



Transboundary Aquifers: Water Wars or Cooperative Conservation?

Stephan Elizander Przybylowicz, WRRC Graduate Assistant Outreach

Water draws people together because water is life. However, when many people, animals, and industries are competing over limited water, things can get tense. Transboundary aquifers are sources of groundwater that defy our political boundaries and often lead to intense conversation about what should be done in order to give everyone a fair share.

In the past 10 years, researchers, policy makers, and citizens have been actively working together under international guidelines to make major improvements to helping solve transboundary water issues. We can now take a broad look around the world to see what is working and what is not.

The Internationally Shared Aquifer Resource Management (ISARM) Initiative has recently published a methodological guide outlining best practices. The worldwide ISARM Initiative is a UNESCO and International Association of Hydrogeologists (IAH) led multi-agency effort aimed at improving the understanding of scientific, socio-economic, legal, institutional and environmental issues related to the management of transboundary aquifers. The guidebook, *Towards the concerted management of transboundary aquifer systems*, uses both case studies and analysis in order to identify the features of successful water management programs around the world.

The guide comes in three parts:

- (1) the need for a more comprehensive approach based on Integrated Water Resources Management (IWRM) principles
- (2) a range of technical, legal, organizational, economic, training, and cooperation tools that can help improve the knowledge and management of resources, and
- (3) a progressive, multi-pronged approach for implementing the concerted, equitable, and sustainable management of transboundary aquifer systems, as well as potential mechanisms for creating and sustainably operating appropriate institutional structures to manage these shared groundwater resources.

While this guide is currently only published in French, an English version is under consideration.

In the meantime, we need look no further than our own transboundary aquifer management along the US-Mexico border. The US-Mexico Transboundary Aquifer Assessment Act was enacted in 2006 in order to assess priority transboundary aquifers along the border, produce scientific products capable of being broadly distributed, and provide scientific information needed by water managers and natural resource agencies on both sides of the border. The Arizona Transboundary Aquifer Assessment Program (AZ TAAP) is an ISARM case study project being led by WRRC Director Sharon Megdal and Chris Scott from the University of

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WRRC Goes a Little Greener with New Rainwater Harvesting Demonstration



The WRRC will be going a little greener and will soon look like the photo-shopped picture at right with a new simple rainwater harvesting installation, thanks to funding from the University of Arizona Green Fund Committee. The new student-led committee approved funding for this project proposal and many more from across the University that involve and educate students and help achieve UA sustainability goals. All the new funded projects are listed on the Green Fund website:

<http://www.studentaffairs.arizona.edu/greenfund/>

The rainwater harvesting system comprised of two 350-gallon raincatchers, a run of eavestrough, and connectors will be in place before the monsoon begins. Captured water will be used to irrigate planting beds at the front of the building. The demonstration will serve to enhance the education and outreach component of the WRRC with a visible and accessible demonstration for the campus and the community. Information on rainwater harvesting will be available. 



Photo: Yancy Lucas.



News Briefs

EPA and ADEQ Considering Stricter Standards for Chromium in Drinking Water

The US Environmental Protection Agency (EPA) and the Arizona Department of Environmental Quality (ADEQ) are considering stricter standards for hexavalent chromium content in drinking water. Chromium +6 is commonly used by electroplating facilities as an algae inhibitor, is in some cooling systems around power plants, and has also been found to leach into groundwater from natural ores.

Chromium received national attention through the film *Erin Brockovich* in 2000, but continues to be found in tap water across the country. Exposure to chromium +6 is known to cause various forms of cancer in both humans and other animals.

In a recent study of 35 cities, chromium +6 was found in 31 cities and was higher than the State of California recommended maximum (0.06 mg/L) in 25 cities. Common household water filters do not remove hexavalent chromium, although some reverse osmosis systems can remove it. Some bottled waters may also contain the chemical because they are often taken from municipal water sources. There is currently no national standard for hexavalent chromium, but this new study is drawing attention to this contaminant and the need for a federal standard.

The impact of a federal chromium standard on Arizona is uncertain at this point, since it is not known how high the standard will be. The current Maximum Contaminant Level (MCL) in the State of Arizona is 0.1 mg/L (100 parts per billion-ppb). A spokesperson from the Arizona Department of Environmental Quality (ADEQ) estimates that a MCL of 0.05 mg/L (comparable to the California standard) would only impact up to 1 percent of the 985 regulated public water systems in Arizona. Only a major jump to an MCL of 0.02 mg/L or lower would possibly impact between 10–34 percent of these public water systems.

The EPA is currently offering guidance to utility companies on chromium testing and research while they consider possible federal testing and limit requirements. 

Correction

An article in the Winter 2011 AWR on the Sloan AQUUS system stating that the system did not require a reclaimed water permit requires clarification. This more detailed description of policy was supplied by the Arizona Department of Environmental Quality (ADEQ) on the Sloan AQUUS Gray Water Technology:

“[T]he Sloan AQUUS system is not a treatment technology or disposal works according to our rules and therefore, would not require permitting under our engineering review program. Household use of gray water is permitted under a Type 1 Reclaimed Water General Permit for Gray Water provided flows are less than 400 gallons per day and all conditions of the general permit are met. However, our Type 1 gray water rules currently prohibit the use of gray water for purposes other than irrigation (e.g., household gardening, composting, lawn watering or landscape irrigation) under A.A.C. R18-9-711(A)(2) and 711(B). Therefore, the AQUUS system would not qualify under our general permit program. Under our current rules, installation of the AQUUS system in homes for toilet flushing would require an individual reuse permit (A.A.C. R18-9-705 and 706).”

The Department will be initiating future stakeholder efforts and possible rulemaking as it explores the Blue Ribbon Panel on Water Sustainability's recommendations concerning the use of reclaimed water and gray water. 

Month Dedicated to Water Awareness

April is Water Awareness Month (WAM) in Arizona. Arizona's first WAM was proclaimed in April 2008 by the governor's office in order to help create a culture of conservation and reduce the impact of drought on our natural resources, economy, and quality of life. Its goal was to instill a greater awareness of water issues through community education, action and celebration.

The theme for WAM 2011 is “AWARENESS—of water conservation issues in our state.” This year, the actions by Arizona residents that organizers hope to motivate are to (1) use water more efficiently, (2) become aware of water conservation activities in their region, and (3) know where to turn for information and resources.

The Arizona Department of Water Resources (ADWR) and the Arizona Municipal Water Users Association (AMWUA) worked collaboratively to expand statewide promotion of Water Awareness Month by creating an interactive website. Water providers and conservation experts around the state contributed information about water-related activities, events, tips, and resources. The WAM web site is full of ideas and activities to help Arizonans learn more about water conservation and become more aware of our state's most precious resource, water.

At the campaign's heart is an interactive, topic-driven calendar—WaterAwarenessMonth.com—that serves as an information hub. Each day has a theme that when clicked on, displays information about activ-

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

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Announcements



The WRRC now on Facebook!

The Arizona WRRC Facebook page can be viewed publicly at <http://www.facebook.com/home.php#!/pages/Arizona-Water-Resources-Research-Center/127189280685470> or by logging in to Facebook and putting "Arizona Water Resources Research Center" in the search box.

This page has news about all programs at the WRRC and will include links to news items, special events, brown bag seminars, and important conference information. We would like to encourage anyone already on Facebook to "like" the page and "share" it with your friends, family, and colleagues. By utilizing current online social media outlets, we hope to introduce more people to the WRRC and encourage greater participation in WRRC events. 



Salinity and Desalination in the Southwest: Challenges and Solutions, April 26–27, 2011

Pivot Point Conference Center/Hilton Garden Inn, Yuma, Arizona

The UA Water Resources Research Center in collaboration with the US Bureau of Reclamation has lined-up a program of outstanding speakers for the 2011 annual conference. Utility managers, policy makers, consultants and scientists will offer regional, national and international perspectives on key issues, including:

- Desalination in water planning
- Environmental concerns
- Regulatory matters
- Technical and cost challenges

Reclamation will share the latest information on the Yuma Desalting Plant pilot run, and attendees will have an opportunity to tour the Yuma Desalting Plant (YDP) and the Water Quality Improvement Center located at the YDP facility.

The full agenda can be viewed at <http://ag.arizona.edu/azwater/programs/conf2011/agenda.html>

Contact hours at the conference will be accepted as **Professional Development Hours (PDHs)** by the State of Arizona Operator Certification Program for re-certification.

Registrations are being taken at cals.arizona.edu/AZWATER/programs/conf2011



Water Awareness continued from page 2.

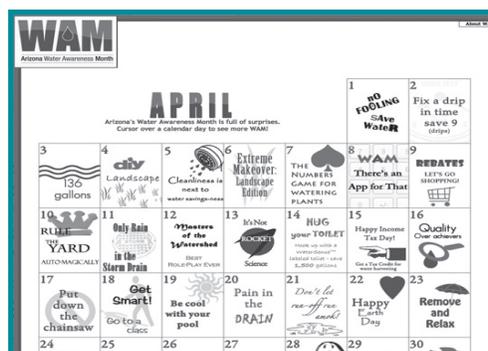
ities and events, how-to resources and handy tips that revolve around that theme.

For example:

- April 4th "DIY Landscape Day" focuses on designing and installing a low water use landscape
- April 9th is all about Rebates for water conservation
- April 18th "Grow Green Kids" Day has interactive games and activities
- April 13th "It's Not Rocket Science" features irrigation timers and tips on watering.

Or, if one wishes, all of the activities, events, resources, and tips can be seen as comprehensive lists.

In addition to the calendar, the WAM Facebook Page and Twitter can be accessed



through the website, and the public is invited to participate in the dialog. There are even places for people to make a pledge about their own water conservation efforts and upload water conservation related photos or videos. Partnering organizations were provided with a turnkey, day-by-day guide to using social media to promote the WAM

website to the public, including a website widget, suggested Facebook posts, and Tweets.

To assess the effectiveness of the WAM web-based, social media campaign, organizers plan on conducting several evaluative activities, including:

- Document the number and type of promotional partners and contributors
- Survey partners for their opinions, suggestions, and results
- Track the number and type of pledges
- Track the tweets
- Track the number of requests to receive a water conservation newsletter.

For additional information, contact: Jo Cook, jcook@amwua.org or Ruth Greenhouse, rgreenhouse@azwater.gov. 



New Resources

Top Water Blogs

Want to know the latest breaking news in water issues? Then check out these 30 best water conservation blogs as published by Online-Degree.net, a resource for online degree schools and programs:

1. **WaterWired:** WaterWired is about “all-things fresh water,” including news, analysis, humor and commentary by the accomplished and always involved Michael E. “Aquadoc” Campana. <http://aquadoc.typepad.com/waterwired/>
2. **Water Conserve:** Water Conserve features a search tool that enables readers to find water conservation news, information, analysis and opportunities. <http://www.waterconserve.org/blog/>
3. **Water for the Ages:** Abby Brown recognizes that water is life, so she has made it her mission to bring attention to important global water issues. She believes that we’re not doing enough to preserve the precious resource, but realizes changes are attainable. <http://waterfortheages.org/>
4. **Blue Living Ideas:** On Blue Living Ideas, you’ll find topics related to water conservation tactics, water purification and filtration, and water politics and economics—just to name a few. <http://bluelivingideas.com/>
5. **Water—Use It Wisely:** Perhaps the most useful post on Water—Use It Wisely is the “100 Ways to Conserve.” (<http://wateruseitwisely.com/100-ways-to-conserve/index.php>) Following them will have you saving thousands of gallons each month. <http://wateruseitwisely.com/blog/>
6. **Water Crunch:** Robert Osborne shares news both serious and humorous. Recent posts cover new water legislation and “7 Tips to Search for Water circa 1958” (<http://www.watercrunch.com/2010/11/7-tips-to-search-for-water-circa-1958.html>)—the latter of which offers perspective on how times have changed when it comes to water conservation. <http://www.watercrunch.com/>
7. **Rainbow Water Coalition:** Rainbow Water Coalition is “mostly about greywater,” which is the waste water that comes from showers, baths, sinks and washing machines. The blog promotes “diversity in the color of water” in order to ensure efficient and healthy use of H₂O. <http://rainbowwatercoalition.blogspot.com/>
8. **Food & Water Watch:** The Food & Water Watch site advocates strong conservation measures, promoting policies that will result in quality drinking water for everyone. <http://www.foodandwaterwatch.org/blogs/>
9. **WaterSISWEB:** Researchers, scientists, students and other people interested in water resources gather on WaterSISWEB to share news and views. <http://www.siswebs.org/water/>
10. **AWRA’s Water Resource Blog:** The American Water Resource Association compiles news and information from respected sources, informing the reader of water conservation measures and their effects. <http://awramedia.org/mainblog/>

11. **JAWRA Blog:** The Journal of the American Water Resources Association, which publishes papers that examine water resources issues, composes a blog that essentially carries out the same function, highlighting interesting studies from numerous researchers. <http://awramedia.org/jawra/>
12. **Water Matters:** The Columbia Water Center’s experts observe the global efforts to protect and preserve our water resources. <http://blogs.ei.columbia.edu/tag/water-matters/>
13. **On Water:** On Water is composed by the Water Resource Center Archives at UC Riverside, covering daily water-related news. <http://blogs.library.ucr.edu/wrca/>
14. **Aguanomics:** Economist and former Wantrup Fellow at UC Davis David Zetland shares his immense knowledge on the economics of water. <http://www.aguanomics.com/>
15. **The Water Law:** Attorney Alex Basilevsky discusses “the legal issues impacting water rights and the water industry.” <http://www.thewaterlaw.blogspot.com/>

Rivers, Lakes, and Wetlands Conservation Blogs

16. **American Rivers:** The River Blog: The staff of American Rivers, a “leading conservation organization standing up for healthy rivers,” authors The River Blog, which focuses on the efforts to preserve the nation’s rivers. <http://www.americanrivers.org/newsroom/blog/>
17. **Riparian Rap:** Steve Gough documents the work of Little River Research and Design—a service provider in river science and conservation. He also discusses the science of river ecosystem conservation and river geomorphology. <http://lrrd.blogspot.com/>
18. **Lake Scientist:** Learn about the news affecting the world’s freshwater resources by perusing Lake Scientist. <http://www.lakescientist.com/articles.html>
19. **The Compleat Wetlander:** The official blog of the Association of State Wetland Managers, Inc. focuses on wetland management, science and policy issues. <http://aswm.org/wordpress/>

Regional Water Blogs

20. **H2ONCoast:** Robert Emanuel of the Oregon Sea Grant Extension studies the North Coast of Oregon, introducing his knowledge on social and biophysical science. <http://blogs.oregonstate.edu/h2onc/>
21. **The Water Cooler:** “California’s first official water blog” monitors water—or the lack thereof—in the Golden State. <http://www.centralbasin.org/blog/>
22. **Aquaforia:** Affiliated with the Water Education Foundation, Aquaforia provides water news affecting the people of California. For example, it covers Colorado River basin, stormwater and desalination issues. <http://aquaforia.com/>
23. **EDF’s On the Waterfront:** The Environmental Defense Fund (EDF) is committed to “protecting California’s ecosystems

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Water Footprint Calculators



Virtual Water for iPhone:

<http://itunes.apple.com/app/virtual-water/id369876250?mt=8>

The Virtual Water app for iPhone is based on the 2007 poster by German designer Timm Kekeritz, which depicts the results from Hoekstra et al in their study, *Water Footprint of Nations, published in 2006*. In this project, the virtual water footprint of a person, company or nation is defined as the total volume of freshwater that is used to produce the commodities, goods and services consumed by the person, company or nation. *The adjective 'virtual' refers to the fact that most of the water used to produce a product is not contained in*

the product. The real-water content of products is generally negligible if compared to the virtual-water content.

The Virtual Water application can be carried anywhere in order to quickly calculate food and beverage choices at the point of decision. Since the app is interactive, the user can estimate the virtual water footprint of an item by choosing the best representation (for example, a cow for a beef patty) and then using the slider to adjust the amount of each product (for example, 8oz of beef). The view called up for each product also offers quick facts and a comparison function, and it will make calculations in both the metric system and US measurements.

Personal Water Footprint Calculator on Facebook:

<http://apps.facebook.com/watercalculator/>

The Siemens Personal Water Footprint Calculator for Facebook focuses on outreach. The calculator utilizes a footprint scheme based on simple tasks, such as how many times people wash their cars or if they leave the water running when they brush their teeth. It then shows the person's estimated water usage compared to the averages for different countries and other users (based on data gathered from various popular studies posted online regarding water usage for household tasks). Finally, it suggests additional ways that water can be saved, such as installing faucet aerators and only running full loads of laundry, and encourages users to make commitments to do these things. Because this application is a part of Facebook, it not only allows individuals to become more aware of their personal water usage, but also to see how much their friends are using and

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Water Blogs continued from page 4.

- and providing reliable water supplies" for the state's farms and cities. <http://blogs.edf.org/waterfront/>
24. **On the Public Record:** A "low level civil servant who reads a lot of government reports" writes about water in California. <http://onthepublicrecord.wordpress.com/>
 25. **Spouting Off:** Mark Gold is committed to making Southern California coastal waters safe and clean, and hopes to inspire action from people who share his concerns. <http://spoutingoff.wordpress.com/>
 26. **Western Water Blog:** The Western Water Blog examines water issues affecting California, Nevada and Colorado. <http://westernwaterblog.typepad.com/>
 27. **Waterblogged:** Water issues in Arizona and the Western United States are covered by Arizona Republic reporter Shaun McKinnon. Lake Mead and the Colorado River are both monitored on the blog. <http://www.azcentral.com/members/Blog/ShawnMcKinnon>
 28. **JFleck at Inkstain:** John Fleck, author and science writer for the Albuquerque Journal, watches and analyzes water resources in the Western United States and the efforts to preserve them. <http://www.inkstain.net/fleck/>
 29. **Wisdom in Water, Please:** Kansans and other people curious about water issues in the Midwest can absorb the wisdom of Wayne Bossert, who has managed the Northwest Kansas Groundwater Management District No. 4 for more than 33 years. <http://nwksmd4.blogspot.com/>
 30. **Great Lakes Law:** Professor Noah Hall composes "a blog on all things wet and legal in the Great Lakes Region." <http://www.greatlakeslaw.org/blog/> 



Special Feature

Winners of the Joe Gelt Undergraduate Writing Competition

The WRRC is pleased to announce this year's winners of the Joe Gelt Undergraduate Writing Competition!

The Water Resources Research Center's annual writing contest is in its second year, commemorating Joe Gelt, WRRC's long-time editor, who recently retired. Undergraduate students at The University of Arizona, Arizona State University and Northern Arizona University were invited to submit magazine style feature articles on a water related topic chosen from a list of six specified categories. The winning articles are published in the *Arizona*

Water Resource and the grand prize winner receives \$100.

Joni Northam is the grand prize winner with her article, "Open-Ocean or Land-based Desalination: Responses to Water Scarcity that Reduce Environmental Impacts." Joni also won the University of Arizona prize. The judges praised Northam's article as "well researched", "interesting and timely," since desalination is currently a hot topic in Arizona.

Joni states that "It is very obvious water is a critical finite resource; with this in mind water has always been of interest to me whether it be water governance, usage, or



access. The idea that every human has the *right* to clean drinking water but does not have the *access* breaks my heart. That is why I focused my piece on making water mobile and potentially more accessible through desalination ships."

Joni is currently studying in the School of Geography &

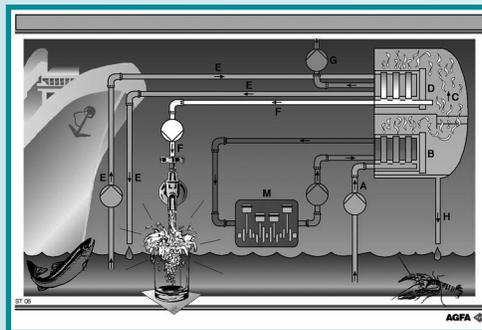
Development at the University of Arizona and hopes to one day work for a non-governmental organization in the Near East/North Africa region that focuses on devel-

Open-Ocean or Land-Based Desalination: Responses to Water Scarcity that Reduce Environmental Impacts

Joni Northam

To desalinate ocean water on ships or on land, that is the real question. The innovative technology of desalination ships is starting to make head way as a possible means to augment drinking water, according to an article in *Arizona Water Resource* (see *AWR* Sep-Oct 2008). With a gallon of bottled water able to be sold for more than a gallon of gas, many companies are searching for effective, cheap, and quick methods of obtaining that clean water. While there are a few well-known strategies for accessing water through non-conventional means, such as collecting rain water, there is still a high demand and need to secure water supplies for future use. With the increasing scarcity and competition for fresh water, desalination is an increasingly attractive option to meet growing demands.

The concept of desalination ships is quite simple. With the ship above water, the anchor is dropped. A long pipeline is then connected to the ship and submerged deep into the ocean where little to no sunlight can reach, thus less life is present. It is very



Source International Union of Pure and Applied Chemistry.

As easy as ABC, ship-based desalination of sea water may be a solution to water scarcity that minimizes environmental impact.

important that these pipelines go deep into the water where there will be minimal disruption to the aquatic food chain. Then, the water is sucked through a small tube and brought up into the ship. The water is then distilled to separate most of the salt from the water. Once the water evaporates it rises and is condensed on various platforms and the salt remains, a heavy substance, sitting at the

bottom. The water is then filtered through numerous membrane screens and is accumulated in one tank. Another ship then comes to the desalination ship and collects the purified water to bring it back to shore. The salt is then dispersed back into the ocean.

California is looking into ship-based desalination as a method to create more water for the California water supply and ease their dependence on the water from inland sources including the Colorado River. If California were to decrease its water withdrawals from the Colorado, this would potentially leave more for Arizona or Nevada with rights to smaller shares of Colorado River water, if they were willing to help pay for the desalination. It might also leave more water in natural ecosystems so as to decrease the rate of depletion and potentially replenish over-extracted water sources like aquifers.

If Arizona were to invest in desalination ships, a similar process might apply: there would be fewer claims on Central Arizona Project (CAP) water. With Arizona being

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oping infrastructure to eliminate poverty. She would like to thank Professor Christopher Scott for introducing her to the writing competition and encouraging her to explore innovative water concepts.

Deborah English won the Northern Arizona University prize with her article, "The Case for Pumping the Big Chino Aquifer." She is studying in the Social and Behavioral Sciences Department at Northern Arizona University.

Deborah states that "I feel it is important to address water issues because in the Southwestern United States we are already facing water problems. I chose my topic because it is important to evaluate the benefits and possible negative consequences of making decisions regarding where, when,



and how much water to allocate to support a population. It is essential that we examine how human uses of water and the natural environments need for water can coexist." Deborah is interested in pursuing a graduate degree in which she can apply her economics background to environmental issues and is in the process of applying to the School of Sustainability at Arizona State University. She would like to thank Dr. Dean H. Smith, her environmental economics professor, for

his knowledge, expertise, and encouragement in motivating her to enter the writing competition.

Articles were judged by an independent panel of writing professionals, which included Shaun McKinnon of the *Arizona Republic*, Joanna Dodder of the *Prescott Daily Courier*, and Joe Gelt, retired WRRRC editor.

This contest is a unique opportunity for student writers to see their work published. The *Arizona Water Resource* reaches a wide audience that includes water professionals and policy makers in addition to the interested public.

Opinions expressed in the students' articles do not necessarily reflect those of the WRRRC, its director, or staff. 

The Case for Pumping the Big Chino Aquifer

Deborah English

Should pumping of the Big Chino Aquifer be allowed and encouraged despite the possible threat it poses to the ecosystems and flow of the Verde River? Two USGS studies found that the upper 25 miles of the Verde River, known as the upper Verde, originate from the Big Chino Aquifer. Although a relationship between the Big Chino Aquifer and Verde River is evident, the complexity of this hydrologic system is not fully understood, and therefore it cannot be said with certainty that pumping of the Big Chino will endanger the rivers survival. It is equally important to sustain both the Verde River and human activities of the area.

Pumping of the Big Chino is currently the least cost means of meeting ground water regulations; while at the same time the Big Chino aquifer is the most practical and reliable water import source currently available. The pipeline project includes monitoring wells that will give clearer insight into the complex hydrological system of the Verde River and its relationship to the Big Chino Aquifer. Investment in the project will therefore yield new knowledge that ben-

efits all parties; and if in fact the Verde River is at risk, actions can be put in place to mitigate damage to the Big Chino Aquifer and Verde River.

Context of the Situation

With rapid population growth and expansion of Yavapai County, the towns of Prescott Valley, Chino Valley, and the City of Prescott face problems finding a dependable water source to support their populations. These towns and cities are a part of the Prescott Active Management Area (PrAMA), covering 485 square miles in central Yavapai County, which contains a large percentage of the population and therefore has a high volume of water consumption. Under Arizona state water regulations, PrAMA is responsible for meeting a safe yield water management goal by 2025. The goal is "to achieve and thereafter maintain a long term balance between the amount of groundwater withdrawn in an active management area and the annual amount of natural and artificial recharge in the active management area," as the Groundwater Code states.

As of 1999, PrAMA is no longer within a safe yield zone. PrAMA is no longer in this safe yield zone because the rate of ground water usage is not balanced with an equal rate of recharge into the aquifer. In other words, water is extracted and consumed at higher rates and volumes than water is replenished into the aquifer, which threatens groundwater availability for future generations of the PrAMA. As a result the cities within PrAMA must find water from outside sources in order to preserve the ground water levels. The pipeline could deliver as much as 3 billion gallons a year into the AMA to meet the safe yield goal.

The Prescott area cities believe that the Big Chino aquifer is the only reliable source of water currently feasible for PrAMA. Other AMAs such as Phoenix supplement groundwater with Colorado River water from the Central Arizona Project (CAP), which is a reliable water import source. PrAMA does not have the ability to import water through the CAP because of high transportation costs. Unfortunately, this factor gives towns in PrAMA a disad-

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Open-Ocean or Land-Based Desalination continued from page 6.

able to process salt water into drinking water, this innovation would lessen the impact of groundwater depletion. With either California or Arizona, or both, potentially utilizing distilling ships, there may be less of an impact on the Colorado River, as well as the other groundwater resources and aquifers. And considering the economy, such a project would surely create jobs in fields such as engineering, ship operations, and truck driving, with different levels of education, making the jobs accessible to many workers in need.

But why desalination ship instead of a land-based plant? First of all there is the environmental impact. While both technologies have the risk of disturbing the surrounding ecosystems, research is leaning towards the idea that a ship has less harmful side effects than those of a land-based site. Also, Arizona would be able to invest in a ship and be exempt from certain California laws and regulations that would apply to a land-based plant, if built in that state, making access to water easier.

A major positive discovery with using desalination ships versus land-based facilities is that the ships use a smaller pipeline that goes deep into the ocean where there is no sunlight and potentially few organisms to upset and so disturb the food chain. The tube is long and narrow making it impossible to suck up fish and other macro-organisms. With land-based pipelines, the tubing can only go so far down before it hits the ocean shelf where many plants and animals may reside. This is not only an issue for altering their natural habitat, but also their physical safety. These pipelines are wider and run the risk of sucking up those animals, not only threatening their safety but also clogging the passage way, which then takes time and money to fix.

With land-based plants not only are animals at risk of being caught in the pipelines' suction, but also the byproduct of the desalinating process is quite harmful. Once the water has been purified, the left over salt is a very hot, extra salty brine. This excess is either collected on land, or it is dumped into one concentrated area in the ocean, disturbing the natural pH balance. Any time the environment is disturbed this can cause a repercussion not only to that local area, but also to any businesses or related development in the present day and generations to come. This potentially could affect Arizona in a number of ways: increased cost of water, indirect chain reactions on the environment, and heightened insecurity of water supplies.

Yet the possibilities of open ocean desalination are enormous. The ships' power plants have the capacity to run on biofuel. A single ship could produce as much as 50 million gallons of drinking water a day—enough for hundreds of thousands of people. Certain companies claim permits for shipboard desalination are far easier to obtain than permits for land-based plants, thereby saving time and money. Some businesses estimate they could have a desalination ship ready for service in 14 months, whereas a land-based plant can take two to five years to build and get permit clearances.

Another added bonus in using a ship versus a plant is the idea of being mobile. The ship can move from one area to another, thereby dispersing the left over salt versus making one area supersaturated from a land-based plant. These ships can also be sent around the world to areas in high need and ideally, with financial backing, can help other areas facing possible severe shortages. 

Big Chino Aquifer continued from page 7.

vantage and the burden of finding their own reliable water source. After much evaluation and research, they decided on the Big Chino Aquifer. PrAMA is able to pump from the Big Chino because of a special exemption to the law that prohibits groundwater transfers into AMAs. Pumping from the Big Chino is therefore a legal water resource proposal.

Offsetting Harm to the Verde River

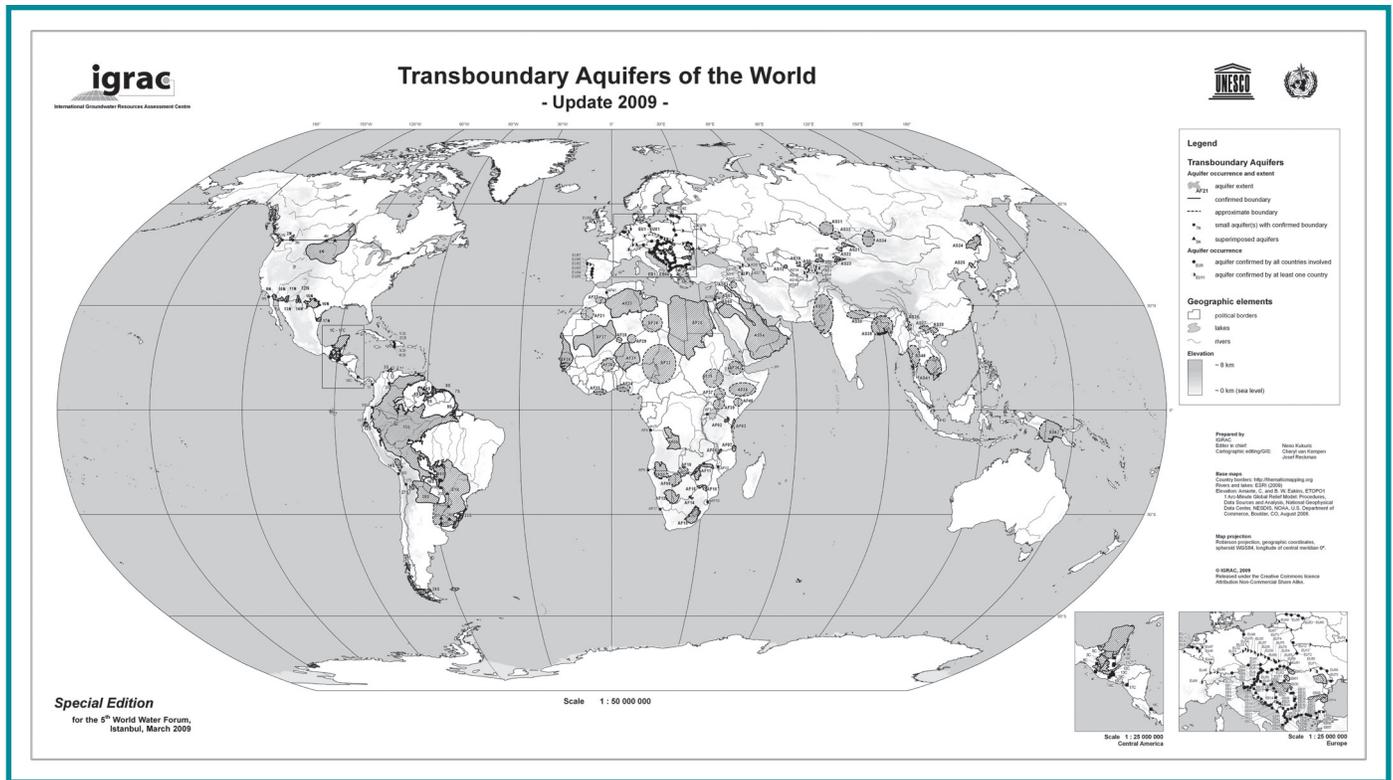
The City of Prescott plans to pump 8,063 acre-feet per year out of the Big Chino sub-basin, which has a total storage capacity of 15,000,000 acre-feet. Prescott's officials do not believe that pumping will harm the Verde River, but to be on the safe side, wells will be in place to monitor basin groundwater levels before pumping starts.

Several strategies have been proposed to offset the negative impacts on the Verde River and Big Chino Aquifer. If monitoring wells do detect a problem with the groundwater levels, then Prescott could mitigate these problems with a three-fold plan. First, Prescott could retire historically irrigated acres that are a part of the Big Chino water ranch purchase, offsetting the pumping. If that does not work well enough, Prescott could purchase even more historically irrigated land, retiring those wells, and thereby offsetting a greater portion of the pumping. The third part of this plan would entail the use of conservation easements throughout the entire basin. This would enable Prescott to virtually govern growth, which occurs along the sub basin, by keeping ranches as ranches so the rate of water use would be stable. Clearly, if the City of Prescott measures the groundwater extracted from the Big Chino basin and if a dangerous level is detected, they could act to sustain the aquifer and the river for the long-term.

Through the process of utilizing effluent (reclaimed water) to meet city needs and taking a percentage of that effluent water to recharge the Big Chino aquifer, the PrAMA could come into compliance with Arizona water regulations. By recharging the aquifer with treated effluent (in combination with natural recharge from rain) the cities could offset the amount extracted, bringing a balance between human uses of the groundwater, and natural uses of the groundwater such as a source of water for the Verde River.

Conclusion

Human failure to conserve groundwater in the past has created the current problems for the Prescott Active Management Area to comply with groundwater regulations. PrAMAs geographic location gives it a disadvantage to import water from other reliable sources, and few options exist to come into compliance with Arizona water regulations. The Big Chino aquifer appears to many residents to be the best feasible option to providing a reliable water supply to maintain the livelihood of the PrAMA population now and in the immediate future. If harm to the Verde River occurs as a result of pumping from the Big Chino aquifer, strategies can be put into effect to offset damage and protect the river's survival. A pipeline to an alternate reliable water resource for long-term use may be a better solution, but the Big Chino Aquifer could serve as a short-term water source. 



Source: The International Groundwater Resources Assessment Centre (IGRAC), 2009.

Transboundary aquifers are common sources of cooperation and conflict around the world.

Transboundary Aquifers continued from page 1.

Arizona Udall Center for Studies in Public Policy and the School of Geography and Development.

Aquifer assessment is a prerequisite to aquifer management and the program has already illustrated the most important component of transboundary water best practices: partnerships.

Water management and policy are shaped by several factors including resource availability, location of water demands and supplies, economics, historic and current legal/institutional frameworks, politics, public values, and information. In order to understand all of the factors at play, organizations must work together on both sides of the border. TAAP involves three US states, two Mexican states, and includes four transboundary aquifers.

Partnerships are embedded in TAAP. The legislation establishing TAAP reinforced the relationship between the US Geological Survey and the universities involved, allocating 50% of the appropriations to USGS and 50% to federally recognized Water Resources Research Institutes/Centers located at US Land Grant universities. The Water Institutes may then subcontract with partners, as needed. USGS and the universities are directed to collaborate with state water agencies, any affected Indian tribes, and the International Boundary and Water Commission (IBWC) as appropriate, as well as Mexico and other stakeholders.

It is important to remember that partnerships must accommodate and reflect asymmetries of institutions and laws because not every agency can afford to put in an equal share and may be operating under different regulations. This work can be facilitated by

the IBWC. The “Joint Report of Principal Engineers Regarding the Joint Cooperative Process United States–Mexico for the Transboundary Aquifer Assessment Program” was signed on August 19, 2009 after a year and a half of informal binational exchange meetings and three formal meetings over a period of five months.

Two meetings were held at the US Section IBWC (March 11 and April 16, 2009) and one was held at the Mexican Section CILA (June 18, 2009), while the actual signature by the two Principal Engineers took place on the border itself. The rationale for the agreement stemmed from the interest of both researchers and agency representatives in the United States and Mexico to ensure a binational process of prioritizing the aquifer assessment process, the flow of information, and the final official acceptance of assessment results. Stakeholders directly involved in drafting the agreement clearly saw the need for a truly binational process leading to a formal agreement that would be officially recognized by both countries.

Under the agreement, the IBWC is to facilitate binational work by assuring concurrence of the United States and Mexico for binational aquifer assessment activities, facilitating agreement on the aquifers that will be evaluated jointly, and establishing and coordinating binational technical advisory committees for each aquifer. The IBWC also serves as an official repository for the binational studies developed.

Another essential component of successful transboundary aquifer studies is to work from the ground up by building a shared vision with stakeholders. Stakeholder involvement results in improved quality of decisions, improved credibility and public support,

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improved implementation and monitoring, and early warning of potential challenges.

Cross-border meetings and field trips under TAAP have involved numerous governmental and non-governmental stakeholders who work to emphasize shared priorities including water availability, climate change, and water quality. TAAP factsheets, meeting minutes, and other materials are offered in both English and Spanish.

In other ISARM case studies, stakeholders have participated through community-based organizations (Senegal River, Africa), being active monitors of project implementation (Komati River, Africa), writing legislation to aid the water management process (Danube River Basin, Europe), and linking short-term community water projects to large-scale management visions (Great Lakes System, USA).

Partnerships, especially new ones, require time, perseverance, flexibility, creativity, respect for different perspectives, appreciation of the need for multiple types of expertise, and good and regular communication. Policy responses in these times of global change and great uncertainty depend on

- (1) good information,
- (2) good dissemination of that information, and
- (3) good understanding of the information.

While collaborative funding and overarching organizational structure may be difficult to create and maintain, the ISARM examples indicate that appropriate policy responses involving multiple stakeholders are achievable in these times of global change. Arizona TAAP and other ISARM programs are excellent case studies of best practices for transboundary aquifer assessment and management, but there is always additional work to be done. The efforts of these programs aim at building capacity for water stakeholders to work together to create cooperative efforts that solve common problems instead of simply fighting over water rights and wrongs. 🏗️

“Agua que no has de beber, déjala correr.” —Spanish Proverb
Translation: *“Let waters you will not be drinking run freely.”* (If you don’t need something, leave it for others to use).

Water Footprint Calculators continued from page 5.

to make their commitments public in order to conserve water as a community.

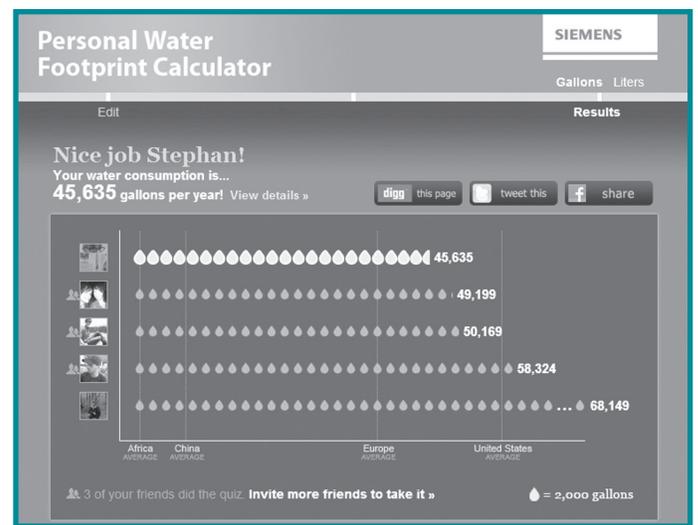
The Siemens Personal Water Footprint Calculator by Friend2-Friend was unveiled last year in honor of World Water Day on March 22, 2010. In less than one year it has users committing to collectively save over 92,369,818 gallons of water per year in the future.

So, will this fun and easy water quiz actually create tangible changes in water habits? Roger Katz, CEO of Friend2Friend, says “Of course, what people say and what they do isn’t always the same. But the average time spent on this application is 3 minutes, about six times the length of a television commercial. During that time users are thinking about their own water-wise habits and seeing conservation tips that specifically address their own areas of water consumption. They also make a commitment publicly, in front of their friends. Those are exactly the kinds of interactions that get people to start making changes in their lives.” 🏗️



Source: Arizona NEMO. *Arizona’s TAAP priority transboundary aquifers are shared with Sonora, Mexico.*

Note: Information about AZ TAAP was gained in large part from presentation materials produced by Dr. Sharon Megdal and Dr. Chris Scott at the University of Arizona. For more information, please visit the TAAP website at <http://ag.arizona.edu/azwater/taap/>



Source: Siemens <http://www.facebook.com/waterfootprintcalculator>
 Facebook results page for your Personal Water Footprint.



Public Policy Review

Sharon Megdal

Back to Fundamentals—On Economics and Water Pricing

Some readers of my column may not know that I am an economist by training. As a graduate student and at the start of my professional career, I focused on government tax and expenditure policy as well as applied statistical/econometric work. The closest I came to the study of water resources was taking an undergraduate class in environmental economics. I started out my professional career as a member of the Economics faculty at the University of Arizona. It was not until I was appointed to fill a vacancy on the Arizona Corporation Commission (ACC) in 1985 that I was introduced to water matters as a regulator of private water companies. For those unfamiliar with the ACC, it is Arizona's statewide public utilities commission. It is a constitutionally established and elected body. I was appointed to fill a vacancy on an interim basis, until the next general election.

In late 1991, in what was another interesting development in my career path, I became the Executive Director of the regional water district that came to be known as the Santa Cruz Valley Water District. It was in that role that I became fully immersed in water. The district was formed on a temporary basis with an interim board and was charged with developing an operating plan that defined the district's role in augmenting the water supplies of the Tucson AMA. I learned a great deal during this interesting, challenging and ultimately frustrating experience. The district was dissolved in 1994 due to a veto exercised by the City of Tucson board member when the interim board voted on permanent formation of the District. I subsequently became a water resources consultant. In 2002, after almost 16 years away from academia, I joined the Water Resources Research Center. I tell you all this because I find the perspectives gained from my training as an economist and my ACC and water district experiences very relevant to my work today.

My experience as an ACC Commissioner helped me realize that fundamental principles of microeconomics were the most important to consider when establishing policy, particularly that related to water pricing. People respond to pricing signals. Prices do affect demand. Here's just one example. During the first half of the 1990s, there was significant concern about the underutilization of the water made available to Central Arizona through the Central Arizona Project canal. There was more supply of CAP water than demand and California had access to water left in the Colorado River by Arizona. I served on a Task Force created by the Director of the Arizona Department of Water Resources to consider options for increasing use of CAP water. It had been expected that, once available, the agricultural sector would use CAP water in place of groundwater. But for most irrigators the CAP water was more expensive to use than groundwater, and there were no regulations in place preventing the use of groundwater. The result was what an economist would have predicted. The agricultural districts chose to use lower cost groundwater. Making a quantity of CAP water avail-

able to agriculture did not translate into its use. The relative costs associated with alternative and available water supplies mattered. Weather conditions mattered, too: 1993 was a particularly wet year.

Some of my recent work connects water pricing with another topic in which I have been interested since my days at the ACC: public versus private ownership of water systems serving Arizona communities. The Arizona Water Infrastructure Financing Authority (WIFA) releases annually a rate survey of water systems throughout Arizona. Information on system connections, water deliveries, pricing structure and ownership is included, making it possible to look at differences associated with public versus private ownership. According to the 2008 WIFA Water and Wastewater Residential Rate Survey (www.azwifa.gov), almost three of four water systems in the state are privately owned. Private water companies are smaller on average, having about 16 percent of the water connections in the state and delivering less than 11 percent of water sold in that year. Whereas five publicly owned systems had more than 100,000 connections, no privately owned system was that large. One of the most interesting findings relates to the prevalence of tiered rate structures where the cost for additional water increases as more water is used. Such a rate structure is considered an effective mechanism for encouraging conservation. Back in the days when I was an ACC Commissioner, there was some resistance to adopting tiered rate structures. One of the reasons was concern that water companies might over-earn or exceed their revenue requirements if water use did not decrease. It took some time before increasing block pricing caught on at the ACC. But things have changed, particularly in recent years.

Examination of the WIFA data for 2003 and 2008 shows that while only 97 private water companies had tiered rate structures in 2003, 153 companies had them in place in 2008. Coupling this with the fact that private water companies typically self-initiate rate setting proceedings at the ACC, this increase is remarkable. It shows what can happen in a short period of time when policies of a rate-setting body change. Of the publicly owned water systems, whose rates are set by local governing bodies rather than the ACC, 65 and 75 had tiered rate structures in 2003 and 2008, respectively. I should note that the total number of water systems was a bit higher in 2003 (437) than in 2008 (424).

The manner in which water regulation is practiced, including rate setting, affects our ability to meet regional and state water policy objectives. We are continuing this work at the WRRC and look forward to sharing our results with you. 



Innovative Educational Program Introduces Middle Schoolers to Water Resources Research

In an increasingly technological world, the ability of Arizona and the United States to innovate and compete will rely on building an effective workforce in Science, Technology, Engineering and Mathematics (STEM) fields. Unfortunately, many students in Arizona have fallen behind students in other states and countries in these areas long before they get to college. The need is urgent to improve educational opportunities for the state's K-12 students to learn to think critically about complex, multifaceted problems and communicate effectively. To meet that need, Arizona Project WET, a program of the Water Resources Research Center, has launched a project to pilot STEM subject integration into the study of water resources. The Water Investigations Program (WIP) offers direct experience for middle school students to conduct scientific investigations.

Teacher cohorts in four schools in Maricopa, Pinal, Pima and Cochise counties have been working collaboratively with education specialists over the school year to guide students through a learning progression that began with investigating their own water use, installing aerators in their bathroom faucets, and calculating water savings. Then building on what they learned about water saving, students studied Arizona's water resources. They used interactive lessons in their classrooms to explore where their water comes from, the connections between groundwater use and Arizona's rivers, and the importance of riparian areas to plant and animal communities.

In the next phase of the WIP, students use their knowledge of water resources, their scientific inquiry skills, and their native curi-

osity to develop their own investigations in riparian areas managed by The Nature Conservancy along the San Pedro River. Thanks to the support of the Water Sustainability Program, twenty graduate students, Mentor Scientists from the University of Arizona, will guide each collaborative learning group in conducting these student-designed field investigations. The middle school students are curious about plant and animal life in and around the river, water quality, stream discharge, and groundwater. They ask questions like "Does the groundwater level change with land elevation?" and "Does the amount of available water determine leaf size?" The Mentor Scientists will facilitate student investigations and share their expertise from the fields of ornithology, geology, entomology, dendrochronology, climatology and many others.

The pilot program finale is a Riparian Symposium on April 29, 2011 at the UA Student Union, where both middle school students and UA mentors will share research results and explore the ways that their work can inform conservation practices in the city and land management practices in riparian areas. The WIP will reach 200 middle school students in its pilot year. This innovative project is funded through a Water Quality Improvement Program grant from the Arizona Department of Environmental Quality and the Water Sustainability Program. The Nature Conservancy will be taking the pilot to the next level and funding a WIP in the Phoenix Valley starting this Fall.

Contact Kerry Schwartz, director, Arizona Project WET for more information (kschwartz@cals.arizona.edu or 520-621-1092).

