



# ARIZONA WATER RESOURCE

The Water Resources Research Center Quarterly Newsletter

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Apache Creek, Apache Creek Wilderness, Prescott National Forest.  
Source: Kelly Mott Lacroix

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## 2015 Highlights

A new 4-page summary and infographic presenting WRRC accomplishments in 2015.

## Publications

The Water Resources Research Center produces research reports, outreach materials, and regular publications, including the Weekly Wave e-news digest, the quarterly Arizona Water Resource newsletter and the Arroyo, an annual publication focusing on a single water topic of timely concern in Arizona. **Sign up online to receive WRRC newsletters, event updates and more at: [wrrc.arizona.edu/subscribe](http://wrrc.arizona.edu/subscribe).**

# Studies Support Planning for Environmental Water — More Research Needed

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

The record high temperatures in June throw into sharp relief the importance of water, especially to the plants and animals that depend on flowing water for their survival. Riparian and aquatic ecosystems are among the most vulnerable systems to climate change, and as temperatures increase, so will their need for water. Yet allocation of water to ecosystems is not required under state law and, except for a few instances, is not considered alongside human uses. Considering the environment alongside human demands is only just emerging in water planning discussions.

Rivers and related shallow groundwater systems need water to survive and provide benefits to people. Ecosystem services include improving water quality, providing recreational amenities, and supporting biological diversity, among others. In addition, healthy rivers and associated ecosystems have an intrinsic value to people that may be expressed in terms of cultural significance, particularly for indigenous cultures. This intrinsic value is often overlooked as it is difficult to identify and quantify.

*Environment continues on page 2*



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## Dear Reader

We hope you have enjoyed receiving our *Arizona Water Resource* newsletter over the years. Since publishing its first issue in February 1992, we have worked to make the *AWR* a publication that responds to a recognized need for water resource news, announcements, and in depth features. Beginning with the winter 2017 issue (January), we will be going to an all-digital format. The change will provide increased flexibility and reduce waste. This issue and the next (Fall 2016) will be the last *AWR*s printed and mailed to subscribers.

If you wish to receive the *AWR* in digital form, please be sure that we have your email address. The easiest way to do that is to subscribe online at [wrrc.arizona.edu/subscribe](http://wrrc.arizona.edu/subscribe). You may also call or email the WRRC at 520-621-9591, [wrrc@email.arizona.edu](mailto:wrrc@email.arizona.edu). We hope you find that we continue to fulfill the *AWR*'s founding mission in its new format. 📧

There are a growing number of people who recognize that water for natural areas is crucial to sustainable development and the long-term prosperity of communities. In the past decade, there has been increased interest in providing water to meet the needs of riparian and aquatic ecosystems in the Western USA. While increasingly recognized on the local level, the need to provide water for ecosystems has not been on the agenda of most politicians and policy-makers.

It can be difficult to include the needs of riparian and aquatic ecosystems in plans when other existing uses already outstrip available supplies. Water deficits this imbalance exposes mean water managers have to be proactive in understanding both the water needs of riparian and aquatic species and community values for them if they want to maintain the rivers and shallow groundwater areas that these ecosystems depend upon. Providing decision makers the best scientific information available in a timely manner is critical.

While easy to assert, actually translating existing scientific information on environmental water needs is complex. This is in part because different species have distinct water needs and these vary depending on your location and the time of year. The water required to maintain a healthy river ecosystem is most frequently referred to as environmental flows, or more specifically, the natural flow regime. For example, to survive and reproduce riparian trees need access to sufficient groundwater and carefully-timed flood flows, for established plants and for new plant growth.

The natural flow regime consists of five elements of streamflows: magnitude (how much), timing (when), frequency (how often does a certain magnitude of flow occur), duration (how long does a type of flow occur for), and rate of change (how quickly does flow go from a “peak” to a “valley”). This graphic shows what each of these elements of the natural flow regime look like through separating an annual hydrograph of the San Pedro River into four seasons (timing), marking similar flow patterns (frequency), where flows remain the same (duration) and a low to peak flow (rate of change). Change to any of these element of flow impacts Arizona’s aquatic and riparian ecosystems if flows are altered beyond the range of tolerance of native species.

Researchers have studied the water needs of Arizona’s riparian plants, quantifying maximum depth to groundwater for survival and timing and size of flood flows for reproduction. For example, multiple studies have concluded that even mature cottonwood trees cannot survive when groundwater levels exceed 10 feet below the surface.

Several studies demonstrate an important connection between water available to riparian vegetation and the health of insects and birds. Eighty percent of all vertebrate species

in Arizona spend some portion of their life cycle in riparian areas. Others studies indicate the flow and water temperature needs of native fish. Arizona has more native freshwater species at risk of extinction than any other state. While studies of individual species are useful, lack of ecosystem level data limits the manager’s ability to ensure flows will protect the whole ecosystem.

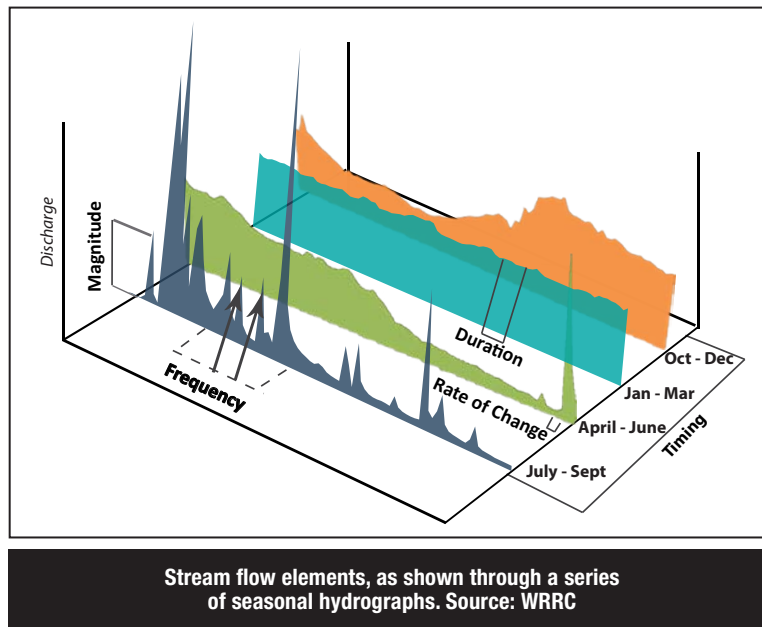
Statewide, ecosystem-level flow requirements remain poorly understood. Most of the flowing streams in river basins across the state have not been studied. There is no simple figure that can be given for the environmental flow requirements of rivers and associated wetlands.

To date, most studies lack the quantitative data that resource managers need to understand riparian and aquatic flow needs. Only about 30 percent of streams in Arizona have quantified or described environmental flow needs. Only one river in Arizona, the Bill Williams River, has received dynamic recommendations for minimum flows for each season, ranges of flow needs, frequency, rate of change, and size of flood flows.

More studies are needed that consider the water needs of both aquatic and riparian species in tandem. Additionally, given the proven influence of groundwater on aquatic and riparian ecosystems, most river basins could benefit from additional studies of groundwater influences on ecosystem health.

Adequate science and understanding of environmental flow needs and how these systems respond to changes in streamflow and groundwater levels are essential for incorporating water for riparian and aquatic ecosystems in water management and policy. As a response to this need, to assess the state of the science on environmental flow needs in Arizona and beyond, and to create a tool for water managers, the University of Arizona Water Resources Research Center developed the Desert Flow Database. This publicly available database catalogs over 400 studies from 144 rivers across the deserts of the U.S. and Mexico, and is a tool for land managers, policymakers, and scientists to use when considering water for riparian and aquatic ecosystems in their management decisions or conducting their own inquiries into environmental flow needs. The database is dynamic and continues to grow as new studies are identified.

Defining the needs of riparian and aquatic species and ecosystems is the first critical step in the broader process of securing and addressing environmental flows. The ability, to place the environment at the table in water management discussions, however, goes beyond the ecology and hydrology of a system. It also involves determining how much water is required to achieve a certain level of river health, a level agreed upon by the water-using community. 🏡



**In this issue of AWR** we are following up on some of the ideas brought forth in the WRRC's Annual Conference, "#AZwaterfuture: Tech, Talk, and Tradeoffs", held March 21, 2016. The conference revealed innovations in technology, communication, and education and explored ideas for meeting water resource challenges. Several of our conference speakers provided articles that bring the conference story to AWR readers. This Special Feature contains their contributions. As is always the case with guest articles, the opinions expressed are the authors' and do not necessarily reflect the position of the WRRC, the College of Agriculture and Life Sciences, or the University of Arizona.

## What to Do about Wicked Water Problems

By Lisa Beutler, Public Affairs Specialist, MWH Global



Lisa Beutler

Photo: Lynn Ketchum, University of Arizona College of Agriculture and Life Sciences

It's a rare day when western water managers don't check the weather. A defining feature of this geographic region of the United States is a lack of precipitation. A second feature is great faith by its people in a technical solution to whatever problem a lack of rain creates.

Long before Europeans arrived, predecessors to the Hohokam people migrated from central Mexico to southern Arizona, bringing domesticated crops and their knowledge of irrigation with them. Their descendants constructed networks of diversion dikes to capture runoff rainwater and cultivate fields. Mission priests expanded and enhanced the historic systems, building new rock dams and small earthen reservoirs. In 1902, the U.S. Reclamation Service (later changed to Bureau of Reclamation) was created to advance a federal effort of "irrigation works for the storage, diversion and development of waters"—to irrigate arid and semiarid lands in 16 Western states and territories.

It worked. The West bloomed. Planners and engineers crisply defined, understood, and fixed problems through technical solutions. It was not simple, yet problems were solvable. Either solutions worked or they didn't.

Lately, more and more water problems seemingly defy standard solutions. This typically occurs for four reasons: incomplete or contradictory knowledge, the number of people and opinions involved, the large economic burden, and the interconnected nature of these problems with other problems.

These are wicked problems. Wicked problems are often hot potatoes tossed back and forth among policy makers, and decreed as too substantial for grand solutions.

Wicked problems are not solved—they can only be mitigated through an approach that emphasizes empathy, abductive reasoning, and rapid prototyping. It is not possible to present an elegant solution and be done.

Horst Rittel, one of the first to formalize a theory of wicked problems, cites ten characteristics of these complicated social issues

1. Wicked problems have no definitive formulation. The problem of poverty in Texas is grossly similar but discretely different from poverty in Nairobi, so no practical characteristics describe "poverty."
2. It is hard, maybe impossible, to measure or claim success with wicked problems because they bleed into one another, unlike the boundaries of traditional design problems that can be articulated or defined.
3. Solutions to wicked problems can be only good or bad, not true or false. There is no idealized end state to arrive at, and so approaches to wicked problems should be tractable ways to improve a situation rather than solve it.
4. There is no template to follow when tackling a wicked problem, although history may provide a guide. Teams that approach wicked problems must literally make things up as they go along.
5. There is always more than one explanation for a wicked problem, with the appropriateness of the explanation depending greatly on the individual perspective of the designer.
6. Every wicked problem is a symptom of another problem. The interconnected quality of socio-economic political systems illustrates how, for example, a change in education will cause new behavior in nutrition.
7. No mitigation strategy for a wicked problem has a definitive scientific test because humans invented wicked problems and science exists to understand natural phenomena.
8. Offering a "solution" to a wicked problem frequently is a "one shot" design effort because a significant intervention changes the design space enough to minimize the ability for trial and error.
9. Every wicked problem is unique.
10. Those addressing a wicked problem must have authority and responsibility for their actions.

Water planners and managers play a central role in mitigating the negative consequences of wicked problems. They will be required to position efforts in new and more desirable directions. This will not be easy, quick, or solitary. It requires methodical, rigorous iteration focused on the system qualities of the problem. Interdisciplinary collaboration that captures a broader knowledge of science, economics, statistics, technology, psychology, politics, and more are necessary for effective change.

Water managers and planners will also need to more actively utilize abductive reasoning in addition to deductive

*Wicked Problems continues on page 6*

## Tradeoffs Reexamined: Moving Beyond Water Scar[ed]city toward Conscious Choices about Our Water Future

by Amy L McCoy, AMP Insights LLC, and Kelly Mott Lacroix, WRRC

The dictionary definition of a tradeoff is “a balancing of factors, all of which are not attainable at the same time” and scarcity is “being deficient in quantity compared with demand”. Taken together, tradeoffs in the face of scarcity are often seen in a negative light. If there is not enough for everyone, “balance” must surely equal loss. And indeed it can. In anticipation of losses, tension and competition can become defining features in discussions of tradeoffs. The expectation of loss also fuels a greater need for clarity, certainty, and assurances that the uncertainty born from scarcity can be addressed. But what happens if instead of examining tradeoffs from the scarcity mentality, which is inherently fear driven, we were to look at a tradeoff as an opportunity for gain in the form of a choice of water futures?

There are few places where the connection between tradeoffs and scar[ed]city in water management are more pronounced than the Western United States

and the Colorado River Basin, which are under stress from drought, climate change, over-use, and over-allocation. Combined, these driving factors are leading to conditions of scarcity, where a looming Declaration of Shortage in the Lower Colorado River Basin is sparking a discussion of tradeoffs to meet a range of demands that far eclipse finite supplies.

Although P.C.D. Milly and others declared in 2008 that “stationarity”—the concept that the variability of a natural system does not change—was dead; the reality is that uncertainty has driven adaptation in water management for many decades. However, there is another side to the coin — tradeoffs offer an opportunity for self-agency and choice about how the future evolves. And importantly, if tradeoffs are viewed as an exercise of choice, they can foster agility and responsiveness as an antidote to uncertainty, as opposed to locking down on rigid rules and institutions as a response to uncertainty.

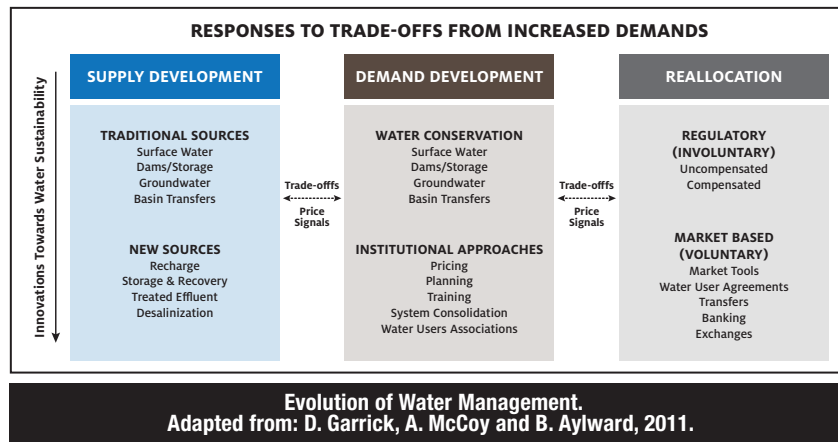
The history of water management can suggest that we have been evolving towards a place of greater choice around tradeoffs — moving from supply and demand development to the era of reallocation. Water management has evolved over time in the quest for security in the face of supply uncertainty and, in many cases, relentless growth. In thinking about water management, demand growth, and tradeoffs, we propose there are two axes and, generally speaking, three eras.

In the first of these eras demands are met using locally available supplies such as groundwater and surface water, and

uncertainty in supply is managed through reservoirs or, in some cases, transfer of water between basins. More innovative approaches to supply development have included use of reclaimed water for non-potable uses, as well as recharge, storage, and recovery of imported surface water and reclaimed water. There comes a point, however, when locally available supplies are exhausted, thus initiating water management actions that include reductions in demand and/or securing new supplies. In this second era, demand management options include conservation and efficiency measures for surface and groundwater, as well as improvements in management institutions, plans, and policies to focus on reducing consumptive uses in order to extend supplies. A key tool in demand “development” is pricing water in order to reduce demand.

Eventually, however, neither supply nor demand development is sufficient to meet demands, and an era of reallocation begins.

This era of reallocation can take two forms: mandatory (regulatory) or voluntary (choice-based). Under regulatory reallocation the choice of who “gets” available water supplies is made from the top down, and may not necessarily reflect a region’s values for their economy or environment. On the other hand, voluntary transactions can be seen



as an exercise of choice over the course of the future. It is an act of creation to have a hand in how the future unfolds.

This is an important point for the future of the Colorado River Basin. While shortage is certainly on the horizon, it is not here yet. This means that collectively we still have an opportunity to play an active role in decisions about how the future looks and unfolds. While changes are likely to be drastic, how those changes impact us remains our choice.

## What’s New in the World of Education Innovations?

By Kerry Schwartz, Arizona Project WET - WRRC

There is a clear and urgent need in Arizona schools. Teachers need integrated Science Technology, Engineering and Mathematics (STEM) instructional units that bring real-world and relevant learning into the classroom. Many districts across Arizona are developing STEM schools and academies, but are still in dire need of curricular components other than the ubiquitous robotics programs. Water, energy, and food, arguably the three most important ingredients needed to sustain the world’s population, should be topics of focus for robust and integrated learning. The innovations for tomorrow will come from the students of today.

*STEM Education continues on page 8*

## Governor's Water Initiative Takes on States Water Planning Challenges

**Hunter Moore, Natural Resources Policy Advisor to Arizona Governor Doug Ducey**

Summer's heat has arrived with its usual triple-digit fury, and with it, you can sense a heightened awareness of the challenges we in the Southwest face in protecting our water resources.

In an arid climate like ours, we must be constantly vigilant about the health of our water supplies.

The challenges are well known. The potential for experiencing shortfalls in Arizona's Colorado River allocations sometime in the near future is increasing. And the water levels in Lake Mead — the great storage reservoir for Arizona's Colorado River water — are dropping.

Residents of some regions of the state that are particularly reliant on groundwater are concerned about the condition of their aquifers. And not unjustifiably so, in many cases. Arizona Department of Water Resources hydrologists are finding that well depths in groundwater-reliant regions like Cochise County and the West Basins of La Paz County are dropping, and residents with shallow wells in parts of La Paz and Mohave counties fear they are beginning to see the same thing happen there.

Governor Doug Ducey has put a premium on protecting Arizona's invaluable water resources. In his State of the State speech in January, the governor noted Arizona's long legacy of far-sighted leaders in water policy and vowed to continue their tradition:

"Right now, a team of our top water experts, users, and providers is charting the path forward," he said.

That includes the team of leaders the governor began gathering early in his administration to participate in his Arizona Water Initiative, a two-pronged, "parallel-track" strategy for collecting accurate data on the condition of our water supplies statewide and for determining the best means of augmenting those resources.

Right now, the Water Resources hydrological teams are crisscrossing the state, measuring the depth of wells and updating the record on the health of Arizona's underground aquifers.

They are systematically gauging the status of water supplies in 22 separate "planning areas" around the state and are seeking out local stakeholders for ideas on how best to resolve the issues they outline.

The Governor's Water Augmentation Council, meanwhile, is studying innovative ways of adding to the Arizona water pool.

Created by executive order last Fall, and with 29 members, the GWAC advises Gov. Ducey on the best means of adding to the supply. Those include direct augmentation strategies such as enhanced water re-use and desalination, as well as conservation efforts.

The effort is long-term. The council — comprised of water-resources experts, watershed advocates, local government

officials and leaders of Arizona's agricultural, mining, and other industries — is tasked with resolving imbalances between the needs of a growing statewide population and available water supplies.

Demand in our dynamic home state is destined to grow.

Water demand in Arizona is expected to exceed supply by as much as three million acre-feet within 100 years, according to an analysis performed by the Water Resources Development Commission. As summarized in ADWR's Strategic Vision report, imbalances are expected to begin to materialize in the next 20 to 30 years. So we have time to craft solutions.

Obviously, the road ahead for the council is a challenging one.

Among the topics at the top of its list of statewide and regional strategies is the resolution of Indian and Non-Indian

water-rights claims — a long-running impediment to gaining control of the state's water resources. Former U.S. Senator Jon Kyl, perhaps the premier expert on Southwestern water law, has identified completion of these "general stream adjudications," as they are known, as a vital step forward for gaining solid control of Arizona's in-state water resources.

The council will not be shying clear of controversy, either (a virtual impossibility where water is concerned, regardless).

The group will look at reforming the state's practice of in-state water transfers. Other Western states have developed market-based water-rights transfer models. Arizona could consider those models, too. And we expect the augmentation council will be taking a good look at them.

Water re-use is an important part of the Strategic Vision. And with good reason. Recycled or re-used water will make up a significant portion of the additional municipal supplies Arizona will need to accommodate a growing economy and population.

As with all things of value, an investment in Arizona's water future will carry a price tag. The council will be examining potential financing mechanisms for upgrading and maintaining the state's water-delivery infrastructure.

That may include a substantial investment in desalination.

As noted in the Arizona Water Initiative annual report released in May, Arizona may need to import water supplies derived from ocean water desalination to augment its existing supplies of surface water and groundwater.

Arizona has a lengthy and laudable history of water planning efforts.

Those efforts have provided us the space to conduct long-term planning initiatives like those now on the agenda of the Governor's Water Augmentation Council.

That's where good planning gets you — assuring that water supplies are always available, a critical feature of Arizona's long-term economic and social stability.

That's the idea. That it is always there.

Even on the hottest, driest days of the year. 🏡



Hunter Moore  
Photo: Lynn Ketchum, University of Arizona  
College of Agriculture and Life Sciences

# Student Spotlight

## Erin Gray, Department of Hydrology and Atmospheric Sciences



Erin Gray is a third-year undergraduate student in the Environmental Hydrology program within the Department of Hydrology and Atmospheric Sciences. As a returning student, Erin strives to maintain a balance between scholastic success and extracurricular commitments. She is the president of her Ultimate Frisbee team and works to improve outreach to women in the Tucson Ultimate community.

As a freshman, Erin was active with Engineers Without Borders and worked to raise funds for the installation of improved showers and latrines to address sanitation issues in a Marquirivi, Bolivia. In her sophomore year, Erin served on the Green Fund Committee, an elected group of students

dedicated to the advancement of sustainable practices and projects on campus through the annual allocation of \$400,000 in grants. Her work with EWB and the Green Fund have given Erin an appreciation for the many student-led outreach efforts that take place on campus.

At the WRRC, Erin is the student assistant for Arizona Project WET, which works to increase water stewardship through the promotion of relevant STEM instruction in classrooms throughout the state. In her work with APW, Erin has had a chance to visit effluent treatment centers, interact with Tucson Water hydrologists, and explore Tucson's unique groundwater recharge facilities.

In addition to her work with APW, Erin assists Dr. Jen McIntosh in investigating the isotopic chemistry in the Cienega Creek Watershed. The experience with field collection methods as well as sample processing and analysis will be valuable tools as Erin prepares to enter the workforce as a hydrologist focused on restoration and conservation after her expected graduation in December, 2017. 🏡

*Wicked Problems continued from page 3*

and inductive approaches.

Abductive reasoning begins with an incomplete set of observations and proceeds to the likeliest possible explanation for the set. This method yields the kind of daily decision-making that does its best with the information at hand, which often is incomplete. In court cases, judge and jury consider whether the prosecution or the defense has the best explanation to cover all the evidence. While reasonable, it is subjective.

Whereas deductive reasoning creates certainty and inductive reasoning quantifies uncertainty, abductive reasoning attempts to create meaning when uncertainty exists.

Managing wicked problems in a new kind of work. It requires changing the questions, managing uncertainty, and creating resilience. It does not solve existing problems but instead drives to a desired future state.

Reframing water issues as wicked problems will be essential for moving forward to a healthy water future. It begins with considering issues and solutions at the system scale. Water projects can no longer be solely the domain of the water community. Creating a change in one part of the water system will change the entire system, including the dependent social and environmental systems, sometimes in unexpected ways. This will require yet another solution to address that situation. It is an adaptive, iterative exercise. Solutions to wicked problems are never one and done.

Traditional approaches that focus on solution-proposing will need to transition to a process that defines a desired state. Solutions then balance and reconcile tradeoffs while considering self-interests of the parties.

Given that issues must be addressed at the system scale, collaboration and interdisciplinary approaches are key. The way the parts work together are as important as how they work individually. While this degree of upfront engagement may seem time-consuming, it takes far less time than the rework required when a lack of integration creates problems.

The largest hurdle may be reframing the public's perception of water management. The faith in the technological solution and the ability of the water professionals to create certain outcomes, while well deserved, does not match the emerging reality.

Introducing a wicked problems framework and the need for adaptive management is key. Also needed is an understanding that solutions for wicked problems are only good or bad, not true or false. This requires a change to previous approaches for defining success.

Moving forward, water managers will continue looking at the weather. The good news is, there are new ways of thinking about how to manage what it brings. 🏡



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## A New Approach to Raising Water Awareness: Beyond the Mirage



by Sharon B. Megdal

The Water Resources Research Center is proud to have partnered in the Beyond the Mirage project. Beyond the Mirage got its start as an alternative approach to water education and engagement. While both the *Layperson's Guide to Arizona Water* and *Keeping Arizona's Water Glass Full*, the background report for the 107th Arizona Town Hall held in November 2015, introduce readers

to Arizona water issues, today's busy schedules and reliance on finger-tip information suggested a new approach was warranted to assist the public in becoming more water-aware. The WRRRC's External Advisory Committee confirmed our plans to develop a new and different platform for water information through partnership with Cody Sheehy and the Communications & Cyber Technologies team of the University of Arizona College of Agriculture and Life Sciences. Envisioned as a multi-part project, Beyond the Mirage would include: (1) a series of short, informative video clips, which the viewer could stack into individualized mini-documentaries; (2) a feature-length documentary, professionally produced in cooperation with Arizona Public Media, with John Booth as our key AZPM partner; and (3) classroom learning media for K-12 students. The clips would include a range of topics and voices. The documentary would be designed to take a broad perspective to a regional or national audience. The WRRRC's role would be to collaborate on identifying important content and interview opportunities, as well as working with Cody and team to review and perfect clips prior to launching the clip stacking web site. Arizona Project WET Director Kerry Schwartz led the K-12 work that engaged middle school students in stack building and sharing. Throughout the effort, Brittany Xiu, Ashley Hullinger, and particularly Susanna Eden worked diligently with Cody, the creative genius behind it all.

Full of ideas and enthusiasm — and with some seed money from the University of Arizona Technology and Research Initiative Fund (TRIF) — the team knew that external resources were needed. The Arizona Community Foundation and its partners presented an exciting and very timely funding opportunity when they announced the New Arizona Prize. It was fortunate that the first competition, the Water Consciousness Challenge, “sought the best digital strategy to raise Arizonans’ consciousness about our water future”. In early April 2015, after a thorough and highly competitive process, the Beyond the Mirage team was awarded the \$100,000 prize.

In addition to getting the team together, providing encouragement, and being interviewed, I worked with Cody on the footage filmed in Israel in October 2015, where he used his drone and other professional equipment transported into and out of Israel. We spent five intensive days visiting constructed

facilities and natural water sites and talking with several experts. It was a pleasure to see Cody in action. I cannot say enough about his professionalism and ability to quickly absorb new concepts.

The web site [BeyondtheMirage.org](http://BeyondtheMirage.org), which includes over 250 video clips, an artificial intelligence system to guide navigation, and a platform for assembling individual documentaries, was launched in March 2016. I encourage readers to visit the site, view clips, and assemble their own video stacks. In my Arizona Water Policy class, small groups of students assembled mini-documentaries of five minutes, which we then viewed together. It was a fun exercise and interesting to see how the focus of the groups differed. The documentaries can be saved on line, but more importantly they can be shared through social media or email link, effectively spreading water consciousness.

The feature-length documentary, *Beyond the Mirage: The Future of Water in the West*, was screened and broadcast in April in Tucson. KUAT Channel 6 in Tucson premiered a 75-minute version of the documentary, which was followed by a panel discussion. In May, KAET Channel 8 in Phoenix aired the 60-minute version of the documentary, which is the version now available on DVD or BluRay. Many have asked if they can access the movie online. Unfortunately, but for good reason, on-line distribution is not yet



offered. The team recently received the good news that the film will be made available through the American Public Television (APT) Exchange to public television stations across the country. As explained in the release issued by AZPM, “American Public Television is a leading syndicator of high-quality, top-rated programming”. APT’s policies require that documentaries it airs are not publicly available before they have been aired. Therefore, live-streaming will have to wait until sometime in 2017.

Something that I learned during this project is that, in order for a documentary to be considered for Public Television, the filmmaker must maintain total control over the creative content. This means that, while WRRRC staff could do fact checks and share in the end-of-movie credits, Cody was the decision-maker regarding film content.

I am pleased to have been part of the Beyond the Mirage team. The full set of supporters and partners for Beyond the Mirage can be found on the web site. I offer my most sincere thanks to all who contributed their time, expertise, encouragement, and resources. The [BeyondtheMirage.org](http://BeyondtheMirage.org) platform is an extraordinary tool that should be kept dynamic and up-to-date. It is true that this will take more resources, but the significant water issues facing our state and region make it imperative that we do so. 🏡



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### Address Service Requested

*STEM Education continued from page 4*

STEM is not just interdisciplinary instruction, it's about thinking. It's when students come up with the questions and then answer them in a whole-brain way. It's systems thinking that leads to reflection and the ability to think about one's own thought processes. STEM units of study offer opportunities for students to think through and reflect on complex issues; study and design systems; apply scientific and mathematical principles; practice the engineering design process; and use technology in purposeful ways. These are the educational components that STEM teachers need now, to drive student-centered instruction.

The Water Energy World STEM Unit is an innovation that answers this current need. With an interest in exploring the intersection of water and energy resources in the southwest, Western Resource Advocates, Arizona Project WET, and The STEMAZing Project began to collaborate a year and half ago. The STEM unit that developed was designed to help educators engage their students with the overarching question: Where do your water and energy supplies come from and how should we manage them for the next 100 years? Since water and energy are inextricably linked, there is a lot of thinking to be done. Water requires energy to purify and transport to the end user. Energy requires water purposes ranging from mining of primary energy sources to cooling of power plants. These ties are important for a literate citizenry to understand in order to make informed consumer choices as well as decisions when they exercise their right to vote.

With a solid foundation first in watersheds and ground water systems and then the science of energy and sources of energy, teachers can look at the connections between these two systems. The connections are investigated through engineering design projects that include harnessing energy from the sun to heat water as well as pumping water uphill to a new location in an engineering design challenge called Pump It Up. Pump

It Up models the Central Arizona Project and some of the design and energy challenges faced when transporting water uphill. Through these relevant, engaging lessons, students will begin to experience the connections between the water and energy systems. To learn more about the Water Energy World curriculum visit: <http://www.stemazing.org/#!water-energy-world/c1vz9> or <http://bit.ly/28IHArB>.

This STEM unit has now been the focus of two three-day professional development sessions as part of the Office of the Pima County School Superintendent's STEMAZing Institute. The Institute for teachers is just one component of the STEMAZing Project, which began in the end of October 2013. The teachers involved have become a force that is positively impacting STEM education in Southern Arizona. Through professional development in the form of one-day sessions during the school year and the three-day Institute in the summer, online newsletters, and community outreach, this program is leading the STEM Education charge in the region. DaNel Hogan, one of the Education Innovation panelists at the WRRC 2016 Conference, has been the driving force of this effort. She's proven that one innovative person can make a difference.

Through partnerships like this that drive integrated thinking and innovation, the need for high quality STEM education for K-12 students is being met. Currently, Arizona Project WET is working with the Watershed Management Group to develop a STEM unit on rainwater harvesting as part of a NOAA grant focused on building community resilience in the face of extreme weather due to a changing climate. Existing APW STEM programs incentivize school, home, and community water conservation through student-driven inquiry and action to install technology that saves water. Engaged students learning and acting for the betterment of their communities is what STEM innovation is about. 🏡