ARIZONA WATER RESOURCE
The Water Resources Research Center Quarterly Newsletter

Volume 23 Number 2 Spring 2015

Contents

Insert

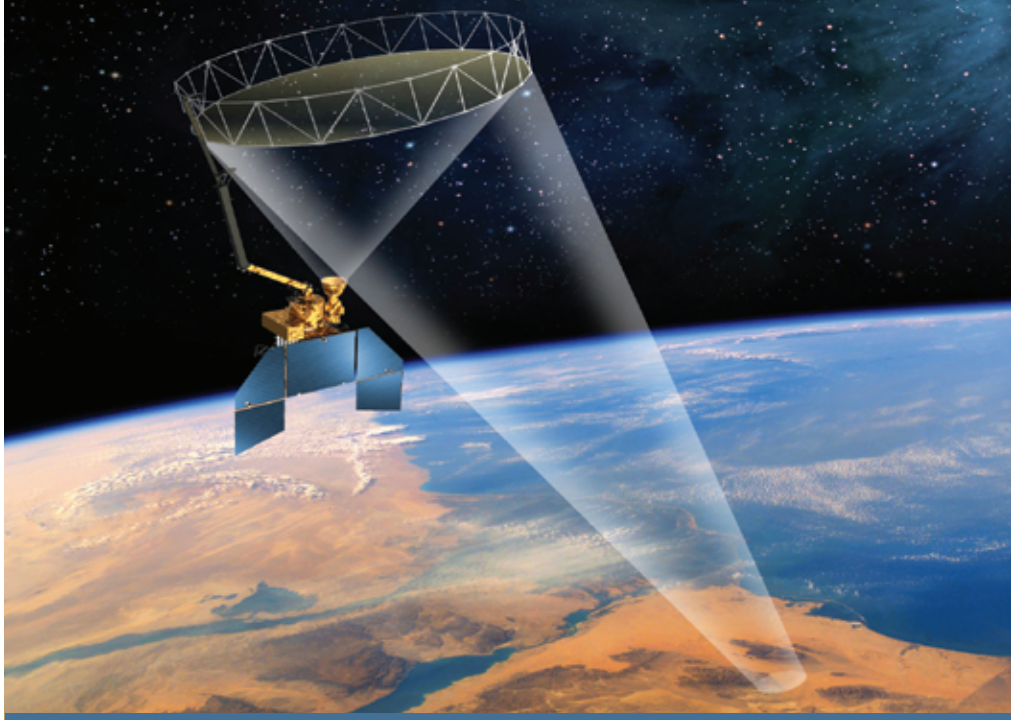
A Framework for Informing Groundwater Management

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**.

THE UNIVERSITY OF ARIZONA
College of Agriculture & Life Sciences
Water Resources Research Center

wrrc.arizona.edu
Find us on Facebook and Twitter
facebook.com/AZWRRC • twitter.com/azwrrc



NASA's soil moisture satellite's antenna captures a swath 1000 km (621 miles) wide. Source: NASA.gov

NASA Takes Earth's Vital Signs by Satellite

by Mary Ann Capehart, WRRC Graduate Outreach Assistant

Glance up at the night sky, and you might see the movement of a celestial object belonging to a fleet of earth-observing satellites launched by the National Aeronautics and Space Administration (NASA). Eighteen earth-focused satellites complete their daily orbits around the earth, not to observe and understand the far reaches of space, but to observe and understand our changing planet. Satellite observatories have the distance from Earth to observe the big picture and the technological sophistication to track changes in the biosphere at high spatial and temporal resolutions. Their images awe the eye and shape our understanding. This article focuses on four earth-observing

NASA continues on page 2

Water Expert Brian Richter Interviewed on His Life and Work

by Ann Posegate, WRRC Graduate Outreach Assistant

On March 5, the Water Sustainability Program and WRRC hosted international water expert Brian Richter in Tucson. He attended a community water dialogue, toured a water harvesting demonstration, spoke with students and gave a public lecture on campus to more than 150 people. Richter has been a global leader in river science and conservation for more than 25 years. He is Chief Scientist for The Nature Conservancy's Global Water Program, where he promotes sustainable water use and management with governments, corporations, and local communities. His new book, *Chasing Water: A Guide for Moving from Scarcity to Sustainability,* was published by Island Press in 2014.

How did you become involved in water management?

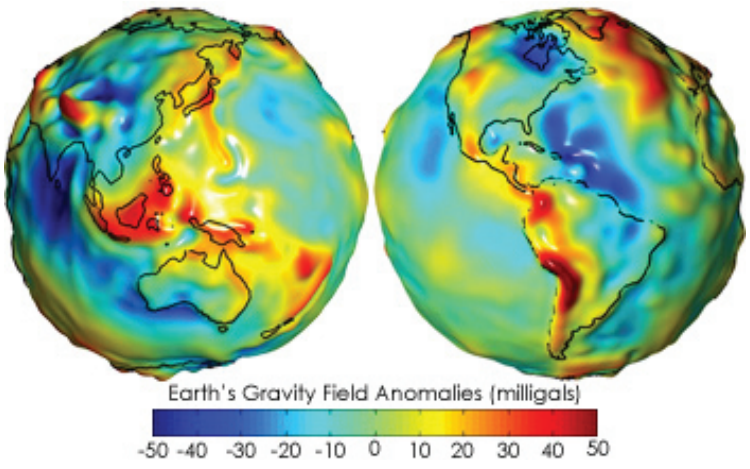
I grew up in San Diego, and we had mandatory water conservation. That made a real impression that water is precious and we need to be careful about it.

Brian Richter continues on page 3

NASA continued from page 1

satellites that bring new data to the needs of water research, management, and decision-making.

NASA's Gravity Recovery and Science Experiment (GRACE) has been called "the giant scale in the sky." It measures discrepancies in Earth's gravitational mass, which varies from location to location, determined in part by the height and thickness of the crust and the density of different materials. Scientists realized that shifts in Earth's gravity occur primarily because water moves from place to place on and under land, in the ocean, and in the atmosphere. GRACE's twin satellites circle the globe about 137 miles (220 km) apart. As the first satellite encounters a gravitational anomaly on the Earth below, it pulls away from the second. As the second satellite encounters the anomaly, it pulls away from the first. An onboard microwave-ranging system makes precise, continuous measurements of these shifts in distance between the two spacecraft. In addition, Satellite Global Positioning System records the exact position of the satellite over the Earth to within a centimeter or less. By comparing monthly maps constructed with these measurements, it is possible to quantify how a region's water storage changes over time.



Gravity anomaly maps constructed from GRACE data show variations in the Earth's gravitational mass. Source: NASA.gov

GRACE has been able to quantify the volume of water needed to end the drought in California. According to a study released in July 2104, it would take over 33 million acre-feet of water to bring water storage in the state's Sacramento and San Joaquin river basins up to normal seasonal levels. GRACE data has been able to demonstrate that the amount of water in storage has been steadily decreasing. Since 2011, the water volumes in the Sacramento and San Joaquin river basins have decreased by more than twelve million acre-feet each year. About two-thirds of the loss is a result of groundwater depletion below California's Central Valley.

GRACE-derived water data is used to monitor monthly changes of water mass in the seven-state basin. A study conducted by NASA, in collaboration with University of California, Irvine, revealed that the basin lost nearly 53 million acre-feet of freshwater from December 2004 to November 2013. This is nearly double the volume of Lake Mead, the largest reservoir on the Colorado River system. More than three-quarters of this total, about 41 million acre-feet, was from groundwater. This information, added to other drought indicators, is used to determine a drought's severity level.

Data from other satellites has been used to track changes in the northeastern reaches of Lake Powell, a critical part of the Colorado River basin system. NASA's Landsat series of satellites enabled scientists to produce a series of natural-color images documenting the fluctuations of water present in the side canyons feeding Lake Powell and other features of the reservoir between 1999 and 2014 as the water volume in the lake dropped to 42 percent of its capacity.

The Landsat program is a joint mission of NASA and the United States Geological Survey (USGS), which manages the National Satellite Land Remote Sensing Data Archive that currently holds more than three million Landsat scenes. Since 2009, Landsat images have been made available to the public free of charge.

The data from the Landsat spacecraft has a record of over forty years of continuous coverage, which makes it a primary global reference for scientific issues related to land use and natural resources. "There are newer, fancier satellite imagers out there," says researcher Eve Halper, of the Bureau of Reclamation, "but they lack the history."

Halper studies the urban heat island effect in arid cities. Landsat images are processed to establish vegetation ratings, at a 30 meter resolution, in order to compile a tree canopy data set. Tree canopy information is combined with local water use to analyze correlations between local residential outdoor water use, green canopy, and heat. Lack of vegetation can impact temperatures, comfort, and energy costs in low-canopy neighborhoods—often those with a vulnerable population due to poverty, says Halper.

Observations from Landsat-8, the newest in the Landsat series, have the spatial resolution to discern individual agricultural fields, each with its own attributes and behavior. Landsat-8's thermal imager observes differences in temperature as fields cool due to evapotranspiration (ET) and can therefore estimate how much water that field consumed on any particular day. Calculating ET from individual fields is useful for agricultural water management. Landsat data has also been used to settle legal disputes over water rights where actual consumption is an issue.

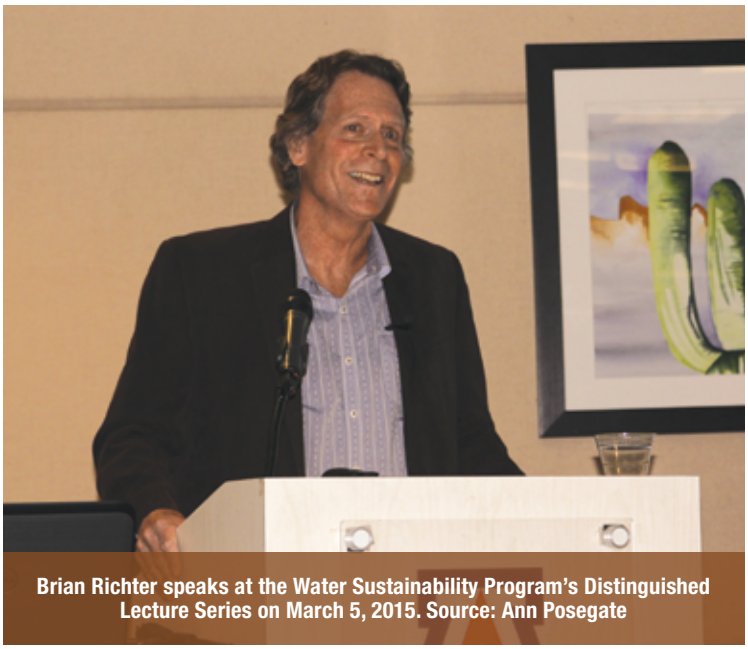
SMAP, the Soil Moisture Active Passive project, is the most recent addition to NASA's fleet of earth-facing observatories. Launched in January 2015, SMAP is designed to study a critical part of the water cycle: soil moisture and its freeze and thaw state. Using active radar and passive radiometry, SMAP allows mapping of water, frozen and liquid, in the top few inches of soil around the globe every three days even through cloud and moderate vegetation cover. Measurements from on-the-ground sensor stations validate the remote satellite estimations under the SMAP program. With these data points added together, SMAP can help researchers in weather forecasting and modeling for climate change and climate variability. SMAP applications will also improve the ability of farmers to assess crop productivity using measurements of root zone soil moisture. Global measurements of crop stress can help in the prediction of famine and allow aid organizations to position supplies of food. SMAP data will also help water resource

NASA continues on page 10

Brian Richter continued from page 1

In high school, I remember thinking if I were to become knowledgeable about water, I would probably never have trouble finding a job. That certainly turned out to be somewhat prophetic.

Then, I worked as a whitewater river guide after college. A new dam was proposed on the Stanislaus River in California. Like everybody else, I had a lot of questions about it. That influenced what I decided to study in graduate school. I wanted to know more about water resources.



Brian Richter speaks at the Water Sustainability Program's Distinguished Lecture Series on March 5, 2015. Source: Ann Posegate

When I was in my early 30s, I realized I had worked for companies and organizations trying to make them more sustainable. I had felt like I was swimming upstream, trying to change the way practices have been applied for a long time. I wondered what it would be like to work for an organization that already believed in conservation and environmental values. That's what brought me to The Nature Conservancy (TNC).

When I joined TNC, only a handful of people had expertise in water. We started from a tiny group, and we built a water practice there. Now, more than 400 people in TNC would consider themselves water specialists. It's been really rewarding and exciting to be a part of that growth.

You've traveled around the world looking at examples of water management. What is one of the most memorable experiences you've had with water abroad?

One that really changed the way that I think about my work was in Africa about seven or eight years ago. I had started to do more international work around dam development in developing regions. Some regions of the world are building a new big dam, 15 meters or higher, every day of the year on average. TNC is doing what it can to make sure the dams are being constructed in the most environmentally, economically, and socially compatible way possible.

I visited two rivers in Africa: the Zambezi, which forms the border between Zambia and Zimbabwe, and the Tana River in eastern Kenya. I saw the same thing in both of these places, and it had a profound impact on me. I saw what it looks like to see people starving in front of your eyes—starving and lacking access to safe, clean drinking water.

In both places, the construction of dams upstream has changed the way water flows into downstream environments where these people live. Hundreds of thousands of people depend on the rivers for fishing and growing crops on the floodplains, which are naturally flooded by the rivers. The people use an ancient practice called flood recession agriculture. Because of the changes in river flows, fish populations declined and the rivers no longer flooded the floodplains.

On the Tana River in Kenya, we talked with a village chief who literally begged for help to try to influence the way the upstream dams were being managed. The crops on the floodplain were the people's sole source of food, so they were literally starving to death.

Until then, I was focused on environmental conservation, trying to keep rivers healthy to support natural ecosystems. All of a sudden, my whole world opened up to the realization that this is about people too. It's about access to water and healthy ecosystems that support our lives, livelihoods, and well-being. When water is managed poorly, it affects every single person on the planet. Improper or inadequate management of water supplies is a universal issue, and it's something that I very intentionally focus on through my work.

How has your new book, "Chasing Water," been received?

In general, very positive. The formal reviews on it have all been supportive and favorable. One of the things that have fortunately been recognized is that I was trying to write simply and clearly about what can be a very complicated issue and make sure readers were introduced to basic foundational issues about water so they would be better prepared to influence opportunities in their own work.

The one bit of criticism that I have gotten is that I wasn't strong enough in my advocacy. But I didn't want to turn anybody off in taking a strong position when I knew that there would be differences of opinion. I wanted it to be an educational book. I wanted readers to finish and understand the book without getting to a point where they would disagree and stop reading.

In the book, you address some of those issues on which people might disagree. Can you talk about your approach to those?

The one thing that is controversial and that I took considerable care in trying to explain is water markets, trade, and privatization. I think there's confusion and misinterpretation around what people label as water privatization. The basic fear is that wealthy, powerful corporations will gain control over water to serve their private needs to the detriment of the poor sectors of our society and to the environment. I'm oversimplifying, but that's the basic concern.

I wanted this book to be read around the world so it could be useful in water-scarce regions everywhere, so I wanted to make sure that it was culturally sensitive. Regarding water markets, I start with the concerns first. They have to be dealt with and

Brian Richter continues on page 4

Brian Richter continued from page 3

there has to be adequate governance in place to protect against unintended consequences around the value and price of water. There has to be full and explicit consideration of environmental water needs as part of that.

In commercial water use, markets can have potentially beneficial effects such as greater efficiency of use and more economically productive uses. That productivity leads to more money coming into the local economy and more jobs. But I was very careful about knowing where the criticisms would come from and tried to address them as best I could.

Another part of the privatization arguments is the issue of public water supply systems. Some people take the position that no private entity should ever be allowed to manage and operate a public water supply system. There have been some very well-publicized, horrific examples of how that could go wrong, for example, in Cochabamba, Bolivia, where the city contracted with a private entity to manage its water supply system. Unfortunately, the rates were raised, and a lot of the residents could no longer afford water. They rioted, a teenage boy was killed in the riot, and terrible things came about. But, I don't believe that you throw out the opportunity of having private companies involved in managing public water supplies if it's done properly.

Richter tours Watershed Management Group facility with Tucson community members. Source: Ann Posegate

Some city governments don't have the expertise, capacity or know-how to manage their water supplies and wastewater systems, so there's a need for that kind of expertise and skill set. Conditions can be placed on contracts that gain the benefits of private investment as well as expertise to manage consequences. The catch is that most places that would look for that kind of help don't have adequate governance in the first place, and things go wrong over and over again. Even though they could prevent those bad outcomes, their governance isn't strong enough to be able to put those conditions in place and enforce them. So, there are certainly valid criticisms.

You attended a community water dialogue in Tucson and learned about local initiatives. In your experience, what is the best way to connect community initiatives with decision-making?

I appreciated the opportunity to learn and talk with people there. They have been able to mobilize a grassroots movement here in Tucson, and I don't know much about grassroots mobilization. What I have thought a lot about is how to open up the doors of the more formal arenas of water management to provide access to community groups.

For example, at the state level, Texas opened up its long-range water planning processes to representative stakeholders. The state has organized conversations around its 16 major river basins and has been very deliberate about who gets to be part of the formal dialogue. It's very representative.

I'm excited about this opening of the doors of what used to be very centralized, technocratic, bureaucratic decision-making about water that was engineering-based and took place at the national or state level. I believe in citizen access to water decision-making because, when the decisions take into consideration local values, needs, and perspectives, solutions are put forth that are more appropriate to the local context. They make more sense because the local people have great ideas about ways to resolve their local water problems, and the solutions tend to be more robust and sustainable. They're economically and culturally appropriate, and the local people have participated, so they're going to live by the decisions and take ownership of them. I think it's a huge step forward, and I think there is going to be a sea change in the way that water planning, decision-making, and rule-setting gets done in the future.

The video and slide show of Brian Richter's lecture at the University of Arizona on March 5, 2015, are available at http://wsp.arizona.edu/node/357.

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.

Editor: Susanna Eden
Designer: John Polle
Layout: Mary Ann Capehart
Newsletter Link: wrrc.arizona.edu/publications/awr
WRRC Website: wrrc.arizona.edu
WRRC Director: Dr. Sharon B. Megdal

Arizona Water Resource
Water Resources Research Center
College of Agriculture and Life Sciences
The University of Arizona
350 North Campbell Avenue
Tucson, Arizona 85719 USA

520.621.9591 FAX: 520.792.8518 Email: wrrc@cals.arizona.edu

WRRC is a Water Sustainability Program Affiliate

WSP Water Sustainability Program Our Water Future

WRRC Director Testifies Before Congress

On Wednesday March 18, Dr. Sharon B. Megdal, Director of the University of Arizona Water Resources Research Center, testified before the U.S. House of Representatives Committee on Appropriations, Subcommittee on Interior, Environment, and Related Agencies. As President of the National Institutes for Water Resources (NIWR), Dr. Megdal spoke on behalf of that organization in support of the Water Resources Research Act (WRRA) program. Administered by the U.S. Geological Survey under the general guidance of the Secretary of the Interior, the WRRA program established the water resources research institutes in U.S. states, territories, and the District of Columbia. Institutes are charged with undertaking water research to solve local, regional, and national water issues, training new water professionals, transferring technology, and disseminating information. Dr. Megdal's testimony highlighted the recent achievements of the water resources research institutes and emphasized the quality and significance of their research. Dr. Megdal also stressed the importance of continued federal support of the Water Resources Research Institute program in understanding and resolving local, regional, and national water problems. Dr. Megdal assumed the NIWR presidency on October 1, 2014 and will hold the position until September 30, 2015.

New SRP Technology Improves Watershed Monitoring

A new photography-based system, named SRP Flowtography™ has been deployed by the Salt River Project (SRP) to track the runoff from snowmelt and rainfall at selected locations in northern Arizona. Essentially a simple, inexpensive way of monitoring stream flow that uses both time-lapse cameras and in-stream visual staff gauges, Flowtography™ tracks the runoff from snowmelt and rainfall and offers visual proof of stream flow or snow accumulation. Developed by Lee Ester, manager of Water Measurement at SRP, Flowtography™ combines time-lapse images synchronized with conventional data. Especially useful for flow events on streams that run only for short periods following rain or snowmelt, the 35,000 photos collected at each site per year are used with electronic data for comparison and verification. After two years of field testing, Flowtography™ is currently being used at several locations across the Salt and Verde watersheds, in the Big Chino Sub-basin, and at portions of four national forests along the Mogollon Rim in northern Arizona. SRP is the largest provider of water to the greater Phoenix metropolitan area.

Federal Government Consolidates Environmental Datasets

December saw the release of two new datasets that consolidate hundreds of datasets from numerous federal departments and agencies into two thematic data hubs: "Ecosystem Vulnerability" and "Water." Both are now available online to the public for free. Departments and agencies include the U.S. Geological Survey, the Bureau of Reclamation, the National Oceanic and Atmospheric Administration, the Department of Agriculture, the National Aeronautics and Space Administration, and the Environmental Protection Agency. The water-themed hub improves the accessibility of government records of stream flow, groundwater levels and water quality spanning more than a century, and estimated water use since 1950. USGS-contributed water datasets include the National Water Information System, the leading source of stream flow, water quality, groundwater, and water use data for the nation. Another key resource is the NOAA National Climatic Data Center's archive of historical precipitation and other climate drivers relevant to the water cycle. In addition, base map data such as the USGS National Hydrography Dataset and 3D Elevation Program, land cover, soils, and other data are provided along with models such as the NASA North American Land Data Assimilation System, which estimates soil moisture and other water variables. The data sets can be found online at https://www.data.gov/climate/

Stormwater Master Planning Underway in LA Focuses on Water Harvesting

Los Angeles is engaged in a major Stormwater Capture Master Planning Process to explore opportunities for increased stormwater capture in order to increase the local water supply and reduce the dependence on imported water. The plan is being developed by the Los Angeles Department of Water and Power with community input through a series of public meetings. The final plan is expected by the summer of 2015. The plan will identify and evaluate alternatives and strategies to increase stormwater capture, including specific actions for implementing the plan's recommendations. Projects large and small in scale will be considered, from central spreading basins to residential rain gardens. The multiple benefits of increasing stormwater capture will also be evaluated, which can include replacing a portion of potable supply, recharging groundwater, and addressing problems of water quality and peak flows in downstream channels, creeks, and streams such as the Los Angeles River. The plan is intended to guide decision making on Los Angeles's water resource policies and programs.

EPA Launches Water Finance Center

A new Water Finance Center at the Environmental Protection Agency has been launched that will connect local governments and utility companies with federal grants to rebuild sewer systems and keep streams and rivers clean. To help address more than $600 billion in needs for drinking water and wastewater management over the next 20 years, the Center will work closely with municipal and state governments, utilities and private sector partners. Federal grants will be used to attract more private capital into projects and promote models of public-private collaboration. This is seen as a model for addressing the needs of cities and towns to provide safe water, rebuild sewer systems, and keep streams and rivers clean.

Announcements

UA Team Wins the New Arizona Prize: Water Consciousness Challenge

A unique project, Beyond the Mirage, was awarded the top prize of $100,000 in the New Arizona Prize: Water Consciousness Challenge. Developed collaboratively by a creative team from the University of Arizona College of Agriculture and Life Sciences, which includes the Communication and Cyber Technologies Department, Water Resources Research Center, and Arizona Project WET, along with Arizona Public Media (AZPM) and marketing professionals, Beyond the Mirage aims to raise the level of awareness and understanding about Arizona's water supplies, demands, and challenges. Beyond The Mirage will use this award to help launch innovative web and social media strategies to engage Arizonans in creating and sharing their own mini-documentaries on the Beyond The Mirage website, expected to launch January 2016. With the help of AZPM, the hundreds of clips that cover all facets of Arizona's water story can also find homes throughout the news media and on major educational sites such as PBS learning media. AZPM also will produce a feature documentary from the same content. The New Arizona Prize, a joint initiative of the Arizona Community Foundation, Republic Media, and the Morrison Institute for Public Policy, seeks to harness Arizonans' creativity "to solve persistent and complex problems." Through the Water Consciousness Challenge, the first competition of a series of New Arizona Prize challenges, organizers are highlighting the importance of raising water awareness in our communities. A panel of judges selected Beyond the Mirage after reviewing presentations from five finalists at the Phoenix Art Museum.

WIFA Awards 2014 Clean Water Project of the Year

The Water Infrastructure Finance Authority of Arizona (WIFA) announced in February that it had selected the City of Prescott to receive WIFA's 2014 Clean Water Project of the Year award for the Airport Water Reclamation Facility Expansion. The $42 million infrastructure project renovated and expanded treatment capacity and now has the ability produce Class A+ reclaimed water from current and near future waste flows. WIFA praised the project's fiscal sustainability, exceptional project management, and commitment to improving Arizona's quality of life through wastewater infrastructure upgrades. WIFA is a state agency that provides financial assistance for water and wastewater infrastructure, investing more than $2 billion over the past 25 years.

Verde River Focus of $2.8 Million NRCS Grant

The U.S. Natural Resources Conservation Service has awarded a grant of $2.8 million for the Verde River Flow and Habitat Restoration Initiative, which seeks to restore river flows and riverside health while supporting the irrigation needs of agricultural producers in the Verde Valley. Partners in the initiative include The Nature Conservancy, Friends of Verde River Greenway, the Verde Natural Resource Conservation District, Arizona Game and Fish, and the Tamarisk Coalition. The funding is from the Regional Conservation Partnership Program, part of the Farm Bill passed in late 2014. In the past five years, The Nature Conservancy and its partners have worked with irrigators to improve irrigation water management by using automated gates, ditch liners to reduce water loss, and improved infrastructure. These efforts, combined with financial incentives for conservation, have meant less water is being diverted from the river. The result has been increased flows along 20 miles of the river in the Verde Valley and improved flows in the Wild and Scenic area between Camp Verde and Phoenix. This new funding will continue to support collaborative efforts to restore flows, including improving irrigation systems and wildlife habitat along the river.

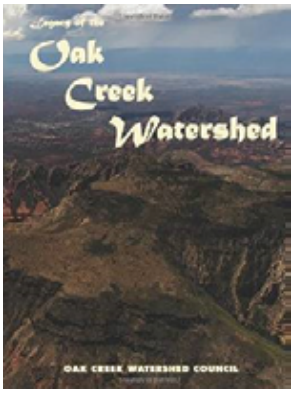
EPA Publishes Draft Contaminants List

In February the Environmental Protection Agency (EPA) published a draft list of contaminants—the Contaminant Candidate List (CCL). Listed contaminants are not currently regulated under the Safe Drinking Water Act (SDWA) but may need to be regulated in the future. The SDWA requires EPA to publish the CCL every five years. EPA uses the list to identify contaminants for study. The Draft CCL is the fourth of the lists EPA has developed and includes 100 chemicals or chemical groups and 12 microbiological contaminants. Listed contaminants include chemicals used in commerce, pesticides, biological toxins, disinfection byproducts, pharmaceuticals, and waterborne pathogens. Contaminants on the CCL are known or anticipated to occur in public water systems at levels of potential concern for public health. EPA will evaluate and consider public review comments when developing the final CCL 4. The draft CCL4 can be viewed at http://www2.epa.gov/ccl/contaminant-candidate-list-4-ccl-4.

EPA Awards $2.5 Million to Arizona to Improve Surface Water Quality

On March 20, the Environmental Protection Agency (EPA) announced the award of $2.5 million to the State of Arizona for projects to help restore water quality in the state's polluted water bodies. The state will add $1.6 million, making $4 million available this year for these projects. This brings EPA's investment in Arizona's surface water quality to more than $16 million since 2009. The Arizona Department of Environmental Quality (ADEQ) and its partners around the state will use the funds to restore water quality in a variety of watersheds, including the Upper Santa Cruz River watershed (Mexico border to Sapori Wash) and Oak Creek, Granite Creek, San Pedro River, San Francisco River, and Blue River watersheds, as well as the Little Colorado River watershed and the Boulder Creek watershed. More information is on the ADEQ website at azdeq.gov/environ/water/watershed.

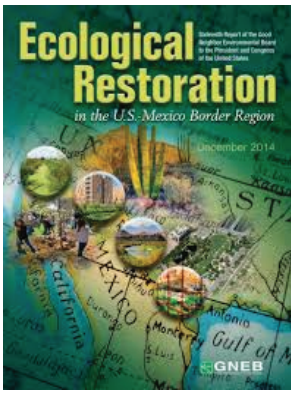
Legacy of the Oak Creek Watershed: Preserving Our Past, Present, and Future



Oak Creek Watershed Council, January 2015

A new book, *Legacy of the Oak Creek Watershed: Preserving Our Past, Present and Future*, examines the watershed from an environmentally holistic perspective, detailing the recreational opportunities, human history, geologic timeline, hydrologic cycle, water law, ecological diversity, and the challenges and opportunities to protect and preserve the integrity of the Oak Creek watershed. Published by the Oak Creek Watershed Council, a local nonprofit dedicated to the sustainable future of Oak Creek and its watershed, the 160-page full color book was the result of contributions from more than 30 individuals, organizations, and citizens groups. It is available for purchase through the Oak Creek Watershed Council website at http://www.oakcreekwatershed.org/shop-ocwc as a hardcopy, Kindle version, or downloadable PDF.

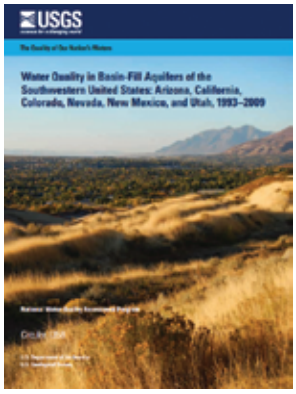
Ecological Restoration in the U.S.-Mexico Border Region



Good Neighbor Environmental Board, December 2014

In December 2014, the Good Neighbor Environmental Board published its 16th report to the President and the Congress, entitled *Ecological Restoration in the U.S.-Mexico Border Region*. Since its creation in 1992 (Public Law 102-532) the Good Neighbor Environmental Board has been charged with submitting an annual report to the President and the Congress, created "to serve as a nonpartisan advisor to the President and the Congress and recommend how the federal government can most effectively work with its many partners to improve conditions along the U.S.-Mexico border", the Board in 2014 dedicated its efforts to border ecology. The report documents issues of environmental degradation along the border, federal actions to ameliorate damage, and recommends activities that could improve the effectiveness of U.S. federal government management of natural resources in the region. The report contains descriptions of current ecological restoration activities, the challenges to their implementation, and opportunities to improve outcomes, citing multiple examples. It then looks specifically at three major watersheds, the Tijuana River, Colorado River, and Rio Grande, to explore how challenges can be overcome. It ends with a list of four major recommendations: that the federal government take a proactive approach to protect existing ecological resources; promote restoration projects; work with Mexican partners; and evaluate flow management options that include use of irrigation and wastewater. The report is available online at http://www2.epa.gov/sites/production/files/2014-12/documents/16th_gneb_report_english_final_web.pdf

Water Quality in Basin-Fill Aquifers of the Southwestern United States: Arizona, California, Colorado, Nevada, New Mexico, and Utah, 1993–2009



Susan A. Thiros, Angela P. Paul, Laura M. Bexfield, and David W. Anning, U.S. Geological Survey, Circular 1358, 2014

A new USGS report describes the occurrence of, trends in, and factors controlling concentrations of contaminants in the Southwest basin-fill aquifers of Arizona, California, Colorado, Nevada, New Mexico, and Utah. It highlights how geology, hydrology, geochemistry, and chemical use affect the concentrations of individual contaminants, and how water use—through irrigation and pumping—has affected concentrations of contaminants from both geologic and manmade sources. USGS scientists assessed water quality in more than 1,000 wells. Contaminants from geologic sources are more common in the basin-fill aquifers than in many other aquifers in the U.S. because of the hot and dry climate, long groundwater flow paths, and the types of rocks and sediments present. The authors found that one in every three drinking-water-well samples contained at least one contaminant at a concentration of potential concern for human health. In particular, arsenic and uranium derived from geologic sources are potential drinking-water concerns. Irrigation and pumping have greatly altered natural flow systems in some areas, carrying manmade contaminants down to shallow and deep groundwater. The report is available online at http://pubs.usgs.gov/circ/1358/

A Case Study in Efficiency: Agriculture and Water Use in the Yuma, Arizona Area

Yuma County Agriculture Water Coalition, February 2015

The Yuma area is one of the most productive agricultural centers in the United States. A new case study compiled by the Yuma County Agricultural Water Coalition, the Arizona Department of Water Resources, and the University of Arizona

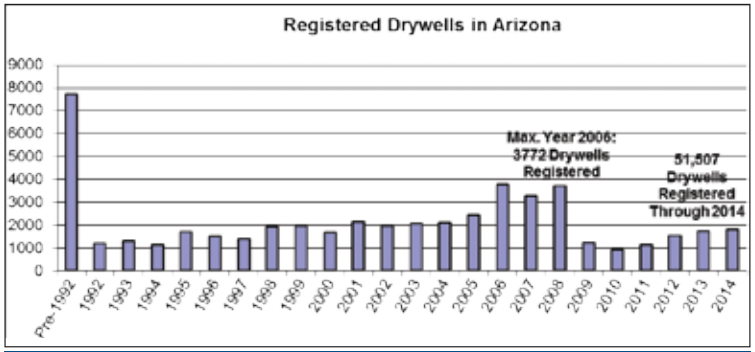
Resources continues on page 12

Dry Wells for Stormwater Management: An Evolving Viewpoint

By Chuck Graf, Senior Hydrologist, Arizona Department of Environmental Quality

Dry wells are bored holes designed to dispose of stormwater into the subsurface. Dry wells first appeared for stormwater control in the 1930s in then-tiny Phoenix. In the early 1970s, local governments in the Phoenix metropolitan area started requiring onsite retention of stormwater to reduce peak flooding, typically requiring that no ponded water remain after 36 hours. The new ordinances led to rapid expansion of dry well use to drain away stormwater. Now, more than 50,000 dry wells have been drilled in the greater Phoenix area. However, this unconventional onsite stormwater management approach has not caught on elsewhere in Arizona—less than four percent of installed dry wells are located outside of the greater Phoenix area. This may change, though, as stormwater is increasingly viewed as an underutilized resource and dry wells are seen as a means for aquifer recharge rather than simply a stormwater runoff control tool.

Until 1987, no legal framework existed in Arizona for the regulation of dry wells, even though thousands were then in use. In 1987, legislation directed the Arizona Department of Environmental Quality (ADEQ) to license dry well installers and establish a registration program for existing and newly constructed dry wells. The law expressly limited the use of dry wells to the disposal of stormwater. This limitation was intended to prevent disposal of hazardous chemicals into dry wells, which in the past had caused severe groundwater contamination plumes (some of which are still under remediation).



Drywell registrations top 51,000. Source: ADEQ

Formal regulation in 1987 effectively sanctioned the use of dry wells and spurred their construction (see figure). By the end of 2014, ADEQ had registered 51,507 dry wells. Dry wells are used for stormwater control and disposal at virtually every new apartment, hotel, office, and commercial complex developed in the greater Phoenix area in the last three decades, and for subdivision and park drainage as well.

The early dry wells in Phoenix were simple dug or drilled holes filled with rocks. Burgeoning dry well use after 1987 prompted design improvements, which allowed solids to settle out and reduced floating material that had clogged earlier designs. Newer dry well designs continue to enhance removal of sediment and floating material, thereby delivering cleaner water to the injection zone. This improves injection performance and extends dry well lifetimes.

The dry well borehole is drilled in alluvial sediments, through any intervening fine-grained and cemented zones, into a permeable layer of clay-free sand, gravel, and cobbles. The permeable layer serves as the injection zone for the stormwater. ADEQ requires at least 10 feet of separation between the bottom of the injection zone and the water table. Because groundwater commonly occurs at great depth in Arizona's alluvial basins, installers often have considerable leeway to find an exceptionally permeable zone above the water table that maximizes dry well performance while maintaining a much greater separation distance than the 10-foot minimum.

Chandler is an example of a rapidly growing Arizona city where dry wells are intensively used for stormwater management. A 2005 study examined the groundwater recharge impact of the dry wells. The study found that 3,763 dry wells were installed within city boundaries, draining 1,400 acres of stormwater retention basins. The study pegged natural, pre-development recharge at 191 acre-feet of water per year (af/yr). Post-development recharge through the dry wells was estimated at 2,100-3,100 af/yr in an average rain year. Dry year and wet year recharge was estimated at 770 af/yr and 8,700 af/yr, respectively. Clearly, dry wells are a significant, if not the primary, source of groundwater recharge within Phoenix-area cities relying on them for stormwater management.

Although still not common, drywells are increasingly being used for stormwater management in communities in other states, notably in Washington and Oregon, but also in California. Perhaps most interestingly, in the Los Angeles area they are starting to be used in an integrated way—as much for groundwater recharge as for runoff control.

Potential adverse groundwater quality impact is the biggest concern about dry wells. Although the definitive water quality study probably remains to be done, a number of studies, including a 10-year study in Los Angeles conducted by the Bureau of Reclamation and others, found little evidence for groundwater contamination. A 1985 study in Phoenix found that dry wells had a beneficial effect on groundwater quality with respect to major chemical constituents. This finding is not too surprising considering the notoriously poor quality of shallow groundwater in many areas due to urban and former agricultural influences. In the Phoenix study, the total dissolved solids (TDS) in stormwater entering the dry well averaged about one-eighth of the native groundwater sampled from a monitor well. (Native groundwater TDS was almost 1,400 milligrams per liter).

Further research is needed, of course, to better characterize water quality impacts. Improved dry well designs and development of new pollution control strategies and technologies are always beneficial. Operation and maintenance best practices need to be optimized and documented, as lack of maintenance is the main cause of dry well performance decline and failure. Continued use of dry wells is a certainty. Care and vigilance in properly locating, designing, and maintaining dry wells will remain key to protecting groundwater quality as dry wells evolve from their traditional use to dispose of stormwater to their employment to recharge urban aquifers.

WRRC ANNUAL CONFERENCE 2015

wrrc.arizona.edu

INDIGENOUS PERSPECTIVES ON SUSTAINABLE WATER PRACTICES

Water Resources Research Center Annual Conference

Hosted in Partnership with the Gila River Indian Community

June 9-10, 2015
Wild Horse Pass Hotel & Casino
5040 West Wild Horse Pass Road
Chandler, AZ 85226

WHAT can be learned from the indigenous perspectives on water?

HOW can this knowledge be used to improve water management?

EXPLORE water stewardship, challenges and achievements with tribal water leaders.

REFLECT on indigenous traditions in caring for agricultural lands and riparian areas as a guide to creating Arizona's water future.

WRRC WATER RESOURCES RESEARCH CENTER

THE UNIVERSITY OF ARIZONA College of Agriculture & Life Sciences Cooperative Extension

GILA RIVER INDIAN COMMUNITY ARIZONA 1939

June 9: 12:30 to 5:00 pm

Traditional Prayer and Blessing

Opening Remarks:
Sharon Megdal, *Director, University of Arizona, WRRC*
Stephen Lewis, *Governor, Gila River Indian Community*

Keynote Speaker:
David DeJong, *Author of Forced to Abandon our Fields, the Agricultural History of the Gila River*

Spiritual and Ceremonial Views of Water, *How tribes relate to water in songs, offerings, how water is respected in indigenous communities*

The Nature of Tribal Water Rights, *Tribal representatives will discuss the history and future of negotiating Native American water rights in Arizona*

Keynote Speaker:
Ofelia Zepeda, *Professor of Linguistics, University of Arizona, Native American poetry reading*

Evening Reception

June 10: 7:00 am to 5:30 pm

Continental Breakfast

Traditional Prayer and Blessing

Keynote Speaker:
John Echohawk, *Founder of Native American Rights Fund, Arizona water issues from a tribal perspective*

Tribal Water Successes and Challenges, *Highlights of tribal water successes and challenges will be discussed by a panel of Arizona tribal water management leaders*

Tribal Riparian Restoration Success Stories, *Arizona tribes have a long history of restoring native riparian areas, Tribal representatives will discuss current efforts in riparian restoration*

Luncheon:
Recognizing 10th Anniversary of Arizona Water Rights Settlement

Arizona Groundwater a Precious Resource, *Tribal water professionals will discuss management decisions related to groundwater, diversifying water portfolios with groundwater recharge*

Tribal Water Use in Traditional Agriculture: Our Youth Represent the Future, *Panelists will discuss current tribal programs developed to engage youth in traditional agricultural practices*

Keynote Speaker:
Harry Walters, *Navajo Historian, Water Culture of Indigenous Communities in the Arid Southwest: A Look Forward*

Learning from the Past, Looking to the Future, *Panelists will discuss how past lessons can be applied to successfully manage water supplies within and beyond Arizona*

Closing Comments

Traditional Prayer and Blessing

Student Spotlight

Ann Posegate, School of Journalism

Ann Posegate is a second-year master's student in journalism. She received her undergraduate degree in environmental science from Elizabethtown College in Pennsylvania and attended the Washington Semester program at American University in Washington, D.C. with a field study in South Africa.

Posegate has worked at mountains, deserts, canyons, rivers, cities, and even an ice sheet, communicating science and environmental concepts to many audiences. She was an educator at the Mount Washington Observatory in New Hampshire, an interpretive park ranger at Grand Canyon National Park, a watershed educator in Washington, D.C. and a freelance writer.

For more than three years, she worked as outreach coordinator for the National Environmental Education Foundation's Weather and Environment program, which provides environmental and climate information to broadcast meteorologists for incorporation into weather broadcasts. She also served as weather-environment writer for the Washington Post's local weather blog, Capital Weather Gang, and covered numerous water-related topics such as stormwater runoff. In 2010, she traveled to Antarctica on a media expedition with the National Science Foundation and reported live from "the ice," a life-changing experience.

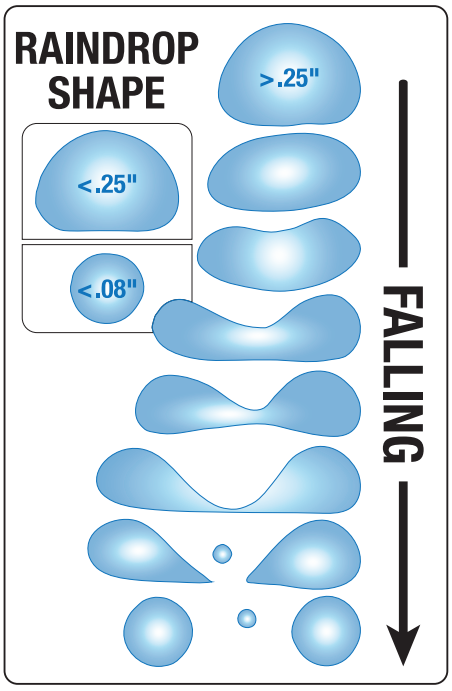
At WRRC, she works as Graduate Outreach Assistant under Water Sustainability Program Director Jackie Moxley. She assists in organizing and promoting events, as well as creating the new UA Water Network website, which will be a clearinghouse for the university's water-related research and activities.

Posegate's studies focus on science and environmental reporting. For her thesis, she is analyzing news media coverage of the California drought. She plans to graduate in August 2015 and in the future would like to work with scientists to communicate research in creative ways.

NASA continued from page 2

managers to predict drought, map flood areas, and assess ecosystem health.

Launched in February 2014, the Global Precipitation Measurement (GPM) project, a joint mission of NASA and the Japan Aerospace Exploration Agency is on course to coordinate a dozen satellites measuring precipitation around the globe. In addition to the GPM Core Observatory, each partner satellite has its own orbit, allowing different portions of Earth's surface to be viewed at the same time, every 30 minutes. The mission is capable of merging data from each of the satellites into a single map, called Imerg, or Integrated Multi-composite map, with a resolution of five by five miles. Data is available in strips, called swaths, which correspond to the satellites' overpasses. This is the first mission to combine data from an international group of satellites to monitor rainfall and snow in near-real time.



Raindrops change shape as they fall. Source: NASA.gov

The GPM project, managed by NASA, has allowed the space agency to produce amazing 3D maps of rain and snowfall around the world at both regional and global scales. A new video, showing precipitation from April to September, 2014, was released by the mission in February 2015. Precipitation is seen from 60 degrees north to 60 degrees south of the equator-roughly from the Northwest Territories of Canada to south of Argentina. Large frontal systems, which can last for days, can be seen in the video at middle latitudes, moving heat and water across the Atlantic and Pacific Oceans. Also visible are deep tropical convective storms popping up across the equator, which move heat from the ocean's surface into the atmosphere, redistributing it throughout the Earth's system.

Scientists have been studying the shapes of raindrops for years. Their shapes depend on size and the forces acting on them as they fall. The GPM mission is designed to investigate the size of rain drops, using an advanced radar instrument aboard the GPM Core Observatory. Knowing raindrop size and shape helps characterize rainfall patterns—larger, flatter drops are associated with heavier rain fall.

These four earth-facing satellite missions are part of NASA's Earth Observing System that launched its first mission in 1997. Since NASA's inception, all of the data received from its spacecraft projects has been archived and made available to the public including over 4 terabytes of new earth science data each day. These missions provide robust data to improve knowledge of our planet's land surface, biosphere, atmosphere, and oceans helping scientists obtain long-term data critical to reaching a full understanding of the interactions between the Earth's physical, biological, and socio-economic systems.

Connecting Students to Water Policy and Management in Practice

by Sharon B. Megdal

One of the highlights of the **graduate course in Arizona Water Policy** I teach each Spring semester is our class field trip. The annual outing provides students with the opportunity to see in practice what we have been exploring in the classroom and through readings. This year's field trip, conducted on March 27, 2015, included stops at Tucson Water's Advanced Oxidation Plant for removing localized groundwater contaminants, the Southern Avra Valley Storage and Recovery Project for recharging Colorado River water for current and future use, and the Sweetwater Wetlands for further processing of treated wastewater. Each site represents an important component of Tucson Water's water supply portfolio and overall groundwater management strategy. In addition, the students visited Central Arizona Project's Twin Peaks Pumping Station, where they saw the CAP canal and the pumps that push water uphill. They also visited Pima County's new Agua Nueva Water Reclamation Facility, which replaced the old (and smelly!) Roger Road Wastewater Treatment Plant and where they saw modern lab facilities used for water quality monitoring. In addition to packing all of this into a one-day field trip, a lunch hosted by BKW Farms provided the group with an opportunity to hear about how growers in the region have re-introduced production of organic White Sonora Wheat, originally brought to the region in late 17th century.

Sharon B. Megdal's Arizona Water Policy graduate class visits Tucson's Sweetwater Wetlands. Source: Betsy Wilkening

My Arizona Water Policy class uses Arizona water as the basis for examining water policy and management options for states and regions beyond our own. Throughout the semester, external experts serve as guest lecturers, and each student must write a paper for the course that explores a particular water-related challenge and policy approaches to resolving it. The guest experts cover timely topics, including water banking and Colorado River shortage, water quality regulations and policy, municipal water planning, agricultural water use, and sustainable water practices at multiple geographic scales. As evidence of the relevance of the course to students in many disciplines and programs, five academic programs at the University of Arizona list the course. This cross listing is consistent with the widespread recognition that addressing water issues in practice requires a multi-disciplinary approach. Course size is limited to 15 in order to enable a truly interactive and participatory experience throughout the semester.

This course is just one of many choices included in the curriculum for a relatively new graduate program at the University of Arizona, the **Master's degree program in Water, Society, and Policy**. In order to help prepare them for jobs in public agencies, private businesses, and non-governmental organizations, the program offers students considerable choice of coursework. In lieu of a research-based thesis, the program's capstone requirement is a six-unit Master's Project. As noted in the brochure for the program: "All students complete a Master's Project selected in consultation with a faculty advisor. Projects are as unique and diverse as the students that participate in this program. [The student] may produce a professional paper, internship report, series of public presentations, public outreach activity with associated background materials, water-focused curriculum, or other substantive product." (https://wrrc.arizona.edu/WS-and-PDP)

This Master's Project connects the student with an external organization with which to work for a minimum of 270 hours on aspects of water management and policy important to the host entity. Students have connected with a diverse set of organizations. I assist my students in identifying a potential host and in reviewing the "scope of work" developed in consultation with the host. Students have connected with different types of organizations, including a large city, a grass-roots sustainability coalition, a business-oriented water coalition, and a foreign scientific research institute. Project work is finalized by a summary report to the student's advisor and a final presentation, which is open to faculty and students involved in the program, the project host, and invited guests. In order to provide additional learning outside the formal classroom, students in the Water, Society and Policy program must also take two semester-long seminars open only to students in the program. In the Spring semester, when I am responsible for the seminar, students attend water-related seminars and lectures offered by schools, departments, and programs across the University of Arizona and then meet as a small group to discuss them. Many of the seminar speakers are water management practitioners.

Feedback confirms that connecting students with those who focus day-in and day-out on the many water management challenges we face at the community, regional, national, and international levels is valued by all involved. Developing and implementing solutions to the myriad water challenges will require contributions from many disciplines and organizations and meaningful interaction among us all.

WRRC
WATER RESOURCES RESEARCH CENTER

THE UNIVERSITY OF ARIZONA
College of Agriculture & Life Sciences
Cooperative Extension

Water Resources Research Center
College of Agriculture and Life Sciences
The University of Arizona
P.O. Box 210437
Tucson, AZ 85721-0437

Address Service Requested

Resources continued from page 7

College of Agriculture and Life Sciences (CALS) draws on both qualitative and quantitative data to tell the story of agricultural water use in the Yuma area. Sections on the Colorado River water supply, water conveyance, and delivery infrastructure; irrigation management, the economic contribution of Yuma County agriculture, and environmental water use are intended to show the efficiency of water use in the highly productive agricultural fields of Yuma County. Authors include N.W. "Bill" Plummer, President of the Agribusiness and Water Council of Arizona; Paul W. Brown; Kurt D. Nolte; Charles A. Sanchez; George Frisvold of the University of Arizona College of Agriculture and Life Sciences; and Patricia Ware, past chair of the Yuma Crossing National Heritage Area Corporation. Appendixes present additional information on the Yuma and Gila Projects, Colorado River law, and crops grown in the Yuma area. The case study proposes that by reporting on the evolution of the Yuma area's highly productive and water efficient agriculture, readers will recognize how little room there is for additional water savings. The case study is available online at www.agwateryuma.com