efforts to effectively manage more diverse waste streams, generate fuel, produce water and fertilizer, and recover other valuable resources. Proposed strategies to go from current conditions to the industry of the future included the efficient use and recovery of resources, coordination of utilities with other community services, engagement of customers and the public in new ways, and deployment of smart technology. Workshop participants identified key challenges, specifically regulatory, technical, social, and financial. Research priorities described in the report would address these challenges. The full report can be downloaded from [http://www.energy.gov/sites/prod/files/2015/10/f27/epwrr\\_workshop\\_report.pdf](http://www.energy.gov/sites/prod/files/2015/10/f27/epwrr_workshop_report.pdf).

## Green Infrastructure Wizard

U.S. Environmental Protection Agency

EPA has released the Beta test version of new web-based tool, the Green Infrastructure Wizard, or GIWiz. GIWiz is an interactive web application that connects communities to EPA Green Infrastructure tools and resources. Green infrastructure uses natural landscapes to manage water and provide environmental and community benefits. With growing community interest in using green infrastructure as a means of addressing water quality and a range of other local goals, the EPA consulted local, state and tribal partners to develop this new tool. Its self-guided format allows users to learn the basics of green infrastructure; explore financing options, visualize and design green infrastructure, learn about using green infrastructure to revitalize neighborhoods and enhance land use; and develop public education and outreach campaigns. EPA is inviting input on this Beta version, with the goal of

making continued improvements going forward. Find GIWiz at <http://www.epa.gov/communityhealth/green-infrastructure-wizard>.

## Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits

National Academies of Sciences, Committee on the On-Site Reuse of Graywater and Stormwater, December 16, 2015

The National Academies of Sciences, Engineering, and Medicine has released a major report by the Committee on the On-Site Reuse of Graywater and Stormwater, “Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits.” Graywater is untreated wastewater from bathroom sinks, showers, tubs, washers, and laundry sinks, while stormwater is rainfall or snowmelt runoff from roofs, parking areas, and other impermeable surfaces. According to this report graywater and stormwater could augment traditional potable water sources where drought and major water shortages affect supplies. However, there is a lack of information on the costs, benefits, risks, and regulation and a need for research and guidelines to frame appropriate responses to any risk to public health and the environment.

The report finds that there is no single best way to use graywater or stormwater to address local water needs, and many important considerations vary widely with local conditions. Best management practices are provided that account for differences in situation and scale. Committee analyses covered the amount of additional water potentially available, the risks associated with use, the costs and benefits of capturing and using these water resources, and legal and regulatory issues.

The pre-publication report in PDF (44.4MB) may be downloaded at no cost from <http://www.nap.edu/catalog/21866/using-graywater-and-stormwater-to-enhance-local-water-supplies-an>.

## Sensitivity of Intermittent Streams to Climate Variations in the USA

by K. Eng, D.M. Wolock and M.D. Dettinger.

*River Research and Applications*, 2015

A new USGS study published in the journal *River Research and Applications* presents an extensive analysis of intermittent streams and describes their sensitivity to past climate. The study focused on the western plains and southwest United States where such streams are prevalent. Five distinct types of intermittent streams were identified for this study, each with a different mixture of the physical processes that resulted in periods of no-flow. The temporal patterns of streamflow were shown to closely reflect climatic patterns. The article can be accessed online at <http://onlinelibrary.wiley.com/doi/10.1002/rra.2939/full>.

## The Ecohydrology of Forest Restoration

by Abe Springer, School of Earth Sciences and Environmental Sustainability, Northern Arizona University



A new day is dawning in the practice of managing forests in the Southwestern United States. A recently inaugurated forest restoration program, the Four Forest Restoration Initiative (4FRI),

seeks to improve forest health on portions of the Coconino, Kaibab, Apache-Sitgreaves, and Tonto National Forests, along the Mogollon Rim in Arizona. A collaborative effort to restore forest ecosystems, 4FRI was born out of a need to reduce the risk of catastrophic wildfire brought by past forest management practices.

As a result of more than a century of fire exclusion, grazing practices, and timber harvest activities, Northern Arizona forests are overgrown with thin, unhealthy trees that are prone to catastrophic wildfire and subsequent catastrophic flooding. 4FRI and other recent forest management actions are designed to support mechanical thinning of the over-dense forest followed by a more frequent fire regime. These thinning projects are designed to support sustainable forest industries that maintain local economies while making forests more resilient.

Significant interest exists in generating better understanding of the ecohydrology of past and present forest management, as well as planned forest restoration actions. Ecohydrology is a field of inquiry that examines how ecosystem management practices affect associated hydrologic systems, including streams, springs, and groundwater.

In Arizona, from the 1950s through the 1980s, projects related to the program “Water for Arizona” carefully examined the responses of experimental watersheds to various forest harvesting practices. Although management actions observed on these experimental watersheds were different from the 4FRI actions, they provide information about the types of hydrological responses we might expect from restoration treatments. Observations from the Wallow, Rodeo-Chedeski, Schultz, and other large catastrophic fires over the past 15 years have revealed the significant costs to hydrologic systems and downstream water users that may be avoided through forest restoration.

Average annual precipitation for the Ponderosa pine forests of Northern Arizona is near 20 inches per year, which is a threshold amount to produce small but measureable increases in runoff and recharge from forest thinning. Around 80 percent of all precipitation that falls in these forests returns to the atmosphere through evaporation and transpiration by vegetation. Of the remaining precipitation, about 15 percent runs off, and between 2 and 4 percent infiltrates to recharge aquifers that supply water to groundwater-dependent springs and streams.

In the Beaver Creek Experimental Watershed, which receives more than about 20 inches of precipitation per year, a small but measurable increase in stream discharge was observed after removing more than 30 percent of tree basal area. This increase in

discharge depends on the climate after thinning and the follow-up treatments. If precipitation in the years following the thinning is below average, or prescribed burns are not used to maintain the thinner forest, hydrological benefits either are not observed or only last a few years. Also, the watershed headwaters experience most of the increased stream discharge benefits. These effects may not extend far enough downstream to have a significant impact on water supply.

Although none of the historic experimental watersheds were designed to observe groundwater effects, aquifers are likely to have a similar response as stream discharge to forest thinning. In years following forest thinning, there would be a small but measureable increase in groundwater recharge and storage if the climate conditions are favorable. Recent research at Northern Arizona University (NAU) supported by Salt River Project (SRP) initiated an innovative recharge measurement study on thinned and unthinned forest stands to confirm this hypothesis. The study is continuing to measure the response of recharge to variability in climate.

Imbedded in the Record of Decision for the Environmental Impact Statement of the 4FRI is a new study of observational watersheds to gauge hydrologic responses to low-, medium-, and high-intensity forest restoration thinning treatments. Observational watersheds, roughly 1,000 acres in size, are located within the Sycamore Creek and Upper Lake Mary watersheds of the first quarter of the overall 4FRI area to be approved for treatment. The study is designed to collect background data prior to forest thinning and then observe the response to thinning and follow-up maintenance burn treatments. NAU designed this study with support from SRP, the City of Flagstaff, the Rocky Mountain Research Station of the U.S. Forest Service, and the Kaibab and Coconino National Forests. Support for some of the instrumentation has been secured, some has been installed, but more support is needed to comprehensively measure all components of the water and energy budgets.

In the 2012 general election, Flagstaff voters were presented a bond issue to provide funding for accelerating forest restoration in two critical watersheds. The potential for catastrophic wildfire in the Shultz Creek watershed poses a severe flooding risk because of impacts on the Rio de Flag that runs through town. Wildfire in watersheds on Mormon Mountain poses risks to the operation and maintenance of Upper Lake Mary, the City’s surface water reservoir. Research by economists at NAU determined there was a strong and significant willingness to pay for watershed services from Shultz Creek and Mormon Mountain. Support of the bond issue by 73 percent of Flagstaff voters confirmed that citizens recognize the value of the watersheds to the health and vitality of the City. The Flagstaff Watershed Protection Program (FWPP) serves as a model for innovative new financing for forest restoration actions, which is receiving national attention.

Many challenges still exist to improve and sustain the services that forested watersheds provide. Additional innovations in financing are needed to accelerate actions necessary to restore the forests of Arizona before additional catastrophic wildfires can destroy them and cause significant harm to their watersheds. Also, to assess whether or not these forest actions have the anticipated hydrological impacts, it is imperative that we carefully measure hydrological responses. The actions taken by such initiatives as 4FRI and FWPP provide tremendous hope for better managing forested watershed services in the future. 🌲

# Student Spotlight

## Ethan Vimont, Soil, Water, and Environmental Science



Ethan Vimont is a first year master's student at the University of Arizona in Soil, Water, and Environmental Science. He received his undergraduate degrees in environmental science and theatre from the University of Colorado in Boulder. Ethan has worked in several places around the world including as a researcher for the United States Geologic Survey on the North Slope of Alaska and as a Peace Corps Volunteer

in Mali and Nepal.

He worked for fifteen months in a rural village in Mali on irrigation, malaria prevention, and literacy under the auspices of the environment program. After war broke out in Mali,

Ethan was evacuated and continued his Peace Corps service in Nepal for another two years in the nutrition program. He worked on mother-child nutrition, drinking water supplies, and girls' empowerment.

His passions are water and finding solutions to water problems facing the world through better management of that resource. With such passions, he quickly found a home at the WRRC where he is currently working on a nationwide project to better understand groundwater quality management and governance across the United States. The first phase of the project is scheduled for completion in the fall of 2016.

Ethan's studies focus on water policy and management along with coursework on water science. His current thesis plans focus on investigating innovative areas in groundwater management. After his expected graduation in May 2017, he hopes to work in the United States and internationally on water conflicts and water management issues. 🏠

*Research continued from page 1*

processes by which trace organic contaminants (TO<sub>OC</sub>s) in treated wastewater are reduced by exposure to sunlight. The project takes the first steps toward identification of the circumstances that favor removal of TO<sub>OC</sub>s and development of mathematical representation of the process. The work consists of a series of controlled experiments in which defined mixtures of organic matter found in treated wastewater and representative TO<sub>OC</sub>s or indicator compounds are exposed to well-characterized light sources. The researchers then measure the rate of disappearance of the TO<sub>OC</sub>s. Software will be written to simulate the experimental reactions, and analyses will provide a foundation for future work. Results are intended to inform management of water quality in surface waters that received treated wastewater. Understanding natural removal of TO<sub>OC</sub>s would also be useful in developing cost-effective methods for restoring water quality of reclaimed water prior to potable reuse.

A project led by Channah Rock, UA Associate Professor /Specialist in Soil, Water and Environmental Science, with Natalie Brassil, Arizona Cooperative Extension Assistant, is part of a larger research program exploring the risks associated with using reclaimed water for irrigation of food crops. The investigators will be developing practical tools for assessing and mitigating the risks faced by growers, field managers, food safety coordinators, and irrigators. Based on previous and on-going research, the work will make connections with research users through focus groups where concerns related to recycled water for produce irrigation will be identified. An analysis of focus group data will provide the foundation for a risk assessment and development of a tool-kit of best management practices.

Work on these projects will begin in March 2016 and results are expected by February 2017. 🏠



Arizona Water Resource is published quarterly by the University of Arizona Water Resources Research Center. AWR accepts news, announcements, and other information from all organizations.

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**Newsletter Link:** [wrrc.arizona.edu/publications/awr](http://wrrc.arizona.edu/publications/awr)

**WRRC Website:** [wrrc.arizona.edu](http://wrrc.arizona.edu)

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## It's Time for Action



by Sharon B. Megdal

Las Vegas is the site of December's Colorado River Water Users Association (CRWUA) annual conference. All the basin states and Mexico are in attendance, with Arizona representation usually the largest. This year's conference marked the first time there were concurrent sessions. It turns out that a statement made during the session I did not attend has caught

my attention. Writer Tony Davis reported in the December 27, 2015 edition of the *Arizona Daily Star* on the presentation made by Jeremy Aquero, a Las Vegas economic analyst, during a session on drought. (I went instead to the concurrent session on agriculture.) Davis reports that Aquero stated: "We are not going to conserve our way to prosperity, or build our way to prosperity, and we are not going to stop growth on our way to prosperity. It will take a master-plan approach to all of those things."

Where do we in Arizona stand in terms of planning for a secure water future?

The strategic vision document released by the Arizona Department of Water Resources (ADWR) in early 2014 listed the options for meeting Arizona's future water needs. They include the following: increased conservation; water augmentation through multiple mechanisms; greater water reuse; possible water exchanges; and addressing some legal, regulatory, and financing issues, including the general stream adjudications and tribal water rights. See [www.azwater.gov/AzDWR/Arizonas\\_Strategic\\_Vision/](http://www.azwater.gov/AzDWR/Arizonas_Strategic_Vision/).

In November of 2015 a large group convened by Arizona Town Hall to address "Keeping Arizona's Water Glass Full" identified six priorities for action: 1) Move forward with Arizona's Strategic Vision for Water Supply Sustainability; 2) Create and fund mechanisms to finance water supply and new infrastructure; 3) Appropriately fund and staff ADWR; 4) Education; 5) Conservation and Augmentation; and 6) Legal reform. The full report of the Town Hall can be found at [aztownhall.org](http://aztownhall.org).

In late December, Governor Ducey appointed his Water Augmentation Council (Council), chaired by ADWR Director Tom Buschatzke, to deliberate on specific steps by "investigating long-term water augmentation strategies, additional water conservation opportunities, and funding and infrastructure needs to help secure water supplies for Arizona's future."

It is indeed time to move to specific action plans that can gain legislative approval, where necessary, and community support. The former will require arriving at action plans that can garner support from multiple geographic and economic interests. Although water legislation has been sparse in recent years, last year's vote to approve extension of the tax levied by the Central Arizona Water Conservation District to fund water banking and Central Arizona Project operations proves that widespread support can be forthcoming even for measures that require local

taxation. Gaining broad community attention and support will require extensive public engagement. High-level treatment of brackish groundwater, seawater, or wastewater will be costly, and the same can be said about the transportation of water, especially in the era of reduced federal funding for infrastructure. In the end, it is the water consumer who pays. Hence, water consumers – all of us – must be educated as to the options and their costs.

When we consider options for closing the demand-supply gap, water conservation is often at the top of the action list for individuals and businesses. In the context of conservation, we from the water sector often speak to the savings from conservation by existing users, whether through changing out toilets, reducing outdoor watering, and/or other water use efficiencies. Planning for new uses must also be considered. How we design our communities and buildings will determine future water use. The work of landscape and building architects, along with land use planners, is highly important. I believe this nexus between design and water use will become even more important in the future. As an educator of university students, particularly at the graduate level, I see the high value of interdisciplinary training, such as we offer through the Master's Program in Water, Society, and Policy and Ph.D. program in Arid Lands Resource Sciences. As a member of the Arizona Cooperative Extension faculty, I see the great opportunity to work with communities throughout Arizona to develop greater understanding of the available options and opportunities to work together. And as a researcher, I see the need to gain greater understanding of the tradeoffs associated with alternative water conservation, treatment, and use strategies.

In all these roles, I see the value of sharing practices and lessons learned with others. For almost a decade, I have been studying the water management strategies of Israel and have shared some of our region's successes, particularly related to transboundary water management, through lectures and other exchanges. I have worked with researchers in Jordan to explore household use of graywater, a water source of great interest in growing, water-scarce regions. While each region's water supply portfolio and water use practices depend on history, values, law, socioeconomic conditions, and other factors, the options for meeting future water needs are similar. They involve demand-side management, deployment of technology, education, and development of acceptable financing and funding strategies, which may include public-private partnerships. Such partnerships, which are foundational to Israel's large-scale seawater desalination, are already playing a greater role in the Southwest. Both regions already see substantial reuse of water, with water recycling likely to play a greater role going forward in Arizona.

Throughout all deliberations, we must consider the implications of our land and water use patterns on Arizona's quality of life and economic vitality. Our water future will require continued technological and policy innovation. A great example of the latter is Arizona's framework for recharge and water banking. Heraclitus is said to have observed that "the only thing that is constant is change." I have great optimism that we will adapt to changing conditions. Though we face challenges, not having the water supplies available to meet future needs is not an option. 🏠



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**REGISTRATION IS NOW OPEN** for the WRRC's 2016 Annual Conference, #AZwaterfuture: Tech, Talk and Tradeoffs, to be held on March 21 at the Student Memorial Union on the University of Arizona campus in Tucson. The conference will showcase innovations in technology, communication, and policy that affect water resources in Arizona and the Southwest.

Three panels of experts will address "Innovative Use of Technology to Enhance Our Water Resource Portfolio"; "Innovations in Education and Communication for a Sustainable Water Future"; and "Tradeoffs Involved in Water Innovation: Implications for Society and for Financing".

- Ann Castle, former Assistant Secretary for Water and Science, U.S. Department of the Interior, will provide the opening keynote entitled "Our Worn-Out Water Security Blankets."
- Lisa Beutler, Public Affairs Specialist at MWH Global, will open the afternoon sessions with a talk on "Solutions to Wicked Problems at Massive Scales: The California Water Crisis."

A poster session following lunch will display water-related research and practical applications, with awards for the best student posters announced at the post-conference reception. The last panel of the day will feature Arizona water agency leaders who will report on forward looking initiatives for the state.

The conference will include an introduction to an interactive web experience called "Beyond the Mirage" that allows online viewers to explore a constellation of short videos on water and create their own documentaries from them. Attendees will be able to interact with the videos at stations set up for use during the reception immediately following the conference.

**TO REGISTER GO ONLINE TO: [wrrc.arizona.edu/conference-2016-regonline](http://wrrc.arizona.edu/conference-2016-regonline)**  
**TO SUBMIT A POSTER ABSTRACT GO TO: [wrrc.arizona.edu/conference-2016-poster](http://wrrc.arizona.edu/conference-2016-poster)**  
Poster abstract submission deadline is February 15