ARIZONA WATER RESOURCE

The Water Resources Research Center Quarterly Newsletter

1964-2014 WRRC 50th Anniversary

Volume 22 Number 2 Spring 2014

Contents

50 Years at the WRRC

The WRRC celebrates its 50th anniversary this year. See the insert on the Center's history in this issue.

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**.

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The Annual Water Resources Research Center Conference convened April 8, 2014 to discuss how to close the gap between water supply and demand. Source: Lynn Ketchum

Conference Speakers Address "Closing the Gap Between Water Supply and Demand"

by Lucero Radonic, WRRC Graduate Outreach Assistant

On April 8, 2014, over 350 people from 49 Arizona communities gathered at the University of Arizona Student Union Memorial Center for the Water Resources Research Center annual conference. Thirty-five speakers from the private and public sectors presented on the gap between water supply and demand, and how to close it. A poster session showcased research and initiatives relating to conference issues and provided an opportunity to celebrate the WRRC's 50th anniversary

The conversation began with a broad perspective focused on the Colorado River Basin (see Next Steps, p. 6) and then zoomed in to analyze the history, challenges, and opportunities at the Arizona level. The conference focused on finding solutions. Through a full day of discussion, presenters and attendees explored many options for closing the gap, including increased efficiency of

Conference continues on page 2

Drought in the Golden State Challenges Agriculture

by Lucero Radonic, WRRC Graduate Outreach Assistant

The state of California started keeping track of its annual precipitation in 1849, and the year 2013 has been the driest on record. With conditions in 2014 showing no signs of improvement, Governor Jerry Brown declared a drought emergency for the state in January. According to data from the U.S. Drought Monitor, released on April 1, 2014, 68.76 percent of the state is experiencing extreme drought with another 23.49 percent on the Central Coast and San Joaquin hydrologic regions undergoing exceptional drought conditions. This is a substantial increase from only a year ago, when no part of California reached extreme or exceptional drought conditions, and severe drought affected no more than 24 percent of the state.

California Drought continues on page 7

Conference continued from page 1

Over 350 people gathered at the University of Arizona for the Water Resources Research Center 2014 Conference. Source: Lynn Ketchum

use, reuse, transfers, and augmentation strategies such as sea water desalination and weather modification.

As speakers repeatedly pointed out, Arizona is not currently facing a water crisis, but leadership and cooperation between water sectors is needed now in order to ensure we do not find ourselves in a crisis fifty years down the road. The gap between supply and demand is a real challenge that needs to be addressed by bringing all water users to the table. As Rodney B. Lewis from the Gila River Indian Community explained, in the last two decades the configuration of the negotiating table has expanded to include important yet previously overlooked water sectors like those represented by Native American Tribes. Similarly, as Taylor Hawes from the Nature Conservancy and Kelly Mott-Lacroix from the WRRC illustrated, the environment may be finding a place at the table when decisions are made about water allocations.

The historical trajectory of water policy and engineering in the state were a constant referent during the conference. This is because, as Michael Lacey remarked early in the day, "our history is our future." Arizona has a long, if at times contentious, history of investing in and developing its water supply to continue living and growing in a desert environment. In less than a century the population of the Southwest increased by approximately 1500 percent, as Kay Brothers, a consultant to the Southern Nevada Water Authority, pointed out. As a graph shown by Lacey illustrated, the population increased seven-fold between 1950 and 2010 in Arizona alone: from roughly 749,587 to 6.4 million people. Water consumption increased accordingly, until the 1980s. Since then, the state has managed to maintain a steady water consumption rate. Population growth is projected to continue in the decades to come, to more than 13 million people by 2060.

Projections show that a growing imbalance between supply and demand will develop over the next 25 years and beyond in Arizona and the Colorado River Basin more broadly. Jennifer McCloskey, Deputy Regional Director for the Lower Colorado Region of the U.S. Bureau of Reclamation explained that the long-term average flow of the Colorado River at Lees Ferry, from the turn of the 20th century to the present, averages 14.7 MAF per year. From 2000-2013 water

Michael Lacey presents the opening keynote speech at the conference. Source: Lynn Ketchum

flow in the Colorado has been at 79 percent of normal. During this period the river has had an average flow of 12 MAF. As Brothers pointed out, this is equivalent to river flows during the dry period in the 1580s, with the difference that at that time not nearly as many people depended on the river. In Arizona, specifically, current water demand is 7.1 MAF, and according to the Arizona Department of Water Resources statewide demand is estimated to reach 9.1 MAF by 2060. According to Lacey, this means that Arizona will see an imbalance between 242,900 and 1,269,700 acre-feet of water.

How can we deal with this gap? As Michael Fullton with the Arizona Department of Environmental Quality stated: "We know there is not going to be any single solution to filling this gap in water supply. Closing that supply and demand gap is going to require us to look at a full menu of options that both might increase supply and reduce demand." Several people throughout the conference stated that while conservation may be the first solution people use, it cannot be the only solution. It was argued that conservation and reuse alone are not enough

The conference included a poster session that showcased the work of 25 research projects and programs. Source: Lynn Ketchum

Conference continued on page 3

Conference continued from page 2

Conference speaker Carol Ward-Morris converses with a member of the audience during a break. Source: Lynn Ketchum

to close the gap, and augmentation has to be an option. Some commenters reinforced the concept that augmentation should be last on the list of options, while others emphasized the need to start augmentation projects now, just as planners for the Central Arizona Project had to put the gears in motion decades before it was realized.

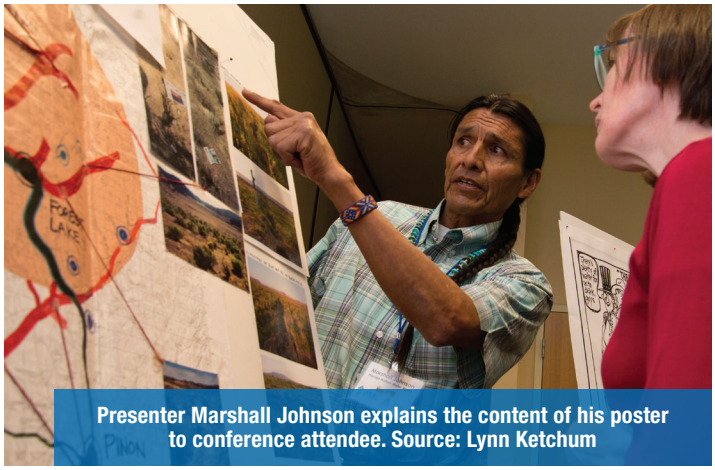
Speakers agreed that Arizona has been at the forefront of water conservation for the last two decades. Tom Davis, General Manager of the Yuma County Water Users' Association, emphasized that agricultural water use efficiency is high in Arizona, where irrigators minimize water costs. Bradley Hill, Utilities Director for the City of Flagstaff, presented the case of Flagstaff as a robust water conservation and reuse program. Since the adoption of its first water conservation ordinance in 1988, the city has adopted other ordinances encouraging low-impact development, water reuse, and gray water and rainwater harvesting. As a result, water use in the city decreased by 40 percent in twenty-five years: from 186 gallons per capita per day in 1989, to 111 in 2013.

Kathleen Ferris with the Arizona Municipal Water Users Association pointed out that Arizona's remarkable success in municipal conservation is evident by the fact that while the population has increased by 152 percent since 1980, water use has increased by only 82 percent. While focusing on developing solutions to conserve water and decrease demand, Ferris emphasized the need for water policy-makers and planners to engage in conversations about smart growth. She argued that "growth should occur when water supplies and infrastructure exist to serve that purpose. We need more infill, to grow organically from our existing water distribution systems. We should stop believing that every acre of land has a right to grow houses."

WRRC Director Sharon B. Megdal welcomes questions from the audience after a panel presentation. Source: Lynn Ketchum

These and other voices questioned how much more water savings can be achieved in the future. Speaking for the regulated community, Margaret Gallogly, Director at Fennemore Craig P.C., noted that developers are happy to adopt water efficiency standards if they are proved to be effective. Joe Gysel, President of Epcor Water, USA, highlighted impediments faced by private water companies when implementing conservation practices. Energy producers are looking ahead to technologies for using less water, said Bruce Hallin, Director, Water Rights and Contracts, Salt River Project, but energy will be needed more than ever in all aspects of water production and use.

Other options considered for closing the gap included water transfers and waste water reuse. Nathan Bracken, Legal Counsel for the Western States Water Council, presented on the reallocation of water from agriculture to municipal uses. This is a controversial option for people who are concerned that agriculture is being perceived as a reservoir for future growth. Bracken noted some actions a state can take to facilitate transfers that benefit everyone involved, including support of innovative arrangements to protect agricultural communities. Tim Thomure, Water Reuse Practice Lead at



Presenter Marshall Johnson explains the content of his poster to conference attendee. Source: Lynn Ketchum

HDR Engineering, presented another controversial option: direct potable reuse, which he maintains will be a solution in some areas. He cautioned, however, that "maximizing direct potable reuse is not the goal; the goal is the right water for the right use."

The role of Indian tribes in water policy discussions was an important point brought up during the conference. Lewis explained that over the last decade, Arizona has started to acknowledge that tribes are entitled to water and that there are ways in which water can be allocated that do not harm existing users. Supply and demand studies are inherently faulty when the tribes are not participants, Lewis observed. As was pointed out by George Arthur, immediate past President of the Colorado River Water Users Association, this was the case with the Colorado River Basin Water Supply and Demand Study, released by the U.S. Bureau of Reclamation in 2012. Reclamation and the Ten Tribes Partnership have since agreed to conduct the "Colorado River Basin Tribal Water Study." As was remarked by Arthur and Jason John, Director of the Navajo Nation Water Management Branch, this is a step in the right direction, but there is still a long path ahead to increase collaboration and cooperation between tribal, state, and federal

Conference continues on page 4

Student Spotlight

Christopher Fullerton, School of Geography and Development

Christopher Fullerton is a first-year Ph.D. student in the School of Geography and Development. He is also completing the Graduate Certificate in Water Policy and is working as a graduate research assistant as part of the WRRC's WaterRAPIDS program.

After graduating with a Bachelor of Arts in History from Yale University, Christopher continued his education at the University of Georgia. He earned a J.D. from the School of Law and a Master's in Historic Preservation from the College of Environment and Design. He structured his plan of study around land use and environmental classwork. One especially influential course involved a multi-disciplinary practicum engaging stakeholders from a variety of local jurisdictions and interest groups to collaborate on an integrated regional riparian corridor and greenspace plan in response to development pressures from the rapidly expanding metro Atlanta region. Christopher wrote his master's thesis on conservation easements and other private land-use tools for protecting valued cultural and environmental resources.

In pursuit of exciting opportunities for training and work, Christopher and his wife Josephine have lived in five states in the past ten years. For Christopher, the relocations proved especially instructive in observing the increasingly important implications of broad-based water resource management, as well as the particularized challenges facing local communities. These experiences informed his decision to return to graduate school to gain a better understanding of how legal, social, and ecological geographies shape and in turn are shaped by water resource management over time.

At the WRRC, Christopher has worked on the Participatory Watershed Assessment for the Upper Gila River, the Environmental Water Needs Assessment Planning program (EnWaP), and the Sustainable Clarkdale project. He has especially enjoyed opportunities to assist with stakeholder engagement and public outreach efforts. Studying the remarkable history and varied landscape of the state has helped him develop a deep appreciation for the breadth of human experiences in Arizona over time, as well as the critical importance of access to reliable water resources in adapting to life in an arid climate.

Regular relocations have allowed for engaging learning opportunities, and Christopher has tried to maintain an appreciation for the lessons he has learned from the different locales where he has lived. One such avenue has been through growing food. Christopher's grandparents in Georgia taught him to grow tomatoes, peppers, and okra, and he has learned to adapt his vegetable gardens over the course of his moves to local conditions and crop varieties. As a volunteer with Native Seeds/SEARCH, he is enthusiastically adapting his plant choices to drought-tolerant Southwestern crops like chiltepin peppers, Magdalena cheese squash, and O'odham tepary beans.

Working and studying at the University of Arizona, a land grant institution with a long-standing commitment to applied research, have been immensely educational for understanding the vital role of a boundary organization like the WRRC in facilitating communication between university-based scientists and public constituencies across Arizona in support of water resources decision-making. He is interested in applying these lessons in his studies of the fluctuating historical boundaries of state and private legal actions in regard to the stewardship of water resources, with a particular interest in how these decision-making processes influence rural livelihoods.

Conference continued from page 3

governments in regards to water governance.

These perspectives were reinforced at a special "Audience Voices" session during lunch, when other tribal representatives raised issues for consideration in any broad and inclusive discussion of water supply and demand.

The call for inclusiveness and cooperation arose again and again through the day as the means to define and implement solutions. As Sandy Fabritz-Whitney, immediate past Director of ADWR, noted, the words "cooperation", "collaboration" and "coordination" were mentioned numerous times and by almost all presenters. Examples of cooperative processes were presented as models for action. An illustrative example provided by Rick C. Lavis, Executive Vice President of the Arizona Cotton Growers Association, was the 1980 Groundwater Management Code. This hallmark legislation was referred to as a model for working together and compromising when necessary in order to address the state's unique and specific needs. John Kmiec, Utilities Director for the Town of Marana, used the Tucson region as another example of how working together has helped to solve regional issues, such as groundwater declines, wastewater use, and water distribution. Similarly, Mott-Lacroix reported from a series of focus groups she held around the state that cooperation was on the top of people's list of strategies for solving community water challenges.

As Sharon B. Megdal, Director of the WRRC, said in her closing remarks, all the ideas that were presented at the conference will continue to circulate across Arizona's water community, and hopefully will go beyond as the number of interested citizens expands. She added, "we need to engage more people. We don't want to leave things unfinished, leaving it to future generations. We need to get people excited about water without getting them alarmed. We don't have a crisis, but we need to excite people into action before we do have a crisis."

Colorado River Flows Through Delta!

In a historic event, water was intentionally released to the Colorado River Delta on March 23, 2014, for the first time in five decades. The gates of Morelos Dam were opened by the International Boundary and Water Commission, to allow for the first pulse flow event towards the Gulf of California. The controlled flow is scheduled to last eight weeks and send more than 100,000 acre-feet of water to the river's delta. This represents less than 1 percent of the river's flow in an average year but is enough to temporally reconnect the Colorado River to the Gulf of California. The pulse flow is intended to mimic the way the Colorado River flowed in the springtime, thanks to snowmelt from the Rocky Mountains, before dams were built and water diverted towards agricultural fields and municipal users. The pulse flow will be followed by a small but steady stream of base flows meant to keep the channel wet to allow for restoration of the riparian habitat. Since water was released, dozens of scientists have been closely monitoring its effect on the ecosystem, from flow rates to seed dispersal. This initiative was part of the Minute 319, a binational agreement signed in late 2012.

Supreme Court Rules Texas-New Mexico Lawsuit May Proceed

On January 27, 2014, the U.S. Supreme Court ruled Texas can proceed to the next step in its lawsuit against New Mexico over the use of Rio Grande water. In 2013, Texas initiated its original action against New Mexico alleging that New Mexico has violated and continues to violate the Rio Grande Compact, an interstate water agreement between Texas, New Mexico and Colorado, by allowing illegal and unauthorized diversions through groundwater pumping. Texas asks that New Mexico be ordered to stop these illegal diversions and to compensate Texas for damages it has incurred because of New Mexico's unlawful activities. New Mexico counters that it is in full compliance with the Rio Grande Compact and that the Supreme Court does not have jurisdiction over the matter. The brief Supreme Court order suggests the court thinks it may have jurisdiction, although it invites New Mexico to file a motion to dismiss the action, which is a procedural right normally afforded to parties in litigation. For farmers in New Mexico, the risk in the case is that a ruling in favor of Texas could force restrictions on groundwater pumping.

NASA Satellites Show Water Losses in Colorado River Basin

Researchers at the University of California, Irvine, reported that surface water losses from the reservoirs along the Colorado River are just a small part of the basin's overall water loss since 2005. They identified the disappearance of groundwater as the most worrisome problem. The UCI research team assessed fluctuations in water storage using data from NASA's GRACE mission, a pair of satellites that translate changes in gravity into changes in water volume. The GRACE satellites measure total water storage – the water in mountain snowpack, reservoirs and rivers, soils, and aquifers. By subtracting the known quantities from other data sets, the value for each component can be calculated. Over a 100-month study period from March 2005 to June 2013, the Colorado River Basin lost 4.6 million acre-feet of water per year. The cumulative losses are equal to 1.3 times the storage capacity of Lake Mead. Preliminary data indicates that most of the water losses could be attributed to groundwater pumping, mainly for irrigated agriculture.

ADWR New Portal Facilitates Data Sharing

The Arizona Department of Water Resources has developed a data portal that provides individuals and organizations with an online interface for reporting and sharing water level data. Third party groundwater levels are directly input into ADWR's Ground Water Site Inventory (GWSI) database. Organizations can request a logon to the portal using the following link: http://www.azwater.gov/WLPortal/Login.aspx. At this time the portal only accepts water level data for wells with a GWSI identification number. The GWSI database is available at https://gisweb.azwater.gov/waterresourcedata/GWSI.aspx. The next version of the portal will incorporate wells that have a 55-registration (well registry) number. The WELLS-55 database contains information on most wells in the state; however, not all wells are registered. Some unregistered wells may be in GWSI but may not be registered. Likewise, many registered wells have not been field verified and are not included in GWSI. Currently, over 21,000 wells have been matched or have a database ID in both GWSI and WELLS-55.

Southern Nevada Water Authority Appoints New Director

John Entsminger succeeded Pat Mulroy as director of the Southern Nevada Water Authority — a coalition of seven local water districts charged with managing the region's water resources and providing for the present and future water needs of residents and businesses in the Las Vegas Valley. John Entsminger joined the Water Authority upon graduating from the University of Colorado Law School in 1999. Former director Pat Mulroy retired in February after two decades as director of the Water Authority.

Nanomaterials Topic of EPA $5Million Award to ASU

In April, the EPA awarded a $5 million research grant to Arizona State University to better understand the impacts of nanomaterials throughout their life cycle—from design, manufacture, use and disposal. Jared Blumenfeld, EPA's Regional Administrator for the Pacific Southwest said in the announcement of the award that the ASU research will help minimize risks associated with these materials and enable the design of safer products.

Next Steps to Close Water Gap in Colorado River Basin

The WRRC conference dedicated it first sessions, after the welcome and opening keynote, to the Colorado River Basin Study Next Steps. The Next Steps program is following up on the "Colorado River Basin Water Supply and Demand Study" conducted by the Bureau of Reclamation's Upper Colorado and Lower Colorado Regions, in collaboration with representatives of the seven Colorado River Basin states. Kay Brothers, co-chair of the Colorado River Basin Study Next Steps Working Groups Coordination Team, made a keynote presentation, which was followed by a panel of representatives from the three workgroups and the Navajo Nation, a stakeholder in the Next Steps program. Published in December 2012, the Colorado River Basin Water Supply and Demand Study characterized current and future water supply and demand imbalances in the basin and assessed the risks to basin resources. In order to move forward to address challenges identified in the study, in May 2013, the Bureau of Reclamation established the "Next Steps" Coordination Team and Workgroups. The Coordination Team directs and reviews the work of the following three workgroups: Municipal and Industrial Conservation and Water Reuse Workgroup; Agricultural Conservation, Productivity and Water Transfers Workgroup; and Environmental and Recreational Flows Workgroup.

Kay Brothers described the next steps process as an effort to find robust solutions for an uncertain water future. She noted that past predictions of population growth greatly underestimated what actually occurred in the Lower Colorado River Basin. At the same time, projected flows in the river were overestimated. She observed, "We can't imagine what the future is going to be." For that reason we have to start now with conservation, reuse and planning for augmentation, she said — "Do it all."

The first panelist was Taylor Hawes, a member of the Environmental and Recreational Flows Workgroup and the Colorado River Director for The Nature Conservancy. She began by explaining that environmental and recreational needs and values should be considered as demands and not merely as metrics. She added that this is the first assessment of environmental and recreational flows in the Colorado River Basin. Phase 1 of their assessment focused on identifying four highly vulnerable river segments for intervention, each with a different geography, different values and impacts. After selecting the sites, the workgroup has moved to assess what data exists and what are the data gaps, what is the state of the resource, and what type of processes are going on at each site. They are also evaluating the existing mechanisms or programs that have been successful at meeting the needs of people and the environment. As she explained, "environmental and recreation needs are very site-specific, there is no silver bullet to solve the issues across the river."

Panelists participate at the Closing the Gap Basin-Wide Session.
Source: John Polle, WRRC

Kay Brothers makes her keynote presentation.
Source: John Polle, WRRC

The second panelist was Reagan Waskom, a member of the Agricultural Conservation, Productivity, and Water Transfers Workgroup, and Director of the Water Resources Research Institute at Colorado State University. Waskom began by highlighting the fact that there are approximately 2.8 million irrigated acres in the Colorado River Basin, not including Mexico. With Mexico, the number climbs up to 3.2 million. Annual consumptive use by agriculture ranges from 8 to 10 MAF, or 70 percent of total consumptive use in the basin. The goal of the workgroup was to quantify current agricultural conservation efforts and transfers, both in and out of the basin. The questions guiding their work were: "How much water can we conserve? How will conserved water be transferred to other uses?" Waskom explained that many water conservation techniques work at the farm level, but this does not necessarily translate to the basin level. The group is developing a baseline of efficiency projects in the river, looking at their outcomes, future plans, and the impact they could have in terms of production.

The third panelist was Carol Ward-Morris, member of the Municipal and Industrial Conservation and Reuse Workgroup, and Program Manager of Demand Management and Sustainability at Arizona Municipal Water Users Association. As part of the working group's assessment, they collected qualitative and quantitative information on successful water conservation and reuse programs. Twenty-five case studies will be highlighted in the final report illustrating that legal implications and water planning criteria vary significantly across the study area. They also tried to quantify past water conservation and reuse savings by obtaining data from 1980 to the present from existing reports, studies, and documents

Next Steps continues on page 12

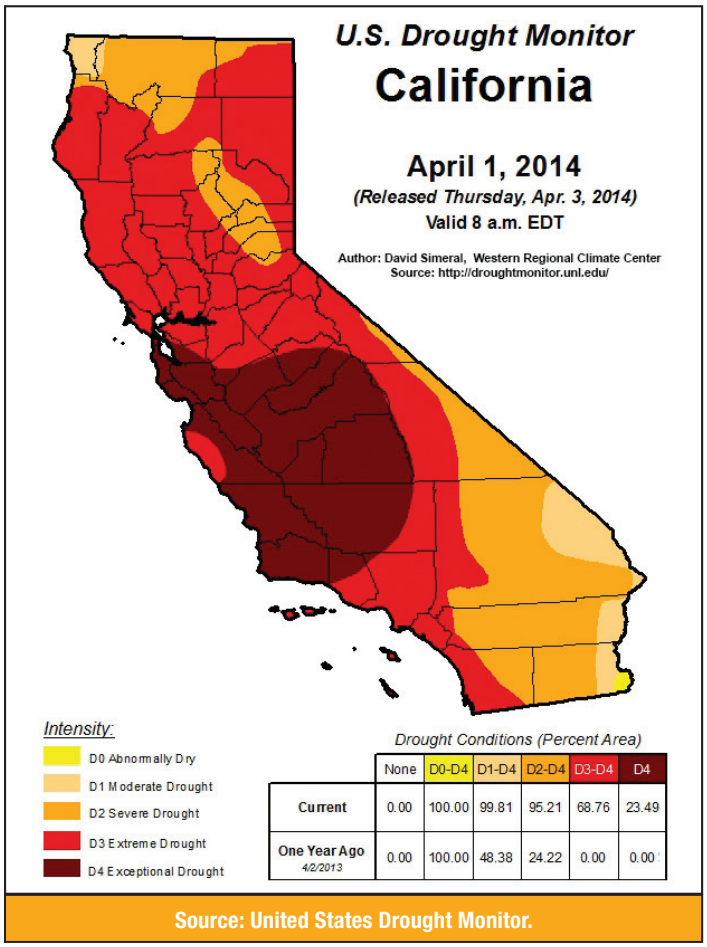
California Drought continued from page 1

Running for roughly 400 miles north-to-south in western California, the Sierra Nevada Mountains are the state's major source for water supply. Most of the drinking water for more than 23 million people in California and one-third of the water supply for the state's agricultural land comes from the spring snowmelt. Water from the Sierra Nevada also makes up half the inflow to the Sacramento Delta, which supports the West Coast's largest estuary and provides water to irrigate more than 3 million acres of agricultural land.

Less winter snow in the Sierra Nevada means less spring runoff and less water availability across the state. To forecast runoff and water availability, every winter season from January to May, teams of skiers conduct monthly snow surveys at pre-selected sites high up across the Sierras: surveyors ski for miles to reach the sites, drive aluminum tubes into the snow to measure depth, and weigh the samples to gauge water content. As April is historically the time when snow is at its peak, data from this month's survey is considered the most accurate snapshot of how much water will be available for future use. This year's April survey revealed that snowpack levels in the central section of the Sierra Nevada were 38 percent of average levels, while the northern and southern sections were at 23 and 31 percent, respectively. Although the levels have increased from earlier in the year, this is the lowest level since electronic record-keeping began in 1960. Dismal snowpack today indicates that drought conditions will continue to affect the state for the next years.

To make matters worse, the state's reservoirs are also running below average levels. About 75 percent of annual precipitation in California falls north of Sacramento, but more than 75 percent of the demand for water comes from south from it. To balance supply and demand, California has seven major systems of reservoirs, aqueducts, and associated infrastructure to capture and deliver water within the state. These large-scale systems allow for the redistribution of water largely from the north to the south. Two of the most important projects are the federal Central Valley Project and the State Water Project, which bring water from Northern California for delivery to agricultural and municipal users in the San Joaquin Valley, parts of the San Francisco Bay Area, and Southern California. The Department of Water Resources reported that Lake Oroville, which is the State Water Project's largest reservoir, is at 49 percent of its capacity. This is 64 percent of its historical average for this time of the year. Conditions are similar at Shasta Lake, the federal Central Valley Project's main reservoir, which is at 48 percent of its capacity. This is 60 percent of its historical average. Similarly, the San Luis Reservoir, a critical reservoir for the State Water Project and the Central Valley Project, is at 42 percent of its capacity, roughly five percent below its historical average.

The California agriculture industry is the largest of any state in the country: California farms produce about half of all U.S. fruits, vegetables, and nuts, and they generate about $45 billion in annual revenue. California farmers are facing tough choices brought about by extremely limited water supply and high cost of irrigation. In the last two decades about one-third of farmland in California underwent a transformation from annual crops to perennials. It is estimated that about 3 million of the approximately 9 million acres of irrigated agriculture in California are now nut orchards and vineyards. The Golden State is the nation's top producer of water-intensive tree nuts with California producing 80 percent of the almonds produced worldwide and 39 percent of the pistachios. Nut production brings over $7 billion in sales every year, with almonds far outpacing other nuts at $6.2 billion in 2013. Grapes, another profitable crop, generated $4.45 billion.



Source: United States Drought Monitor.

However, these profitable perennials impose significant challenges at times of drought. Fields dedicated to growing annuals like lettuce and tomatoes can be fallowed during drought and replanted later, without an investment loss. This is not an option for nut trees, which need ten years of growing and a steady supply of water before they yield enough to pay for themselves. Furthermore, water deficits affect nut orchards not only in the year in which stress occurs, but also in the following seasons when nut size and load are generally reduced.

Faced by the consistent water requirement of these trees, farmers are letting orchards dry up and in some cases making the tough decision to tear them out. Some farmers hope that by sacrificing a percentage of their orchards, they will have enough water available for the remaining trees during the drought. For example, one farmer in Fresno County gave up 1,000 acres of his almond orchard to keep the remaining 4,000 acres alive. By cutting down the trees, he estimated a loss of approximately $10 million in revenue. Exact numbers of how many acres of orchards have been sacrificed since the drought intensified are not available, but farmers believe that the number will only increase as snowpack in the Sierra Nevada Mountains remains below historical levels.

Spring rains have provided some relief but were not sufficient to end the drought challenging state water users.

Securing Arizona's Water Supplies for Its Next Century–Strategic Vision for Water Supply Sustainability

Jeff Tannler, Active Management Area Director, Arizona Department of Water Resources

Arizona has been successful in managing its water resources for over a century. As a result of having one of the most arid climates in the United States, Arizonans have faced challenges in ensuring that there are sufficient, secure and sustainable water supplies available. Because of the foresight of early leaders, through the development of the Salt River Project, the authorization and construction of the Central Arizona Project and the enactment of the 1980 Groundwater Management Act, Arizona has successfully developed the water supplies needed to support a thriving economy. These efforts were solution-oriented to meet not only the immediate needs of the State, but also address the future water supply challenges that Arizonans' would face. Since the late 1950s, Arizona's population has grown by 470 percent and our economic output has grown by 1,528 percent, but fortunately our current water use remains essentially the same.

Colorado River. Source: Arizona Department of Water Resources

As history shows, Arizona has been proactively building resilience and implementing innovative water management strategies to secure dependable water supplies for our future. Today, Arizona is at a point where it must face its next challenge in water supply security and management. The Arizona Department of Water Resources (ADWR), in partnership with many in Arizona's water community has participated in the development of comprehensive water supply and demand analyses. Through the work of the Water Resources Development Commission and the Colorado River Basin Water Supply & Demand Study, based on growth projections, we have identified the potential water supply and demand imbalance that may result if no action is taken to secure future water supplies. The result of these analyses conclude that within the next century Arizona may need to identify and develop additional water supplies of nearly one million to just over three million acre-feet of water to meet the projected demands.

In an effort to begin to address the projected imbalance, on January 14, 2014, the Arizona Department of Water Resources released "Arizona's Next Century: A Strategic Vision for Water Supply Sustainability". Developed at the request of Governor Brewer, the Strategic Vision is the most comprehensive analysis of how to address the projected gap between currently developed water supplies and projected water demands to date. The Strategic Vision provides a solid foundation for Arizona's future economic prosperity, it is envisioned as an approach to meet our challenges head on and provide Arizona policy and business leaders with strategies that can be pursued in order to develop and acquire water supplies to support expected growth. The ADWR has compiled various strategies to address Arizona's future water supply challenges.

A Sample of identified Strategic Priorities include:

Resolution of Indian and Non-Indian Water Rights Claims

Arizona has been successful in resolving, either in whole or in part, 13 of 22 Indian water rights claims, providing substantial benefits to both Indian and non-Indian water users. However, the general stream adjudications, which began in the 1970s, remain incomplete. Until that process is complete, uncertainty regarding the nature, extent and priority of water rights will make it difficult to identify all the strategies necessary for meeting projected water demands.

Continued Commitment to Conservation and Expand Reuse of Reclaimed Water

Conservation is the foundation of sustainable water management in our arid State. The continued commitment to using all water supplies as efficiently as possible is necessary to stretch our existing water supplies and has delayed the need to acquire other, more expensive supplies. Additionally, many non-potable uses are currently being met by reclaimed water including the landscape irrigation of parks. Full maximization of reclaimed water use can meet half of the projected imbalance across the state. As demands increase and water supplies become more stretched, the need to explore and invest in direct potable reuse for drinking water supplies will become necessary.

Expanded Monitoring and Reporting of Water Use

Metering and reporting water use across the State would support and enhance analysis of current hydrologic conditions. Currently, monitoring of water use outside of the Active Management Areas and Irrigation Non-Expansion Areas is limited. Data collection is a crucial element of the development of groundwater models, which have proven to be valuable tools throughout the State in developing more thorough understanding of hydrologic systems and evaluating future conditions and potential impacts of new uses and/or alternative water management strategies.

Identifying the Role of In-State Water Transfers

A source of significant controversy across the State, in-State water transfers have been the focus of much debate throughout Arizona's history. A comprehensive analysis of water transfers is needed in Arizona. Evaluation of long-

Strategic Vision continues on page 9

Aaron Lien Receives a Carson Scholars Fellowship

Aaron Lien is a 2014 recipient of the Institute of the Environment Carson Scholars Fellowship. Aaron is a former WRRC senior researcher and a Ph.D. student in the Arid Lands Resource Sciences program. His Ph.D. research involves working with ranchers in southern Arizona to better understand their attitudes and preferences toward wildlife conservation, especially jaguars, an endangered species, to improve conservation efforts. The Carson Scholars Program is designed to build a network of students and faculty devoted to furthering knowledge and awareness of the environment and its interactions with people.

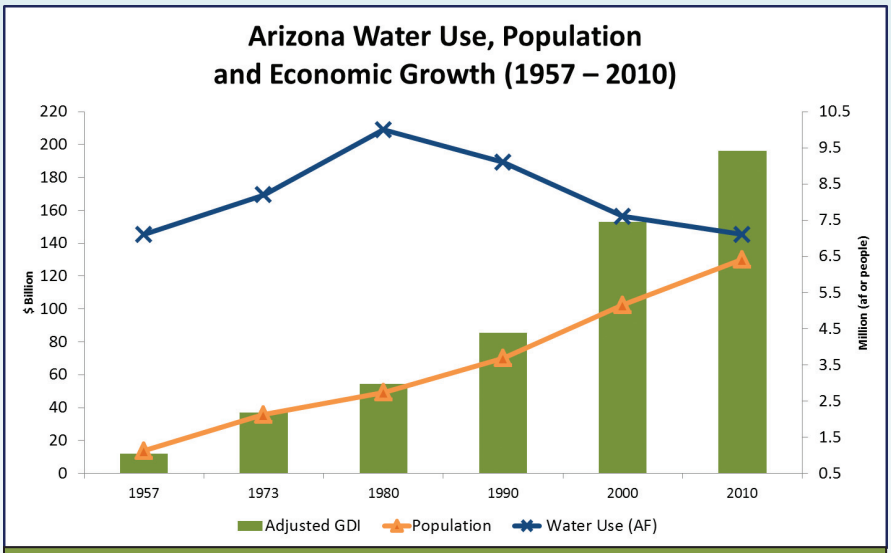
Leah Edwards Honored with Pillars of Excellence Award

Leah Edwards, a senior at the University of Arizona, has been honored with a Pillars of Excellence award. Leah has worked since 2011 at the WRRC in Water RAPIDS (Research and Planning Innovations for Dryland Systems). The Pillars of Excellence is awarded to students and alumni who exhibit academic excellence and contribute to their field and to the university. For the past two years, Leah has been working on sustainability initiatives at the university, and currently serves as the Chair of the Students for Sustainability Waste Reduction Team. She plans to spend her future career integrating environmental economics into policy and the economic system.

3 Students Win Poster Prizes at WRRC's Annual Conference

Three winners were awarded prizes for the best posters at the WRRC's Annual Conference poster session by Michael Fulton of the Arizona Department of Environmental Quality, which sponsored the session. Two posters tied for first place: Hwee Hwang's poster (UA Dept. of Civil Engineering and Engineering Mechanics), "Comparison of Regional Water Supply System Sustainability, Robustness, and Resilience for Two Different Tank Operations," and Aloah Pope's poster (University of Arizona School of Natural Resources and the Environment), "Linking Bayesian and Agent-Based Models to Simulate Complex Social-Ecological Systems in the Sonoran Desert." The second-place winner was Todd McOmber (University of Arizona Dept. of Soil, Water and Environmental Science) for his poster, "Is Treated Wastewater Effluent Improving the Water Quality of the Upper Santa Cruz River?"

Strategic Vision continued from page 8



Source: Arizona Department of Water Resources

term versus short-term transfers may actually provide insight into how water transfers can be developed to protect or even benefit local communities.

Supply Importation – Desalination

Importation of water from outside of Arizona will likely be required to allow the State to continue its economic development without water supply limitations. Supplies derived from ocean or sea water desalination can be imported directly into Arizona to meet the water needs of municipal and industrial water users, while at the same time providing aesthetic, recreational and ecological benefits.

Develop Financing Mechanism to Support Water Supply Resiliency

The strategies identified in the Strategic Vision, both statewide and regional, will require capital investment. Some areas of the State need immediate assistance in developing water projects, specifically in portions of rural Arizona.

No single strategy can address projected water supply imbalances across the State. It will take a portfolio of strategies to be implemented dependent on the needs of each area of the State. It is very important to recognize the uniqueness of the various regions throughout the State and the varying challenges facing those regions. As we analyze the various strategies there are specific measures that have widespread potential benefit to all Arizonans.

The Strategic Vision proves that while the State as a whole is not facing an immediate water crisis, now is the time to begin addressing this challenge by implementing this Strategic Vision for Arizona's water future. The lack of an immediate problem increases the potential for inaction, the risk of procrastination and insufficient motivation to plan and invest in our future.

The Strategic Vision is available at: http://www.azwater.gov/AzDWR/Arizonas_Strategic_Vision/

Resources

An Arizona Guide to Water Quality and Uses

Janick F. Artiola, Gary Hix, Charles Gerba, and James J. Riley. University of Arizona. College of Agriculture and Life Sciences: Cooperative Extension. January 2014.

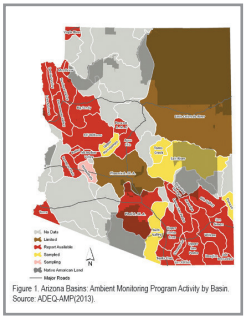
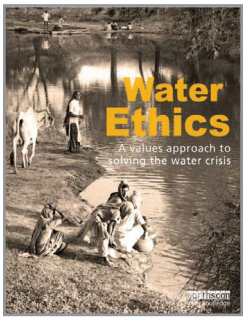


Figure 1. Arizona Basins: Ambient Monitoring Program Activity by Basin. Source: ADEQ-AMP(2013).

This short publication from the University of Arizona's Cooperative Extension program provides an overview of water sources, their water quality, and possible uses across the state. The report focusses on nine water sources: Private and shared well water, public water utilities, surface water, recycled water, gray water, pool/spa and home treated water, black and industrial water (raw sewage), and water harvesting. In each section the authors provide an overview of water quality for the specific source, as well as guidelines and resources useful for users interested in learning more about it. The report also presents a "Water Quality and Uses Triangle", which divides water quality into three major groups (pathogens, salinity, and specific contaminants) and places major water sources in relation to the three groups. This diagram is intended to aid home and well owners evaluate various sources of water, determine their likely water quality, and identify appropriate uses for them. The guide can be found at http://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1610.pdf

Water Ethics: A Values Approach to Solving the Water Crisis.

David Groenfeldt. Routledge Press, New York. 2013

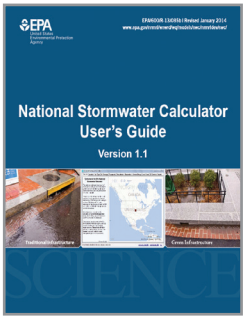


This book introduces the idea that ethics are an intrinsic dimension of any water policy, program, or practice, and that understanding what ethics are being acted out in water policies is fundamental to an understanding of water resource management. Thus, in controversies or conflicts over water resource allocation and use, an examination of ethics can help clarify the positions of conflicting parties as preparation for constructive negotiations. The author shows the benefits of exposing tacit values and motivations and subjecting these to explicit public scrutiny where the values themselves can be debated. The aim of such a process is to create the proverbial 'level playing field', where values favoring environmental sustainability are considered in relation to values favoring short-term exploitation for economic stimulus.

The book shows how new technologies, such as drip irrigation, or governance structures, such as river basin organizations are neither "good" nor "bad" in their own right, but can serve a range of interests which are guided by ethics. A new ethic of coexistence and synergies with nature is possible, but ultimately depends not on science, law, or finances, but on the values we choose to adopt. The book includes a wide range of case studies from countries including Australia, India, Philippines, South Africa and the United States. These cover various contexts including water for agriculture, urban, domestic and industrial use, the rights of indigenous people, and river, watershed and ecosystem management.

National Stormwater Calculator and Climate Assessment Tool, Phase II

U.S. Environmental Protection Agency.



The EPA released phase II of the National Stormwater Calculator and Climate Assessment Tool package. As part of President Obama's Climate Change Action Plan, the calculator is a desktop application that estimates the annual amount of stormwater runoff from a specific location. The calculator includes changes in seasonal precipitation levels, the effects of more frequent high-intensity storms, and changes in evaporation rates based on validated climate change scenarios by the Intergovernmental Panel on Climate Change. The updated version includes future climate vulnerability scenarios. This adds future climate scenarios to last year's phase I release, which included local soil conditions, slope, land cover, historical rainfall records. Users can enter any U.S. location and select different scenarios to learn how specific green infrastructure changes, including inexpensive changes such as rain barrels and rain gardens, can reduce stormwater runoff. More information on the National Stormwater Calculator can be found at http://www.epa.gov/nrmrl/wswrd/wq/models/swc/

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Learning Globally, Acting Locally

By Sharon B. Megdal

I am writing this column on March 22, 2014, World Water Day (WWD) from my home in Tucson. In 2012, I spent part of WWD teaching a high school class in environmental studies in Nazareth, Israel. In 2013, I participated in the premier WWD program in The Hague. This year, I am spending this day reflecting on the two-way relevance of global connections.

For several years now, I have had the pleasure of being part of a binational team working on a transboundary aquifer assessment effort along the United States-Mexico border. We are nearing completion of binational reports for the Santa Cruz River and San Pedro River aquifers. These bilingual reports, which have been prepared within the Cooperative Framework established in 2009 by the International Boundary and Water Commission (IBWC), represent an unprecedented degree of cross-border coordination of mapping and data integration. The nature of our aquifer assessment collaboration, along with the binational collaboration on matters related to the Colorado River, where I have had less personal involvement, are of interest around the world. The IBWC and its processes for development and adoption of joint reports and Minutes to the 1944 Water Treaty, such as the historic Minute 319, can serve as models to approach transboundary efforts elsewhere.

Speaking of the Colorado River, in the past year, I worked on the paper, "A Tale of Two Rivers: Pathways for improving water management in the Jordan and Colorado River Basins". Though the basins are far apart geographically, my three co-authors and I argue that there are common factors with respect to available policy and management options. Analysis of these factors provides insights into the similarities and divergences of the basins' respective future pathways.

In the past year, I also continued to work on a grey water project in the Jordan Valley with colleagues from the Jordanian Royal Scientific Society. The pilot project is designed to stretch water supplies in one of the most water-stressed countries in the world. Water collected from homes is treated through a system using local filtration materials. The resulting water is then used for agricultural irrigation. In Arizona, we, too, make use of grey water – or more generally recycled water – for non-potable uses to preserve potable quality water for uses that require meeting drinking water quality standards. A recent survey of grey water policies by an Israeli researcher showed Arizona to be a leader in grey water use regulations and policies.

I have written before about the global interest in and relevance of Arizona's groundwater management framework. As the utilization of groundwater increases to meet growing demands for water, there is increasing interest in Arizona's framework for groundwater storage and banking. My direct involvement in groundwater recharge goes back over 20 years, to when I served as Executive Director of the (now defunct) Santa Cruz Valley Water District. It continues to this day through my service as a member of the board of directors of the Central Arizona Project and through my Arizona Water Policy class. Our class field trip focuses on artificial recharge as a mechanism for storage and treatment. I have recently collaborated with an Australian colleague and a CAP analyst on first a presentation and now a paper, entitled "Water banks: Using managed aquifer recharge to meet water policy objectives". The paper describes the workings of the Arizona Water Banking Authority and the reasons for its implementation. For almost 20 years the statutorily authorized AWBA has been storing excess Colorado River water for times of shortage. The paper goes on to explore conditions under which water banking could successfully be applied to other parts of the world, including Adelaide, South Australia. A recent international symposium, ISMAR 8, which was held in Beijing in October 2014, has led to a special issue of the journal Water on the policy and economics of managed aquifer recharge (MAR). I am serving as lead guest editor and look forward to the compilation of papers on this subject from around the world.

These and other projects with international dimensions – including work with colleagues from the University of Arizona, UNESCO and OECD on water governance – have applications here in Arizona. Interactions with international experts provide valuable opportunities to show the relevance of our water management successes and challenges and learn from experiences abroad. However, there is no region in the world that I am aware of that has it all figured out. And water management challenges are too complex for a cookie-cutter approach. Nevertheless, efforts to identify best practices for groundwater governance, as just one example, can have relevance at all geographic levels. (See www.groundwatergovernance.org and www.wrrc.arizona.edu/groundwater.)

There is general agreement around the world that education at all levels and effective, inclusive stakeholder engagement and dialogue are crucial to the identification, adoption, and implementation of sound water management practices. In many cases, the obstacles to adoption are not engineering or financial, but rather political or institutional. Decision makers will want to know there is public support for their selected options. Institutional mechanisms that allow and encourage dialogue may not exist in some locales.

Many of the approaches, particularly some of those being contemplated to close Arizona's supply-demand gap, require considerable advance planning. While the experiences of others around the world can and often will be of assistance to us, in the end the solutions in Arizona – and around the world – will most often be designed at the local and regional levels.

Postscript: The WRRC conference panel that focused on "how" we close Arizona's gap underscored the importance of leadership. When faced with policy choices and difficult tradeoffs, implementation of solutions will require champions and involvement of a diverse set of players. More on this in our next newsletter!

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Next Steps continued from page 6

for areas with over 100,000 people. However, they soon found out that existing documentation was not sufficient or readily available, and that specifics about what is reported varies across providers. She reminded the audience that conservation assumptions often do not reflect local circumstances and it is necessary to identify a variety of challenges and opportunities to be able to find local and regional solutions.

The final panelist was Jason John, Principal Hydrologist and Branch Manager at the Water Management Branch of the Navajo Department of Water Resources. He began by explaining that the Navajo Nation did not participate in the "Colorado River Basin Water Supply and Demand Study" and this presents challenges for determining current and future supply and demand in the basin. His presentation focused on water development, water rights, and water use in the Navajo Nation. He stated that water use planning in the Navajo Reservation was designed for 50 gallons per capita per day, while off the reservation municipal consumption is designed for 100-160 gallons per capita per day. He estimated that more than 90 percent of the Navajo Nation uses unreliable sources of groundwater supply and suggested that in the near future they will need to expand their access to surface water supply. In light of this, the Navajo Nation, as part of the Ten Tribes Partnership, will continue to engage in the Colorado River Basin Study Next Steps program by participating in a study aimed at evaluating tribal water demands in the basin, he said.

Phase 1 of the First Steps process is anticipated to be completed in the summer of 2014.