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Audience members at the 2018 conference, *The Business of Water*.
Photo: Lynn Ketchum UA College of Agriculture and Life Sciences

ARIZONA WATER RESOURCE

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The Business of Water Broadly Interpreted at 2018 Annual Conference

by Susanna Eden, WRRC

The Business of Water is an unusual topic for a water conference, despite the fact that business considerations enter into most, if not all, decisions affecting water resources. What exactly is the business of water and what aspects of the topic should a conference address? The Water Resources Research Center's 2018 Annual Conference answered these questions broadly. As might be expected, many talks focused on funding

and financing issues, but others looked at collaborations, exchanges, economic justice issues, environmental values, and social forces that influence or are influenced by business practices.

The three keynote talks reflected this comprehensive approach. According to Ian Lyle, Executive Vice President, National Water Resources Association, the prospect for federal funding of water projects looks uncertain, largely because of political uncertainties and partisan positioning. Without federal funding, local and regional project sponsors must find

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Opening keynote on *The Business of Water* presented by Ian Lyle, Executive Vice President, National Water Resources Association



Public-Private Partnerships panel (left to right) Chris Higgins, Mike Irlbeck and John H. Moffat

Feature

innovative financing strategies. The panel on Public-Private Partnerships (P3s) picked up this theme with several case studies—San Antonio, San Diego, and Pima County—where different public-private arrangements were employed to suit the needs of different jurisdictions for different kinds of projects. The key to designing these P3 arrangements was in balancing the risks and costs among the parties.

Stephen R. Lewis, Governor of the Gila River Indian Community, approached the business of water from a different angle. He wants the Community’s actions to serve as a “moral compass” to guide policy making on matters of economic, social, and cultural significance. He noted that with the water committed in their 2004 water settlement,



University of Arizona President Robert C. Robbins introduces Governor Stephen R. Lewis

the Community is in a position to achieve their long-term goals for reviving their agricultural heritage and the life of the Gila River. At the same time, they can contribute to Arizona’s immediate needs to shore up Lake Mead and to secure water storage credits for future growth.

The idea of “moral compass” was at the center of the following discussion of water transactions. A guide is needed to navigate the complexities involved in moving water because



Gila River Indian Community Governor Stephen R. Lewis delivers keynote on Water Transactions



Water Transactions panel (left to right) Sharon B. Megdal, Peter Culp, David Wegner, and Cynthia Campbell

nearly all such actions have an impact beyond the parties to the transaction, not just economically, but also in terms of intangible values and the vitality of environmental systems. In Arizona, where pressures for change encounter an inflexible legal system, water transactions are difficult but inevitable. Fortunately, new approaches are developing beyond the relatively simple exchange of money for water. Creativity and collaboration are the keys, as demonstrated by the City of Phoenix in its exchanges with the other municipalities to achieve mutual goals efficiently.

The third keynote was presented by the Director of the Arizona Department of Water Resources, Tom Buschatske, who described the challenges the state is facing as it looks into the future. These challenges result from a concatenation of historical development, legal inflexibility, drought, and disagreements about the best path forward. Despite its many water management successes, the state must continue negotiation with neighbors, collaboration among stakeholders, and engagement with the public. The ability of Arizona to attract and support the businesses that turn the economic



Arizona Department of Water Resources Director Tom Buschatske presents closing keynote: The Business of Water - The Future

engine depends to a large extent on approaching its water challenges with a unified front.

The importance of Mexico to the business of water in Arizona was underscored in Director Buschatske’s remarks, especially the opportunities provided by the recent agreement with Mexico—Minute 323. Cross-border cooperation was a theme of the luncheon discussion, which focused on the border region. The conversation, moderated by WRRC Director Sharon Megdal, featured Salvador López-Córdova, NAD (North American Development) Bank’s Chief Environmental



Lunch discussion (left to right) Edward Drusina, Salvador López-Córdova, and Sharon B. Megdal

Officer, and Edward Drusina, the U.S. Commissioner for the International Boundary and Water Commission. Although they have very different histories and responsibilities, both the institutions the discussants represent work to improve water and wastewater services within the border region. Through the efforts of NADBank, the gap in meeting basic water needs has been declining, but there are still gaps in collection and treatment of wastewater. The IBWC, with responsibilities dictated by the 1944 Treaty between Mexico and the United States for the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, operates three international wastewater treatment plants and monitors and measures river water deliveries from one country to the other.

After lunch, the afternoon panels took up issues relating to water in the environment—the collaborations that are preserving or restoring natural water systems and the opportunities healthy natural water systems provide for



The Environment and the Business of Water panel (left to right) Ted Kowalski, Yamilett Carillo, Taylor Hawes, Tood Reeve, and Kevin Moran

economic development. Companies are beginning to recognize their vulnerability to disruptions from environmental degradation and are trying to manage the risk. Corporations care about how is their customer base is affected and often are moved by social perceptions. A few companies are building water stewardship into their business plans. Often their actions involve collaboration with NGOs such as The Nature Conservancy, which puts corporate funding to work on conservation and restoration projects. Philanthropic organizations such as the Walton Family Foundation can tackle systemic problems relating to freshwater resources by working

with other funders, NGOs, public entities, and businesses. A concerted effort is needed.

The panel exploring the links between water and economic opportunity presented the experiences of four very different communities: a large city (Phoenix) and a medium-size city (Tucson) on mostly dry rivers, a smaller city on the Colorado River (Yuma), and a small town on the Verde River (Clarkdale). Despite their differences these communities recognize that water vital to economy. Economic development in Phoenix is closely coordinated with water planning. Tucson is exploring the potential of a Santa Cruz River Heritage Project to bring high-quality recycled water to the downtown river, which could push the downtown renaissance to the next level. In Yuma, the National Heritage Area, a large river restoration



Poster prize winners Hany Almotairy, Erin Gray, and Emily Hyde with Sharon B. Megdal and Vince Vasquez representing the poster session sponsor Water Asset Management

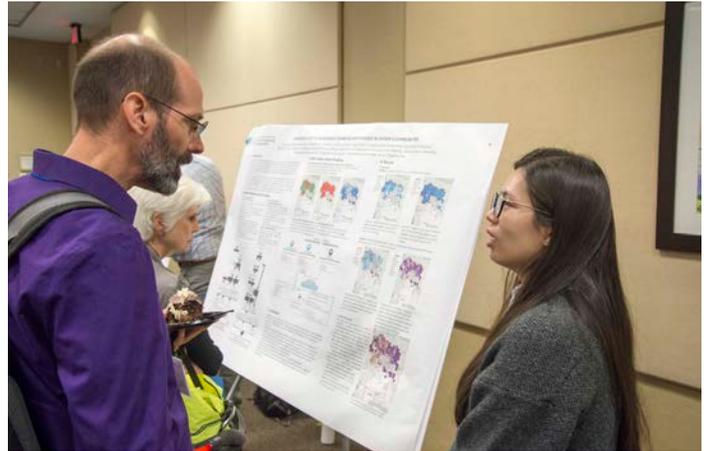
effort, created a framework for economic development. In the Clarkdale area, collaborative efforts over many years turned the “dirty Verde” into an ecotourism destination.

A poster session displaying the latest in water research rounded out the conference’s inclusive approach to the business of water. Scientific and technological advances underpin business development and economic progress. I suggest: The poster session featured 21 posters presenting work on solving an astounding range of water issues. Student poster contest winners were selected by a panel of expert judges. The winning posters reflect the variety of topics covered during the conference. First prize went to “Using Water Isotopes and Solute Chemistry to Investigate the Hydrology of Surface Water in the Cienega Creek Watershed” (Erin Gray). Second and third place winners were “Accumulation of Heavy Metals in Aquaponic Systems and Effects on Bacterial Antibiotic Resistance” (Hany Almotairy) and “Water Leachability of Inorganic N and P from Turfgrass Leaf Tissue” (Emily Hyde).

All photos by Lynn Ketchum, University of Arizona College of Agriculture and Life Sciences

The following photo-collage captures the spirit of this unique and informative conference.





All photos by Lynn Ketchum, University of Arizona College of Agriculture and Life Sciences

Arizona's Citizen Scientists Make an Impact

by Sam Potteiger, WRRC Student Outreach Assistant

Natural resource scientists and managers depend on data, which is often costly and difficult to collect. Citizen science engages members of the community in scientific investigations through observation and other data collection activities. Opportunities for citizen involvement are increasing as the value of “crowd sourcing” is recognized and strategies are developed for assuring data quality. In Arizona, citizen science has been employed to provide data on rainfall, streamflow, and water quality, among other topics.

Rainlog, a cooperative rainfall monitoring network for Arizona, was developed at the University of Arizona. Because rain gauges in Arizona are sparse, there are large gaps in rainfall data coverage. This data sparseness translates to difficulty in accurately estimating precipitation. Citizens who participate in Rainlog are helping to fill data gaps by measuring and reporting rainfall at their homes or work places. To encourage wide-spread participation, Rainlog was developed to be easily accessible. Anyone with a rain gauge and access to the Internet can participate. Data collected through the Rainlog network is used for a variety of applications, including watershed management, weather reporting, hydrologic research, and drought planning. Participants can see their observations and the observations of neighbors instantaneously. Rainlog displays all data on real-time, high-resolution precipitation maps on its web page. These maps are useful in tracking variability in precipitation patterns and potential changes in drought status.

A well-established application of citizen science in Arizona is wet/dry mapping. The Nature Conservancy launched this program on the San Pedro River in 1999 to monitor the extent of flow in the river in the driest part of the year. On the third Saturday in June, volunteers walk, ride on horseback, or even kayak along discrete stretches of more than 220 stream miles. They are trained to use GPS units to pinpoint where the flow starts and ends. With this data, The Nature Conservancy hopes to assist scientists and water managers to quantify long-term trends in surface water patterns, better understand groundwater/surface water interactions, and manage wildlife populations and riparian habitats. Already, mapping has helped preserve the welfare of the San Pedro. Data from the first 12 years of wet/dry mapping show a steady increase in the wetted section of a five-mile stretch of the river where irrigated farms were retired for water conservation. Because of the success of wet/dry mapping of the San Pedro, similar efforts have been undertaken elsewhere in Arizona, including the Agua Fria River, Cienega Creek, and at tributaries to the San Pedro. Mapping at Cienega Creek even revealed a previously unmapped perennial stretch of the stream.

Riverwatch, an effort by the Friends of the Santa Cruz River (FOSCR), is another well-regarded example of citizen science in Arizona. Riverwatch is FOSCR's water quality monitoring volunteer group. Each month, the group samples the river for

physical, chemical, and biological water quality parameters. Field monitoring data has been collected by FOSCR along the Santa Cruz since 1986. Because of the extent and quality of its database, FOSCR frequently collaborates with the Arizona Department of Environmental Quality (ADEQ), other government agencies, and various research groups. One dataset provided by FOSCR was instrumental in securing \$59 million in federal funding to upgrade a treatment plant, greatly improving water quality in the flow downstream from the plant—which Riverwatch has documented.

ADEQ has recognized the value of citizen science and has made it the focus of its new initiative, Arizona Water Watch. The initiative has two programs designed for volunteers aged ten and up: Citizen Science Water Monitoring and the Arizona Water Watch mobile app. Citizen Science Water Monitors undergo training to collect and prepare water samples for testing to help scientists find pollution sources and monitor restoration projects. By working with ADEQ scientists, citizens are able to design studies for their waterways and play an important role in their environmental protection. The Arizona Water Watch mobile app is simple and easy to use and anyone with a smartphone can download it for free from the app store. The citizen scientist visits a water body and takes a picture of it. Location coordinates are automatically recorded from the phone's GPS. Next, participants answer a series of “yes/no” questions about the body of water. Finally, users submit their observations, which are automatically entered into an ADEQ database. Scientists then use the data in analyzing water quality issues, updating flow data, and identifying water bodies for future studies.

Citizen science is also a powerful tool for scientist-community collaboration. Dr. Monica Ramirez-Andreotta integrates this approach into her National Science Foundation (NSF) funded project, Gardenroots, which trains people in underserved communities to monitor the quality of their harvested rainwater, garden soil, and home garden crops. Participants take samples of their garden soil, the water from the garden hose, a few vegetables from the garden, and a few clippings from garden plants. Some samples they analyze themselves and others they hand over to a laboratory for analysis. A key tenet of the project is to utilize citizen science as a means of empowering communities. Dr. Ramirez-Andreotta is quoted on the Gardenroots website commending the ability of citizen science as a process that “not only makes scientific information more readily available, it also engages community members in the process of scientific inquiry, synthesis, data interpretation, and the translation of results into action.” Through participation in Gardenroots, underrepresented populations can have an improved understanding of environmental health, allowing them to more readily participate in environmental decision-making.

Citizen science is an important resource for scientists. In Arizona, citizen science efforts have demonstrated the value of citizen participation in data collection and connecting the scientific community with the public. The ADEQ's new Arizona Water Watch mobile app points the way toward broad public engagement in generating scientific knowledge.

Record Year Predicted on Salt-Verde System

According to the Arizona Department of Water Resources, 2018 is a record year, but this is not a record to cheer for. The water runoff season (January-May) in the Salt-Verde watersheds is likely to be the driest since records have been collected. ADWR's Arizona Water News summarized the situation with information from multiple sources. The Salt River Project's runoff totals in the Salt and Verde reservoir systems for the period January-March are at their lowest since 1913. These discouraging totals come in the wake of a disappointing December-February snowpack season, which produced most of the snowpack only at the highest elevations in the watershed. Using SNOTEL data, the Natural Resource Conservation Service estimated snowpack values in the range of zero to 40 percent of normal. The spring does not hold much hope for moisture either. Forecasts indicate Arizona will experience drier than normal weather through at least the first half of April, and chances do not look good for a "Miracle May" like the one that rescued the Colorado River in 2015.

Study Boosts Credibility of Cloud Seeding

In January, a study funded by the National Science Foundation proved for the first time that silver iodide introduced into clouds forms ice crystals that fall out as precipitation. Researchers in Idaho used radar and aircraft-mounted cloud physics probes to detect evidence of the processes that lead to precipitation. The results of the study, published in PNAS, indicate that cloud seeding can enhance natural precipitation. Although the study focused only on the physical chain of events—initiation, growth, and fallout of ice crystals—rather than the effectiveness of cloud seeding, it is being cited to justify further investments. A 2014 study conducted in Wyoming found that cloud seeding could increase snowfall by 5 to 15 percent. While a 10 percent increase would be a boon to water users, it is within the natural variation of winter storms and therefore difficult to attribute to cloud seeding. Despite these reservations, Arizona, California, and Nevada have funded cloud seeding in the Rocky Mountains for over ten years and they will share the cost of nine more years with Colorado, New Mexico, Utah and Wyoming. The PNAS article is available at <http://www.pnas.org/content/early/2018/01/12/1716995115>.

Phoenix and SRP Agree on Water Recovery

The City of Phoenix has entered into a 40-year partnership with Salt River Project to help ensure reliable water deliveries in the future during extreme drought and shortage conditions on the Colorado River. Under this first-of-its-kind agreement, SRP will reserve capacity in its extensive system of wells so that in the future Phoenix can recover long-term storage credits for water that was stored within the Salt River Project water service area. During the term of the agreement, SRP will provide Phoenix up to 20,000 acre-feet of water per year pumped from SRP's wells located within the Salt River Reservoir District. The city will

pay a one-time fee, then a fixed rate up to 100,000 acre-feet and a higher fixed rate past that threshold. For more information: <https://www.srpnet.com/newsroom/releases/030818.aspx>

Mission Garden Celebrates Agricultural Tradition

The Santa Cruz River was the source of irrigation water for thousands of years. Tucson has revived cultivation of traditional gardens near the Santa Cruz through its Mission Garden project. The garden is located on the historic floodplain at the site of a Native American village that was there when Father Kino first arrived in the Tucson area. Today the garden uses drip irrigation with potable water from Tucson Water, but they are prepared with a purple pipe system to take reclaimed water in the future. The site of community events and tours, the Mission Garden is hosting the 3rd annual San Ysidro Festival on May 19th. The festival celebrates the harvest of White Sonora Wheat, the first wheat variety introduced to North America. It is a revival of an old Tucson tradition that dates back to the early days of Spanish settlement in the region, blending indigenous and Old World food traditions. Learn more about the festival at: <http://ediblebajaarizona.com/3rd-annual-san-ysidro-festival>

New Filtration Material Created

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia recently announced a breakthrough in water purification technology. The technology uses a newly designed form of graphene, a single layer of tightly packed carbon atoms forming a hexagonal lattice. A strong and flexible material, graphene has many industrial uses, including water filtration. The CSIRO design, called 'Graphair,' is made from soybean oil and is simpler, cheaper and faster to make than graphene. When tested on water samples from Sydney harbor, the Graphair membrane filtered out 99 percent of contaminants after only one pass through. The researchers hope it can replace the multi-stage processes currently needed. Learn more at: <https://www.csiro.au/en/News/News-releases/2018/Tiny-membrane-makes-Sydney-Harbour-drinkable>

Hurricane Alerts Will Now Include Storm Surges

According to NOAA's National Hurricane Center, 90 percent of hurricane-related deaths are caused by water—flooding, storm surges, and high surf. To reduce this number, the Center made changes to its warning system and began issuing watches and warnings specifically for storm surges associated with tropical storms and hurricanes. A storm surge warning is issued within 36 hours of "life-threatening inundation from rising water moving inland from the shoreline," while a storm surge watch is generally issued within 48 hours. Storm surge maps are made available with watches and warning. For more information, see <https://www.nhc.noaa.gov/surge/warning/>.

Water Transactions: Ethical Considerations

By Richard Morrison, Chairman, Morrison Enterprises

(Prepared remarks presented by Sharon B. Megdal and the WRRC Annual Conference: *The Business of Water*, March 28, 2018)



March 22 was World Water Day. I read some accounts of conferences held around the world on that day. I couldn't help but be interested in the fact that, at one of these meetings, the conferees voted to oppose the sale of water rights. Can that be surprising?

Water transfers are nearly always controversial, even in Arizona, where planning for our state's water future

is of prime importance. Obviously our view of such transfers may be influenced by our sense of place. By this I mean, although most of us were raised to revere free enterprise and economic efficiency, and we might generally agree with the proposition of economic theory that our resources should be subjected to some highest and best use, if you live in rural Arizona, when the subject is water transfers, you are not necessarily interested in economic theory. You are definitely worried about water flowing to money and you shout out, "Hey, not so fast!" That is the reaction in Mohave County just now to the Central Arizona Project's acquisition of farmland. It is also the basis for a growing concern in Yuma County about the acquisition of farmland there by hedge funds. I do know some private equity funds that have acquired farmland in Arizona for the expected appreciation in the land itself. But there is growing concern that hedge funds are investing for the prospect of transferring water.

Are there ethical considerations in all of this? You bet there are. And sometimes economic justice issues, too. In the public arena ethics should translate to public virtue. What would that look like?

Imagine for a moment what it would mean to our political process if each of us could honestly say, "I want the same good, the same opportunity, and the same consideration for you as I want for myself." It is also helpful to ask, as did Peter Block in his book *The Answer to How is Yes*, "What do you want most that money alone can't buy and you can't have it unless others can have it as well?" Well, of course everyone wants and needs water. Or you can think bigger than that. Thinking

with reference to the very big picture, an answer to the question might be sustainable planetary success or the ability to live freely at various ages and stages. It can be argued that people are not necessarily being virtuous when they express personal desires for sustainable planetary success. However, an action plan designed to accomplish such goals will inevitably consider the needs and the desires of others, and thus, justice theory becomes relevant to the development of an action plan.

I will give you an example of the tie between policy choices and economic justice that comes out of Arizona's Native American water rights settlement agreements. I remember arguments in the midst of Gila River negotiations about the extent to which the tribes should be able to market water allocated to them in the settlements. The issue interested me because I had written my Master's thesis years before on economic justice theory as applied to the settlement of Central Arizona Indian water rights claims. Frankly, as we were negotiating the settlements I was very respectful of the widespread Native American practice of taking the long view in planning for the future. Specifically, as described in many publications, Native American tribes typically plan for the "seventh generation." In other words, with every decision, be it personal, governmental or corporate, consideration must be given to how it will affect our descendants seven generations into the future.

Planning for unborn generations can certainly be an ethical principle. However, when I did my academic research, I quickly saw what most of you probably figured out long ago: whatever your guiding principles, the difficult part of applying them is in prioritizing the principles themselves, that is, *vis-à-vis* each other. The difficulty can be illustrated with reference to principles of economic justice. A literature review of relevant material will generally produce the conclusion that these six principles of economic justice win widespread public and private approval.

1. Justice requires equal respect and concern for all.
2. Justice requires special concern for the poor and oppressed.
3. Justice requires responding to basic human needs.
4. Justice requires human freedom.
5. Justice requires contributions to the well-being of the community.
6. Justice requires the fulfillment of our obligations to future generations.

To quickly illustrate my point about priorities, is it not obvious that the fourth of these principles, requiring human

freedom, may conflict with the sixth, requiring fulfillment of our obligations to future generations. In other words, in the exercise of our freedom in the present day, we may elect to maximize economic benefit to ourselves by marketing water that will be needed by future generations of people living where the water came from in the first place. So, sometimes decision making with reference to even widely adopted principles will be difficult.

I am introducing the subject of sustainability, which has long been an interest of the University of Arizona Water Resources Research Center. Sustainability itself can be viewed as an ethical issue when it comes to the intrinsic value of water in relation to the land above it or to land in the immediate vicinity of a natural watercourse. Some people also think about the impact of water transfers on the land in the same way as others think about the problem of extinction among plants and animals—noting that extinction is forever. In some locales, water transfers could result in an irrevocable loss of both habitat and economy. But here is the point about the intrinsic value of water to a place. In the words of author James White, “Because the intrinsically valuable is that which is good as an end in itself, it is commonly agreed that something’s possession of intrinsic value generates a *prima facie* direct moral duty on the part of moral agents to protect it or at least refrain from damaging it.”

Do no harm. How often we have heard that guideline in various contexts. I think most folks believe that is a laudable goal. Do we think it applies to the management of the water resources in our state? Certainly I recognize that voluntary water transfers are often *viewed* as essential in the western United States to balance the ever-changing demand and supply of water in the desert. However, I think the organizers of this conference are suggesting it is possible and advisable to study the impacts beyond the interests of buyer and the seller to determine whether or not the transfers are ethical, particularly with reference to how non-parties will be affected. We can also explore whether the individuals involved on behalf of the parties to the transactions have an ethical responsibility as individual persons, one that is distinguishable from the win-win solution parties typically seek. In this context, although there are some who may believe public virtue requires nothing more than conformity to the law’s requirements, I want to say unequivocally that I have never thought what is legal is what is ethical. Compliance with law would be expected, to be sure, but it is a relatively poor standard when one considers that the law is of necessity incomplete. In our system of laws, we all know the nation does not attempt to legislate all that is moral, for example. Not everything as to which a criminal code is silent is considered to be moral, and not everything that is immoral is rendered criminal. That is why the individual virtue of the voters and the persons elected is vitally important to the welfare of all who are served by government—there is a huge gap between what is legislated and what is desired.

But doing no harm may require some new procedural safeguards that don’t exist today outside the context of Native American water rights settlements; this could be another

of the useful purposes served by the judicial branch of our government. Many or most of you know that our Native American water rights settlements have generally required judicial approval obtained pursuant to a special procedural order promulgated by the Arizona Supreme Court. Non-parties to the settlements have had the opportunities to come into court and explain how their interests are or will be harmed by the settlement provisions.

I ask you, should Arizona require similar hearings before water transfers can be made? Do we expect that the possible emergence of an adjudication approval procedure for the settlement of non-federal claims will take care of all due process concerns? Really? What about the problem of notice? Are there other procedures outside of a settlement context that would provide adequate opportunity for third parties to protect their interests? You might say, well, a lot of the contemplated transfers will require a change in law. There will be opportunities for a hearing in the legislature. Maybe, but an opportunity for a hearing is not the same thing as an actual hearing. Furthermore, we live in a time of almost unprecedented political polarization over almost all public policy issues. Will we be content to let the parties to a water transfer agreement fight it out against their objectors in the media, or in the legislature, where a change in law may be required to facilitate a transfer?

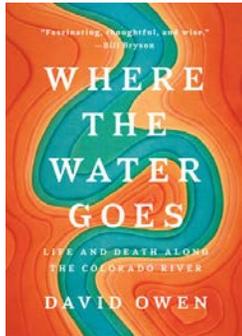
Should that be all there is to it—pure politics—or should there be ethical benchmarks against which even that which is or may become legal can be tested, and what would those ethical benchmarks look like? There are several systems of ethics from which to choose. For example, there are consequential and non-consequential ethics. In consequential ethics, the outcomes determine the morality, the rightness or wrongness, of the act. An act is viewed as immoral, or “wrong”, when it has a negative outcome on the greater number of people. So, decision makers try to predict the consequences of their choices. The problem with consequential ethics is that our ability to accurately predict the results of our choices is often limited and our predictions may be just plain wrong. But that doesn’t mean we shouldn’t try to agree on ethical standards for decision making about water transfers. It can be a huge discussion, but one worth having.

Here is my final point: Whether we are talking about institutional decision making or individual decisions, it cannot be enough that we know how to *talk about* ethics. It is necessary to *act* on our ethics. There’s a character issue that cannot be ignored. Ethical people possess an internal disposition that will sustain ethical practices. It’s a disposition that will enable us to overcome the harms, dangers, temptations, and distractions which discourage us from ethical practices. This is the proper role of virtue, a term seldom heard these days. Virtue is important in business as in life generally – because the law by itself will not take us where we want to go as a civilized people. Law gives us order, but ethics has the potential to secure happiness and health. The true victim of any failure of ethics will be the natural and social world that nourishes and sustains us.

Where the Water Goes: Life and Death Along the Colorado River

By David Owen

Riverhead Books, 2017



From its headwaters in the Rocky Mountains to its terminus in the deserts of northern Mexico, the Colorado River is the focus of aspirations, livelihoods, community, controversy, and conflict. A wake-up call in the form of a travelogue, *Where the Water Goes* explores the river's history from the days of John Wesley Powell to its current state as the most important water source in the American Southwest. David Owen begins his book

near Boulder, Colorado and works his way down to the Mexican border, following the 1,400-mile-long Colorado River and taking numerous side trips, to tell the story of one of the most complex water systems in the world. He exposes the issues that threaten the river, its dependent ecosystems, and its users and explores their complexities, revealing that there are no easy solutions. Additional suggested readings for every chapter are listed in the back.

David Owen is a staff writer for the New Yorker and his book is based on his article "Where the River Runs Dry," which appeared in the May 25, 2015 issue.

OECD Principles: From Policy Standards to Practice

Edited by Aziza Akhmouch, Delphine Clavreul, Sarah Hendry, Sharon B. Megdal, James E. Nickum, Francisco Nuñez-Correia & Andrew Ross

A Special Issue of Water International, Volume 43, 2018

This publication was a joint initiative by the Organization for Economic Cooperation and Development (OECD) and the International Water Resource Association (IWRA) featuring the work of the OECD's Water Governance Initiative in framing principles for water governance. The publication provides a showcase for approaches and efforts to use the principles as a tool for complex multi-stakeholder dialogue. Following an introduction to the OECD principles, the papers, which are co-authored by groups of diverse stakeholders involved in the OECD Water Governance Initiative, include the bridging the policy-implementation gap, social learning through stakeholder engagement, assessing water governance practices,

and lessons learned from practical applications. The special issue is available at: <https://www.tandfonline.com/toc/rwin20/43/1?nav=tocList#>

Dramatic Declines in Snowpack in the Western US

By Philip W. Mote, Sihan Li, Dennis P. Lettenmaier, Mu Xiao & Ruth Engel

Climate and Atmospheric Science, Nature Partner Journals, March 2018

A significant portion of water used in the western United States is runoff and infiltration from mountain snowpack. Snow accumulates on mountains in the winter and melts with the coming of warm weather. A comprehensive study analyzing the snowpack at West-wide snow monitoring sites with long records finds that 90 percent of these sites show declines. The percentage of locations showing decreasing trends is increasing dramatically, and averaged across the western United States, the April 1 snow water equivalent has decreased since the mid-1900s by roughly 15–30 percent or 20-40 million acre-feet, or as much as five times Arizona's total annual water use. The authors found the greatest declining trends in the Pacific states and in locations, like Arizona, with mild winter climate. The full article is available at <https://www.nature.com/articles/s41612-018-0012-1>

Divergent Trends of Open Surface Water Body Area in the Contiguous United States During 1984 to 2016

By Zhenhua Zou, Xiangming Xiao, Jinwei Dong, Yuanwei Qin, Russell B. Doughty, Michael A. Menarguez, Geli Zhang & Jie Wang

Proceedings of the National Academy of Sciences, March 2018

A recently published study from the University of Oklahoma Earth Observation and Modeling Facility reports surface water trends for the continental United States from 1984 to 2016. The authors analyzed 37,000 Landsat images and generated annual surface water body frequency maps for the past 30 years. The study showed statistically significant decreasing trends in the Southwest and Northwest and statistically significant increasing trends in the eastern United States. Because these divergent trends are mainly driven by climate, they are likely to continue. The PNAS article can be accessed at <http://www.pnas.org/content/early/2018/03/20/1719275115>.



Public Policy Review

Photo: Cynthia Campbell

The Business of Water is Everyone's Business

by Sharon B. Megdal

On March 28, 2018, the Water Resources Research Center held its annual conference. The topic, The Business of Water, was selected to bring attention to the myriad ways monetary considerations influence water management decisions and investment. The presentations and panel discussions throughout the day illuminated the variety of innovative approaches to infrastructure funding, water transactions, and water-based environmental and economic improvements deployed throughout Arizona and the West.

Financial considerations influence the way we think about investments in water projects. Our opening keynote speaker, Ian Lyle of the National Water Resources Association, noted the uncertainties associated with looking to Washington, DC, for assistance with water infrastructure funding. At the regional and local levels, projects may benefit from Public-Private Partnerships, such as those discussed by our opening panel. Large water treatment or conveyance projects require considerable work and can take many years to complete. The panel speakers, who represented a wealth of experience working on complex financing projects and partnerships, addressed the risk assumed by the private sector. Although there are risks, investors value the "safe space" that water projects represent once they are completed. The private sector can be more creative and agile than the public sector, but the risk assumed comes with a price.

The conference section on water transactions focused on their many forms, complex nature, and ethical aspects. Gila River Indian Community Governor Stephen Roe Lewis, who was introduced by University of Arizona President Robert C. Robbins, highlighted the importance of self-determination and the rocky road that led up to the 2004 Arizona Water

Settlements Act. He explained how the many water projects are addressing the needs of all water using sectors, including the environment, and spoke to GRIC (Gila River Indian Community) educational efforts. Governor Lewis informed the audience on how they have looked to alternatives to water leasing and how partnerships have contributed to propping up Lake Mead water levels to forestall declaration of shortage for the Lower Colorado River region by the U.S. Secretary of the Interior.

The panel that followed further elaborated on the complexities, lessons learned, and ethics of water transactions. Attorney Peter Culp emphasized the need to improve the use of the water resources we have through investments, and City of Phoenix Water Resources Management Advisor Cynthia Campbell explained how partnerships with others have enabled Phoenix to enhance water system efficiency and sustainability. I had the privilege of reading Morrison Enterprises Chairman Richard Morrison's thoughtful commentary on water ethics (see Guest View). I would like to focus here on the part of his comments on which I received the most feedback, namely his discussion of the tie between policy choices and economic justice. He wrote that economic justice should have the following six attributes: equal respect and concern for all, special concern for the poor and oppressed, recognition of basic human needs, human freedom, contributions to the well-being of the community, and the fulfillment of our obligations to future generations. He explained how his experience working on Native American water settlements led him to acknowledge that requiring human freedom may conflict with fulfilling obligations to future generations. He commented: "In other words, in the exercise of our freedom in the present day, we may elect to maximize the economic benefit to ourselves through the marketing of a resource that will be needed by future generations of people living where the water came from in the first place. So, sometimes decision making with reference to even widely adopted principles will be difficult." Indeed, the many tradeoffs associated with water transactions, including those related to economic justice, are varied and complex.

In recognition of our region's proximity to and relationship with Mexico, the luncheon program focused on water resource management and infrastructure investment issues in the border region. The International Boundary and Water Commission and the North American Development Bank facilitate water and wastewater investments and management in the border region. IBWC Commissioner Edward Drusina and NADBank Chief Sustainability Officer Salvador López Córdova explained that, like elsewhere, funding availability will determine infrastructure investment opportunities.

The Environment and the Business of Water panel provided insights into innovative programs being accomplished through funding partnerships involving NGOs and philanthropic organizations. Through leadership from not-for-profit organizations, but often with support from for-profit businesses, we are witnessing greater consideration of water for natural systems in water-related investments. While water use by the municipal, agricultural, and industrial sectors are regularly if not always well measured, the environment tends to be the forgotten sector. Most recognize that recreation, tourism, and property values depend on the condition of our natural environment. Nevertheless, the not-well-measured water requirements of healthy natural systems have limited legal standing in Arizona. A paper I co-authored in 2011, entitled "The forgotten sector, Arizona water law and the environment" (*Arizona Journal of Environmental Law and Policy* 1(2), pp. 243-293), discussed the importance of voluntary transactions in bringing the environment to the table as a water-using sector. In fact, as the panel illustrated, this has happened since publication of the article.

The panel on Water and Economic Opportunity, which included featured speakers from Yuma, Clarkdale, Tucson, and Phoenix, underscored how water availability and innovative water projects enhance the vibrancy of our local economies. Whether we live along rivers, mostly dry riverbeds, or not near rivers at all, carefully planned water systems and water features contribute to economic development and the enjoyment of the places in which we live.

Clearly, the business of water affects us all. Despite successes, we live where water supplies are limited relative to water demands. Closing speaker Arizona Department of Water Resources Director Tom Buschatzke underscored some key challenges Arizona faces. Whether communities depend on groundwater or surface water, challenges abound. Moreover, their nature changes over time.

Fostering understanding of Arizona's water resource challenges, along with the opportunities to address them, is a key priority of the Water Resources Research Center, and our annual conference is a signature WRRR program. We thank the excellent speakers, the more than 300 people who attended the conference, and the conference sponsors for contributing to a meaningful and informative dialogue. Finally, I would like to extend my personal thanks to the staff and conference volunteers, including the Conference Planning Committee, for their contributions.

Conference presentations and related materials can be found at <https://wrrc.arizona.edu/conference-2018-agenda>.



Sharon B. Megdal, Ph.D.

*Director, Water Resources Research Center
The University of Arizona*

All of Dr. Megdal's Public Policy Columns are available here:

<https://wrrc.arizona.edu/columns>



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WRRR 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

Phone: 520.621.9591

FAX: 520.792.8518

Email: wrrc@email.arizona.edu

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