



ARIZONA WATER RESOURCE

The Water Resources Research Center Quarterly Newsletter

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The "Over the Hill Gang" (a group of local trail-building volunteers) works on the North Loop Trail in Watson Woods Riparian Reserve in Prescott, AZ. Source: Prescott Creeks

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Student Spotlight



Katie Banister is a second year master's student of Urban Planning with a specialization in Environmental and Regional Planning. She is also pursuing a Graduate Certificate in Water

Policy and working as a graduate assistant for the WRRC's Environmental Program.

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Publications

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

Along Urban Waterways: Cities Try New Strategies for Clean Waters and Shaded Streets

by Lucero Radonic, Graduate Outreach Assistant and Susanna Eden, WRRC

In the City of Prescott, the Watson Woods Riparian Preserve, along Granite Creek, is an oasis for wildlife and humans surrounded by development. The city's wastewater treatment plant and transfer station are located a block to the east, a lumber company and a concrete block manufacturer are located to the south, Highway 89 and some dense subdivisions are to the west. Over the last century, this riparian area has been a sand and gravel mine, a dumpsite, a 4-wheel playground, and a shooting range. In 1995, the City of Prescott established the Watson Woods Riparian Preserve and transferred its management to Prescott Creeks, a grassroots organization working to improve the health of the local Granite Creek Watershed. With the labor of community volunteers, Prescott Creeks realigned four sections of the degraded creek channel giving them a more natural course and revegetated the floodplain to restore riparian habitat

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Tucson Community Groups Win Conserve to Enhance Environmental Restoration Grants

by Katie Banister, Brittany Xiu and Candice Rupprecht, WRRC

Four environmental restoration projects are improving Tucson's livability thanks to a unique program that motivates the city's water customers to use less water in their homes or businesses and to donate some or all of the associated savings on their water bill to fund local environmental enhancement projects. Designed by the University of Arizona Water Resources Research Center (WRRC), Conserve to Enhance (C2E) was first offered to residents of Tucson, Arizona in 2011. The success of Tucson C2E allowed funds to

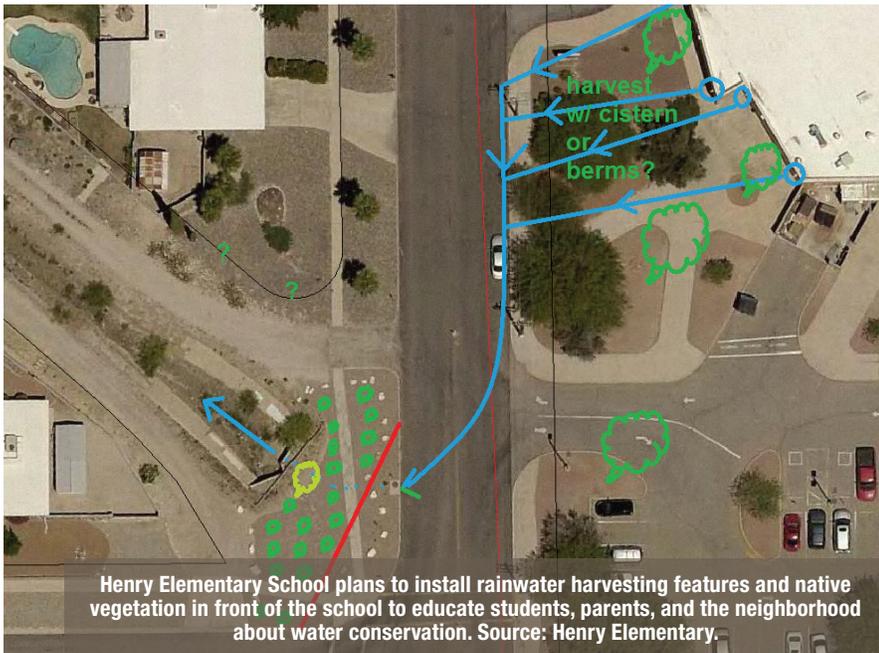
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be distributed to recipient sites throughout the Tucson area, through an annual application process overseen by the Tucson C2E Board.

In 2013, nearly \$30,000 was awarded through the Tucson C2E Community Enhancement Project grant program. Proposals were solicited from neighborhood groups interested in enhancing urban waterways and local washes that have been degraded throughout Tucson by excessive runoff, erosion, invasive species, and garbage. The three project sites selected in 2013 are currently under construction, with expected completion in the summer of 2014.

The first award was granted to Henry Elementary for their Henry Elementary WINS! – Wash Improvement and Neighborhood Sustainability Project. Neighborhood and student volunteers will remove invasive species, plant 50 native trees, and install a rainwater cistern to benefit the newly named urban wash that runs in front of the school using C2E funds. This work will improve habitat on the campus and in multiple adjacent waterways, while educating students and neighbors about the importance of native trees, litter prevention and urban heat island impacts.

A second C2E grant was awarded to the Northwest and El Cortez Neighborhoods for their 1st Ave./Seneca Greening and Beautification Project. Neighborhood volunteers will install native landscaping and create roadside curb cuts along a highly traveled pedestrian path. The improved landscaping is intended to calm the adjacent automobile traffic, make the area more walkable, and reduce storm water runoff.

The third grant went to the Mountain/1st Avenue Neighborhood for the Mitchell Park Wildlife Habitat & Green Infrastructure Project. They will use C2E funds to replace 9,000 square feet of turf with native vegetation and install curb cuts and earthen swales to divert storm water from the neighborhood streets. Improved wildlife habitat at Mitchell Park will also reduce local temperatures and enhance recreation opportunities. Neighbors, as well as the City of Tucson Parks Department, are helping with this project.

Atturbury Wash, located in southeast Tucson, was the first Tucson C2E environmental enhancement site. Conducted by

the Tucson Audubon Society, this project was awarded over \$12,000 in 2012 to replant native vegetation lost to drought and flash floods and create a demonstration site for passive water harvesting techniques. Tucson Audubon Society and community volunteers dug three basins and planted 50 native trees and shrubs in these basins across the 1-acre site. Volunteers built a raised trail system for visitors to enjoy and used the excavated soil to direct rainwater and runoff into the three new rainwater harvesting basins. A drip irrigation system was installed to support the new vegetation with water provided by the City of Tucson Parks and Recreation Department, who owns Atturbury Wash. Educational signage will be placed onsite this fall explaining what has been done and will feature a photo point monitoring station where citizen scientists can take pictures from a fixed location, upload them to the C2E website, and help Tucson C2E track changes at the site over time. Similar signs and photo

point monitoring stations will be installed at all future Tucson C2E sites.

Tucson C2E has been in place since 2011, when collaboration between the WRRC, the local water utility Tucson Water, and nonprofits Sonoran Institute and Watershed Management Group implemented the C2E pilot program. The Tucson program has been well received by the community and program participants have conserved 2.7 million gallons of water by employing conservation strategies ranging from behavioral changes to rainwater harvesting installations. Donations to C2E result directly from participant water savings and additionally from an “Open Space and Riparian Enhancement” check box program on the Tucson Water bill. Combined check box and participant donations have raised over \$60,000 for Tucson C2E.

The check box allows all Tucson Water customers to contribute to C2E on their monthly water bill, whether or not they are registered Tucson C2E participants. Tucson Water continues to work with Tucson C2E to increase participation in the utility’s check box program. If 5 percent of customers in the Tucson Water service area join C2E, an estimated 250 million gallons of water would be conserved annually and more than \$500,000 would be available for restoration efforts each year.

New participants are always welcome to join the C2E program and current expansion efforts are targeted at recruiting regional business participants as well as ongoing efforts to engage residential participants. To explore how a business can function as a C2E participant, Panda Restaurant Group, Inc., the parent company of Panda Express, agreed to pilot this relationship and is working with Tucson C2E to better define how business participant roles and needs differ from residential water users.

C2E is expanding to other communities throughout the Southwest and is showcasing the Water Use Dashboard, which will go live in November, 2013. The Dashboard offers a comprehensive set of program implementation tools to interested utilities. It provides water consumers with a wealth of information about their water use, tips on how to conserve,

and improve water quality. In an area where non-point source pollution is a serious water quality issue, these changes help slow stormwater runoff and filter *E-coli* bacteria and other contaminants.

In 2012, the Arizona Department of Environmental Quality (ADEQ) awarded the Prescott Creeks group funds to create green infrastructure demonstration sites across the city. Green infrastructure refers to constructed landscape features that rely on natural systems to provide services such as capturing, cleaning and infiltrating stormwater; creating wildlife habitat; and shading and cooling streets. Examples of green infrastructure include rainwater harvesting basins along restored streams and vegetated drainageways in parking lots and along streets. The funds granted by ADEQ to Prescott Creeks are being used to create microbasins—small depressions lined with rocks and native vegetation that catch stormwater. They allow pollutants to be absorbed and broken down through microbiological processes while creating green shaded pockets in the city.

In 2013 the Environmental Protection Agency (EPA) launched the Urban Waters Initiative to advance the restoration of urban waters and promote public access to urban waterways. The initiative supports community groups like Prescott Creeks working towards the restoration of urban waterways through improved stormwater management. Granite Creek restoration work was featured in the series of Urban Water Voices videos the agency has posted to highlight local efforts and strategies.

Other communities across Arizona have also begun to address the challenges presented by deteriorated urban waterways. One of the earliest examples of stream restoration at the heart of an urban metropolis is the Rio Salado Environmental Restoration Project, which restored a 5-mile section of the Salt River that runs through central Phoenix. With upstream dams and diversions, the riverbed was dry except after storm events. In 2001, Phoenix residents approved a \$16 million bond issue to fund riverbed cleanup and habitat restoration.

The project converted the river from an industrial dumpsite into an oasis of native wetlands and riparian habitats. More than 1,000 tons of trash were removed from the area during cleanup. Then the City worked with the Flood Control District of Maricopa County and the U.S. Army Corps of Engineers to construct a low-flow channel, plant thousands of native trees, and create a 20-mile network of trails. In addition to five non-potable groundwater wells, the site is irrigated by 22 stormwater drains that discharge into it at multiple locations. Today, this oasis offers passive recreational and educational opportunities like bird walks, bike rides and interpretative hikes, while also providing stormwater management to reduce flood damage in the urbanized floodplain. In addition, 60 percent of the water delivered to the project is expected to infiltrate into the aquifer.

In Yuma, the wetlands and riparian areas along the lower Colorado River are experiencing a similar transformation aimed at habitat restoration and riverfront redevelopment. The Yuma East Wetlands is a 1400-acre restoration project supported by a public-private partnership between the City of Yuma, the Arizona Game and Fish Department, the Yuma Crossing National Heritage Area, the Quechan Tribe and private landowners. Over the 20th century, this area became disconnected from the Colorado River, dried up and turned into a landfill dominated by non-native vegetation like salt-

cedars and tamarisks.

Starting in 2004, non-native vegetation was cleared and a backwater channel was excavated and reconnected to the Colorado River through water-control structures at the inlet and outlet of the new channel. Volunteers planted native vegetation, including 5,000 bare-pole willow and cottonwood cuttings, along 40 acres of the channel's shoreline and wetlands. With the return of the water, the native cattail/bulrush habitat naturally rebounded, and during the breeding season the bird population doubled. The initial 350-acre area was restored with \$2.5 million in funding from the Arizona Water Protection Fund to support wildlife habitat as well as year-round recreation and educational opportunities, complete with trails and picnic areas.

In Tucson, the city and county are also working to restore degraded riparian environments of the major regional drainage systems, according to recommendations made in the Sonoran Desert Conservation Plan (SDCP). The SDCP integrates natural resource protection and land use planning activities into one single plan for Pima County. One of their recommendations was to restore the Rillito River arguing that this would bring ecological and social benefits to the urban area. The Rillito is part of a network of intermittent and ephemeral streams that crisscross Tucson and serve as water drains during storms. Although the Rio Antigo stretch of the Rillito once supported a forest of mesquite, cottonwood and willow, by the turn of the 21st century, it was a dry, bank-stabilized wash that flowed only during storm events.

As part of the Rio Antigo Restoration Project, approximately 36 acres of riparian habitat along the south bank of the Rillito River were restored. Some minor land recontouring was done, bank slopes were flattened and native vegetation planted. In some areas the cement lining the existing drainage channel was removed and more sinuous channels were shaped to slow water movement. Small earthen catchment basins and drainage channels enhanced passive water harvesting. Reclaimed water was used to supplement rainwater harvesting during the early phase to ensure the establishment of the vegetation.

Tucson is also addressing urban waterways

Urban Waterways continued on page 4



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restoration through promotion of green infrastructure practices that control stormwater pollution onsite before it reaches the city's streams and washes. The city's commercial water harvesting ordinance, adopted in 2008, requires commercial developments to meet 50 percent of their landscape water demand using harvested rainwater, prepare a water harvesting site plan and water budget, meter outdoor water use, and use irrigation controls that respond to site-specific soil moisture conditions. More recently, Tucson's Green Street Policy requires that green infrastructure features, such as vegetated street-side basins, be integrated into all publicly funded roadway development and re-development projects. The policy also requires that projects provide 25 percent tree canopy and 25 percent shrub and grass cover.

The EPA is now encouraging municipalities and community groups to integrate green infrastructure features like those installed in Tucson and Prescott into their stormwater management practices. Originally developed and implemented in temperate states, green infrastructure is providing a growing number of communities across Arizona a strategy to convert stormwater runoff from an urban waste to a resource. The use of green infrastructure constitutes a major change from former techniques that

straightened stream channels to improve their ability to convey urban runoff while armoring their banks to reduce erosion. These techniques often resulted in dry riverbeds with overturned shopping carts, piles of debris and overgrown invasive shrubs. Whereas single-purpose stormwater infrastructure directed urban stormwater away from the built environment, green infrastructure captures and treats rainwater where it falls and directs the resource to creating environmental, social, and economic benefits for urban communities.

As explained by the EPA, green infrastructure is a cost-effective tool for stormwater management, water conservation and flood mitigation. In the arid and semi-arid Southwest, it can also help alleviate the heat island effect by providing water for irrigating urban landscapes.

The fast growing cities of the Southwest experience the urban heat island effect as an issue of growing concern. The general measure of urban heat island effect is an increase in the overnight low temperature, meaning that urban desert nights do not cool down as they used to and they stay significantly warmer than surrounding non-urbanized areas. Land developments with vast expanses of concrete and asphalt absorb heat during the day and emit it during the night. For example, Tucson's urban temperatures are approximately 5.5 degrees Fahrenheit warmer than they were last century, with

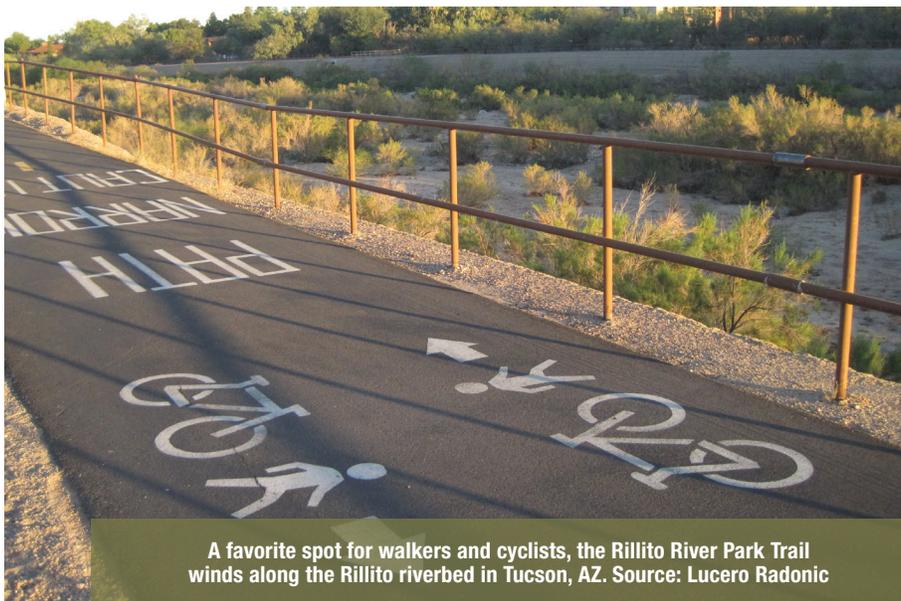
more than 3.5 degrees of the warming occurring in the last 30 years. More notoriously, from 1948 to 2000 the average daily temperature in central Phoenix increased by approximately 5.5 degrees Fahrenheit and the nighttime minimum temperature by approximately 9 degrees Fahrenheit.

Green spaces help mitigate heat, but vegetation requires water. Green infrastructure features capture stormwater to irrigate shade trees and vegetative cover and can reduce or eliminate the need for supplemental water. In Tucson some neighborhoods are retrofitting their streets to divert stormwater to green infrastructure features. Guided by the Watershed Management Group, a local nonprofit organization, residents plant native vegetation and build bioretention basins to hold stormwater for onsite irrigation. Bioretention basins are simple landscaped depressions that slow and treat on-site stormwater runoff via a number of physical, chemical and biological processes.

They capture, clean and infiltrate storm water from nearby roads and driveways reducing flooding along city streets while providing passive irrigation to native vegetation that provide much needed shade and green space.

Three out of four Arizonans now live in urban areas. Buildings and pavement dominate their landscape. Urban waterway management in the 21st century is

working to restore and enhance a greener landscape, while maintaining public safety. Although not without challenges and controversy, projects like those undertaken in Prescott, Phoenix, Tucson, and Yuma point towards acknowledgement of the values of healthy urban stream ecosystems and roadside green spaces. 🌱



A favorite spot for walkers and cyclists, the Rillito River Park Trail winds along the Rillito riverbed in Tucson, AZ. Source: Lucero Radonic

C2E Grants continued from page 2

information about rebate programs available from participating utilities, and the opportunity to donate to local or regional C2E programs. Water use information includes a breakdown of indoor and outdoor water use, average annual and monthly use, comparison of current and past use, daily water savings, and comparison of the individual and the community average use. The Dashboard will also provide a suggested donation based on water savings and will allow consumers to set up recurring donations. Water conservation tips will be seasonally timed and both tips and rebate information will be customizable for each participating community so that the Dashboard displays locally relevant information for participants. For more information please visit www.conserve2enhance.org. 🌱

CAGR and Tucson Finalize Water Credit Transfer

On September 5th, the Central Arizona Project Board of Directors approved a historic agreement between the Central Arizona Groundwater Replenishment District (CAGR) and the City of Tucson on Colorado River water recharged in Pima County. Over a 20 to 25-year period, CAGR will purchase a total of 100,000 acre-feet of long-term storage credits from Tucson, and can purchase up to 5,000 acre-feet per year. The CAGR, established in 1993 by the state legislature, serves as a method for property developers and water providers to demonstrate a 100-year assured water supply under Arizona law. Tucson generated the credits by storing renewable water supplies, including CAP water and reclaimed water, at several recharge facilities near Tucson. Because the recharge facilities and stored water are located outside of the city's water service area, Tucson determined that it is unable to efficiently recover and directly utilize them. Thus, both parties consider this agreement a win-win situation. The transaction provides CAGR with water storage credits to meet its replenishment obligations in the Tucson region. Concurrently, the transaction allows the City to optimize its water portfolio by replacing water located outside of their service area with funding for development of local water resources and infrastructure.

Unique Underwater Method Used for Horse Mesa Dam Repair



A section of the new vane on the dive barge. Source: Michael McNamara, SRP

In September 2013, engineers at the Salt River Project (SRP) successfully executed a unique underwater method to repair a damaged intake structure for Horse Mesa dam's hydroelectric Unit 4. In June 2012, the collapse of a guide vane inside the penstock intake—that is, the huge pipe that passes through Horse Mesa dam from Apache Lake into the generating unit below on the Canyon Lake side—shut down Unit 4 and the 119 megawatts of electricity generated by its pump-back unit. To repair the damage SRP

might have had to drain Apache Lake, significantly affecting marina operations and boating enthusiasts at the reservoir. Instead, they worked with Seattle-based Global Diving & Salvage on an innovative underwater technique. Global Diving & Salvage hauled 29 tractor trailer loads of equipment to the site, including an enormous working barge system to support the construction efforts, as well as cranes, boats and other support features. The effort necessitated a 24-member crew working around the clock on the barge to support the divers working under water. Twenty crew members worked above water while two teams of two divers, trained not only as divers

but also as construction personnel worked 10-hour shifts. The teams used a specialized technique called “saturation diving.” A diving bell brought a team to the work area 160 feet below the surface of Apache Lake from a pressured habitation vessel on the barge. One diver remained in the bell for 5 hours while the other worked on repairs and then they reversed roles. The second two-man crew took over the work for the next 10-hour shift. The teams remained under pressure for 30 days while work was completed. This arrangement allowed them to work underwater for long periods of time at a greatly reduced risk of decompression sickness.

Rio Verde Community Earns Audubon Award for Sustainable Communities

The Rio Verde—a private community east of Scottsdale—has earned the Green Community Award from Audubon International, a non-profit environmental education organization. Rio Verde is the first community in the Western United States and the second private community in the country to earn this award for its green initiatives. Rio Verde's initiatives include native landscaping and fruit tree planting for public consumption, local food sourcing for on-site dining facilities, and a solar-powered community center. In addition, the Rio Verde Country Club utilizes reclaimed wastewater for irrigation, and landscaping crews use integrated pest management whenever possible. The Green Community award recognizes environmental achievements and is an intermediate milestone en route to earning the designation as a Certified Audubon Sustainable Community.

Reclamation Forecasts Low Lake Powell Water Release for 2014

As part of its ongoing management of Colorado River reservoirs, the Bureau of Reclamation determined that only 7.48 million acre-feet (maf) would be released from Lake Powell in water year 2014 (Oct. 1, 2013 – Sept. 30, 2014). An annual release of 7.48 maf is a 9 percent reduction from 2013 and the lowest release since the filling of Lake Powell in 1963. Lake Mead is projected to decline an additional eight feet during 2014 as a result of the lower Lake Powell annual release. However, Lake Mead will continue to operate under normal conditions, with water users in the Lower Colorado River Basin and Mexico receiving their full water allotments. These projections reflect Reclamation's 24-Month Study Report, which provides projected reservoir operations for all major system reservoirs in the Colorado River Basin over a two-year period. Projections are updated monthly to reflect changes in weather and the resulting hydrology. Thus, they are subject to change as the year progresses, and the picture may improve if there is good winter snowpack. Annual releases are based on reservoir levels in Lake Powell and Lake Mead and the 2007 Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead, which provides Colorado River users with a degree of certainty about annual water deliveries. 📊

Announcements

WRRC Graduate Student Jacob Prietto Wins Second Place in CAP Water Research Competition

Jacob Prietto, a graduate research assistant at the WRRC, recently won Second Place in the Central Arizona Project's 2013 Award for Water Research competition. The competition is open to undergraduate and graduate students enrolled in any of Arizona's colleges or universities. Students submit research papers focusing on water issues that affect Central and Southern Arizona and the Colorado River. Prietto's award-winning paper, "Stakeholder Incentives for Effluent Utilization in the Tucson Metropolitan Region and Recharge in the Santa Cruz River," discusses the challenges, opportunities and decisions water managers must account for to effectively develop effluent as a valued water resource. The paper draws on his research, which focuses on the effluent-dominated section of the lower Santa Cruz River. He is collecting and analyzing water quality samples at the wastewater treatment outfalls and monitoring wells along the river to determine their influence on the streambed infiltration of effluent during non-storm flow conditions. Prietto is pursuing a Master of Science degree with the Department of Hydrology and Water Resources at the University of Arizona. His research paper is available online at: <http://www.cap-az.com/documents/public-information/afr/Jacob%20Prietto%202013.pdf>

USDA and Department of Interior Announce Partnership to Protect Water Supply from Wildfire Risk

The U.S. Department of Agriculture and the U.S. Department of Interior launched the Western Watershed Enhancement Partnership, which will be implemented in collaboration with local water users and private partners. The Partnership is part of President Obama's Climate Action Plan and it will work to identify and mitigate risks of wildfire to the nation's water supply, irrigation and hydroelectric facilities. The National Forest system provides drinking water to more than 60 million people nationwide. The share of water supply originating on national forest lands is particularly high across the West. Healthy forests filter rain and snowmelt, regulate runoff and slow soil erosion. When wildfires occur, these "ecosystem services" are lost. Sediment, debris and ash can wash into streams and rivers damaging water quality, critical water resource infrastructure, and natural habitats. This damage often requires millions of dollars to repair. The goals of the Western Watershed Enhancement Partnership are to restore forest and watershed health, to reduce fire risks and to proactively plan for post-wildfire response actions. The new partnership will begin with a pilot project in the Upper Colorado River in Northern Colorado and additional pilots are expected in Arizona, Idaho, California, Washington, and Montana.

EPA National Stormwater Calculator Available Online

As part of President Obama's Climate Action Plan, the Environmental Protection Agency (EPA) released the National Stormwater Calculator. This desktop application estimates the annual amount of rainwater and frequency of runoff for any site in the United States, to help homeowners, developers, landscapers and urban planners make informed land-use decisions and protect local waterways from pollution caused by stormwater runoff. Estimates are based on local soil conditions, slope, and historic rainfall records. Users provide information about the specific site's land cover. They then select the types of features they would like to use to control stormwater from a palette of low impact development (LID) controls or green infrastructure (GI) practices. Information is provided on each of seven defined green infrastructure installations to help users decide which stormwater management practices to install. Each year billions of gallons of stormwater carrying trash and chemicals flow into streams, rivers and lakes. This tool is intended help bring LID/GI into general use as a strategy for mitigating these undesirable stormwater impacts. By the end of 2013, an update to the Stormwater Calculator will be released that includes the ability to link to several future climate scenarios. For more information, visit <http://www.epa.gov/nrmrl/wswrd/wq/models/swc/>.

EPA Launches Online Tool for Finding Environmental Impact Statements

The Environmental Protection Agency (EPA) launched an interactive map-based tool that provides access to information on environmental impact statements (EIS) filed with EPA. The National Environmental Policy Act requires federal agencies to consider the impacts and any reasonable alternatives of proposed projects and other actions. For proposed projects with potentially significant impacts, federal agencies prepare a detailed EIS, which is filed with EPA and made available for public review and comment. EPA is required to review and comment on EISs prepared by other federal agencies. The web tool offers multiple search methods for finding an EIS of interest. Identifying information can assist users in locating EIS documents from other repositories. Some EIS documents can be downloaded directly in PDF, as can EPA comment letters. The web tool can be found at <http://nepassisttool.epa.gov/nepassist/eismapper/index.html>. 📄

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Water Community Loses Two Leaders

by Susanna Eden, WRRC

In July 2013, Arizona lost two important figures in the field of water resources. One a hydrological scientist, the other an environmental advocate and lobbyist; both were known for their profound knowledge and pragmatism.

“Dr. Herman Bouwer dedicated his life to the advancement of water resources research, planning, and development on a global scale. He was a trusted friend and teacher to many of us that work in the field of water resource management in Arizona, throughout the United States, and in many countries around the world.” This tribute appeared in the Arizona Hydrological Society newsletter, an organization that in 1997 awarded Bouwer a Lifetime Achievement Award and in 2000 named a scholarship program in his honor—the Herman Bouwer Intern Scholarship, to which he donated his monetary award from the Prince Sultan Bin AbdulAziz International Prize for Water in the field of Artificial Groundwater Recharge. He also received the National Groundwater Association’s Life Member Award.

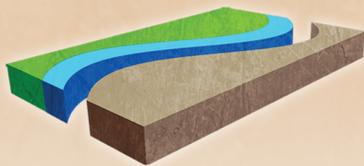
Bouwer was chief engineer with the Water Conservation Laboratory of the U.S. Department of Agriculture for many years and in that position he distinguished himself as one of the world’s foremost groundwater hydrologists and experts in the field of artificial groundwater recharge. As the AHS newsletter observed, his pioneering work in groundwater recharge with particular emphasis on the reclamation and reuse of sewage effluent through Soil Aquifer Treatment was influential not just at home in Arizona, but nationally and internationally. He

was the author of many journal articles and books, including Groundwater Hydrology published in 1978. The science of groundwater recharge has lost a leader with his passing.

Priscilla Robinson, whom I first met in 1985 as a graduate student conducting interviews for a project on water conservation, impressed me with her no-nonsense attitude. Many times over her long career that attitude, along with her deep knowledge of water issues, had an important impact on policy and management decisions in the Tucson area and beyond. She was a major force in framing Arizona’s environmental legislation, including the Groundwater Management Act, signed into law in 1980, and the Environmental Quality Act of 1986, which created the Arizona Department of Environmental Quality. As Tony Davis described eloquently in the Arizona Daily Star, “her interests were much broader than water, extending across environmental issues to issues of social justice, and continuing throughout her life.”

Robinson was director of the Southwest Environmental Service from 1975 to 1988, a non-profit organization working for the protection of the environment. During her tenure, SES gained a reputation for responsible leadership and informed commentary on environmental issues. After retirement, she participated in the Tucson/Pima County Water and Wastewater Infrastructure, Supply and Planning Study, a multiyear effort that published its Phase 2 report in 2009. As recently as May of this year she was quoted in the Daily Star expressing a frank assessment of a proposed pipeline to carry Central Arizona Project water south from Tucson to a groundwater savings facility. Her voice in environmental policy deliberations will be missed. 🏡

WRRC 2014 CONFERENCE



CLOSING THE GAP BETWEEN WATER SUPPLY AND DEMAND

TUESDAY, APRIL 8, 2014

8:00 AM - 5:00 PM

STUDENT UNION MEMORIAL CENTER
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WRRC Conference 2014

Water demand in Arizona exceeds renewable supplies by a gap that will grow to an estimated million acre-feet by 2060. The WRRC, in collaboration with the Arizona Department of Water Resources (ADWR), will host state and regional water managers, researchers, academics, and the public in a vital conversation on our water imbalances and options for bringing the water scales into balance.

ADWR Director, Sandy Fabritz-Whitney will give the opening keynote address to set the stage for a day that will also include a celebration of the 50th Anniversary of the University of Arizona WRRC as a National Water Resources Research Institute!

Call for Poster Abstracts

The WRRC is now accepting abstracts for the Annual Conference Poster Session. Interested students, researchers, and practitioners are welcome to submit poster abstracts. Cash prizes will be awarded to the top three student posters. **The deadline for poster abstracts is Monday, Feb. 3, 2014.**

Submit your abstract and read more about the 2014 Annual Conference at wrrc.arizona.edu/conference/poster-abstracts.

Sponsorships Available

Showcase your program or organization by becoming a WRRC Annual Conference sponsor. Conference sponsorships, unique break sponsorships, and luncheon sponsorships are available. For more information, contact Susanna Eden at seden@cals.arizona.edu.

Low Impact Development and Green Infrastructure: A Multibenefit Solution to a Multifaceted Problem

by **Evan Canfield, Pima County Regional Flood Control District, and Irene Ogata, City of Tucson**

When Tucson's water harvesting guru, Brad Lancaster, illegally cut the curb in front of his house to collect stormwater runoff, he did so on a Sunday to avoid notice from local authorities. Today government agencies encourage, reward, and in some cases, require water harvesting. So what's changed? The multiple benefits of using decentralized structures to capture and utilize rainwater are being recognized as the solution to many of our water resources problems. These benefits include reduction in demand for potable water, improved water quality, flood mitigation, habitat creation, urban heat island mitigation, and creating a more pedestrian-friendly community. For these reasons water harvesting and decentralized stormwater management practices have gone from being outlawed to becoming mainstream.

Implementation and construction of Green Infrastructure (GI) features along major collector and arterial roads now includes greater institutional requirements of design detailing, grading and modeling done by professional engineers and landscape architects. Pima County and the City of Tucson are preparing guidance for the beneficial use of stormwater at the neighborhood scale in response to shared recognition that stormwater has become a major element in the equation of balancing water needs in urban areas. Creation of this Low Impact Development and Green Infrastructure Guidance Manual coincides with the direction of stormwater management promoted by the Environmental Protection Agency (EPA) in developing new Clean Water Act stormwater rules.

The goal of Low Impact Development (LID) is for post-development runoff to mimic pre-development conditions. In most cases, this means creating small-scale GI features that use vegetation, soils and natural processes to mitigate stormwater volumes as close as possible to where rain falls. Much of the runoff from impervious surfaces flows into these features rather than increasing roadway flooding, and thus can reduce the need for investment in traditional stormwater management structures. The City of Tucson has partnered with the non-profit organizations Watershed Management Group and Tucson Audubon, which enlist citizen volunteers to provide hands-on installation of water harvesting features and GI on residential collector streets.

Locally, elected officials, grassroots organizations and the general public have supported the implementation of GI/LID. The Pima Association of Governments Regional Council has recognized the potential benefits of Low Impact Development and Green Infrastructure by adopting a resolution supporting GI/LID. The City of Tucson passed a Commercial Water Harvesting Ordinance requiring commercial projects to integrate water harvesting in their development plans. An internal Department of Transportation Green Streets Policy requires all public streets to integrate GI from the initial design concepts.

For residential properties, Tucson Water has a rebate program offered to customers who plan to install a rainwater harvesting system. Participating customers must take a workshop where they learn the principles of water harvesting to ensure their residential systems are designed and installed effectively. These workshops have been an overwhelming success, necessitating additional workshops taught by educators and professionals from the University of Arizona/Pima County Cooperative Extension, Watershed Management Group, and Southern Arizona Rain Gutters --a local business.



The Pima County Regional Flood Control District is in the process of preparing new design standards for stormwater detention and retention. These new standards will allow the flood control benefit of LID/GI to be calculated so that the use of these features can be justified in terms of their flood prevention and mitigation benefits. Integrating GI/LID practices is becoming more the norm than the exception as we begin to integrate the concept of the triple bottom line of environment, economics and social equity into development in the urban areas.

At the national level, the EPA recently released the National Stormwater Calculator, which provides a standardized way to calculate the stormwater captured by common GI practices using local climatic conditions. Many professional organizations have their specific rating system and GI/LID practices are recognized in all. These include: Leadership in Energy & Environmental Design (LEED) certification by the US Green Building Council (USGBC); Sustainable SITES from the American Society of Landscape Architects and the Lady Bird

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Katie Banister is a second year master's student of Urban Planning with a specialization in Environmental and Regional Planning. She is also pursuing a Graduate Certificate in Water Policy and working as a graduate assistant for the WRRC's Environmental Program.

Katie received a Bachelor of Science in Soil Science from Cal Poly in San Luis Obispo, California. Upon completing her undergraduate degree, she worked for the USDA Natural Resources Conservation Service (NRCS) on the Soil Survey of Yosemite National Park. As a member of a small team, she described and sampled soils in the backcountry of the park for four years, producing data that is now used by the National Park Service to inform their management activities.

After her time with the NRCS, Katie's career took a scenic detour. To have more time with her young daughters, she envisioned, planned and opened a small children's retail store in Monterey, California. She successfully operated the business for seven years, wearing many hats including mother, buyer, accountant, supervisor, marketing coordinator, data manager and customer service representative.

While doing this, Katie sat on a Land Use Advisory Committee (LUAC) for Southern Monterey County to learn more about local land use decisions. Members of each of the 13 LUACs in Monterey County are appointed by the Planning Commission to review land use changes and development issues affecting the county. The planning commission then uses comments from LUAC members as local input on potentially contentious issues.

In 2009, a project of large scale and consequence came before the LUAC. An oil and gas company was seeking approval to use hydraulic fracturing technology to explore the Monterey shale formation, which underlies most of the area. As she learned how significant a change this type of oil development would be from older technologies used in the region, Katie joined with other local citizens to petition the county to reconsider

the issue and deny the necessary permits for exploration. The group's largest concerns were the amount of water to be withdrawn from the relatively small local aquifer, the possibility of groundwater contamination, and the admission from the California Department of Oil, Gas and Geothermal Resources that they were not monitoring "fracking" technology in any significant way.

These events influenced Katie's decision to return to the university and pursue a career that would allow her to make a positive impact in her local community. She sees urban planning as a way to pair her interests in both the built and natural environment.

At the WRRC, Katie works on the Participatory Watershed Assessment for the Upper Gila River and the Conserve to Enhance projects. She assists with stakeholder engagement and the production of information about the projects. In the past year she most enjoyed creating an interactive timeline of the history of the Upper Gila River based on the memories of local historians, land managers and long-time residents who gathered at a special meeting of the Gila Watershed Partnership.

This past summer Katie interned with Watershed Management Group, a non-profit organization in Tucson that promotes community based solutions for natural resource sustainability. She researched urban forestry initiatives from around the United States, looking for ideas that can be applied to the desert southwest to address stormwater problems, the urban heat island effect, and overall community livability.

Katie's experience at the WRRC bridges her background in natural resources and environmental science with her future in urban planning. Through her work she is learning about the ways water can affect how communities develop and she feels more knowledgeable about the tools communities and individuals can use to improve the management of their water supply. In the future, she would like to work to promote municipal development that uses natural resources, including water, more efficiently. She is interested in designing cities for healthy lifestyles via green infrastructure, urban forestry, alternative forms of transportation, and local food production. She believes more trees and bicycles (and the infrastructure to support them), and better use of water resources are the keys to a happy, healthy city. 🏡

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Johnson Wildflower Center; and Envision, developed by the Institute for Sustainable Infrastructure and Harvard's Zofnass Program for Sustainable Infrastructure, and supported by the American Society of Civil Engineers and the American Public Works Association.

Here in Pima County, what began as a quiet grassroots effort recognizing the importance of valuable water resources in an arid climate has come full circle with local and national jurisdictional acknowledgement, and professional recognition to include GI/LID as an essential integration for development to occur in a sustainable fashion in the southwest desert. 🏡

WEEKLY WAVE

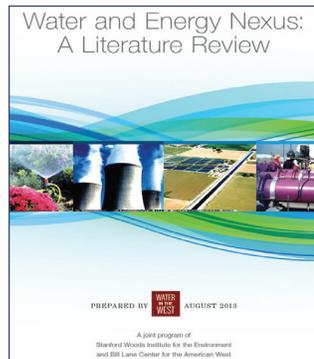
News and events from
the Water Resources
Research Center

The Weekly Wave e-News Digest is distributed each Friday, and contains announcements for the WRRC Brown Bag Seminar Series and Annual Conference, updates from the WRRC's many outreach and research programs, and much more.

To subscribe to the Weekly Wave go to:
wrrc.arizona.edu/subscribe

Water-Energy Nexus: A Literature Review

Water in the West, a joint program of Stanford Woods Institute for the Environment and Bill Lane Center for the American West, Stanford University, August 2013

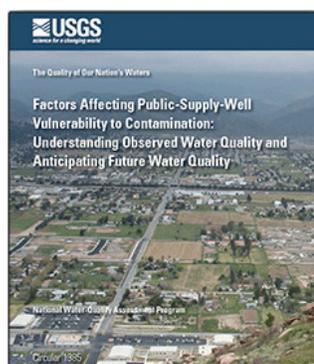


This literature review on the water-energy nexus provides an overview and analysis of the policy, scientific and technical research on the connections between water and energy conducted between 1990 and 2003. It is a comprehensive survey of the literature from the academic, government and nonprofit sectors, organized around water and energy life cycles. The first section explores

energy used by the water and wastewater sectors, and the second section documents water used to generate different forms of energy. Critical findings are presented along with opportunities for future research in this area. The full report is available at <http://waterinthewest.stanford.edu/>.

Factors Affecting Public-Supply-Well Vulnerability to Contamination: Understanding Observed Water Quality and Anticipating Future Water Quality.

Sandra M. Eberts, Mary Ann Thomas and Martha L. Jagucki. U.S. Geological Survey, Reston, Virginia, 2013

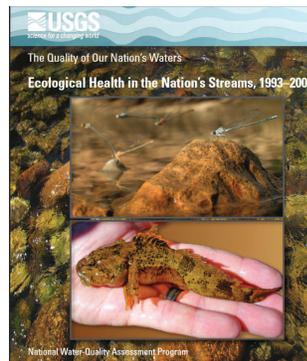


This new report from the U.S. Geological Survey (USGS) provides insight into which contaminants in an aquifer might reach a well, and when, how and at what concentration they might arrive. The study examined ten different aquifers across the nation and found that there are differences in public-supply-well vulnerability to contamination, even when contaminant sources

are similar. This is because conditions specific to each aquifer affect how long contaminants remain in groundwater and how rapidly they move to wells. The study also found human-induced changes in recharge and groundwater flow caused by irrigation and high-volume pumping had changed aquifer geochemical conditions in numerous study areas. Study findings indicate that information on contaminant input, contaminant mobility and persistence, and the intrinsic susceptibility of the aquifer within the area that contributes water to a well can be used by water managers to protect water supplies from contamination. The report is available at <http://pubs.usgs.gov/circ/1385/>.

The Quality of Our Nation's Waters - Ecological Health in the Nation's Streams, 1993-2005

Daren M. Carlisle, Michael R. Meador, Terry M. Short, Cathy M. Tate, Martin E. Gurtz, Wade L. Bryant, James A. Falcone and Michael D. Woodside. National Water Quality Assessment Program, U.S. Geological Survey, Reston, Virginia, 2013

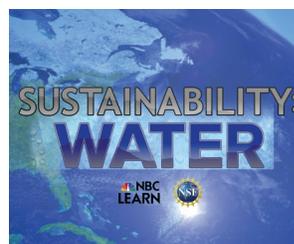


A new report from the U.S. Geological Survey (USGS) explains how the health of U.S. streams is being degraded by multiple factors, including stream flow modifications and elevated levels of nutrients, salinity and contaminants such as pesticides. To assess the health of streams, scientists examined the relation between the condition of three biological

communities (algae, macro invertebrates and fish) and factors with known potential to alter stream health. At least one altered biological community was found in 83 percent of the assessed streams, and 86 percent of the streams had been modified by dams, diversions, flood control structures or groundwater withdrawal. The report found that stream health was reduced in the majority of streams located in agricultural and urban areas, where elevated levels of salinity, nutrients and pesticides are widespread. However, one in five of these streams was in relatively good health, showing that it is possible to maintain stream health in watersheds with substantial land and water-use development. The USGS provides access to this report at <http://pubs.usgs.gov/circ/1391/pdf/circ1391>.

Sustainability: Water

Video Series. National Science Foundation and NBC Learn, 2013



The National Science Foundation (NSF) and NBC Learn collaborated to produce this seven-part video series that examines significant challenges to managing water supply in selected regions and cities across the United States. Videos feature NSF-funded

scientists from a diversity of fields, geographic locations and institutions. The first video introduces viewers to the water cycle and each subsequent video explains a specific challenge, how this challenge affects the water supply, and how scientific research can help trace a path to a sustainable future. These videos seek to advance public understanding of the impacts of human activity on the long-term health of this essential resource and the need to manage it wisely. All seven episodes are available free for teachers, students and the public at the NSF (<http://science360.gov/series/sustainability-water>) and NBC Learn websites (<http://www.nbclearn.com/water>).

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Shortage Projections May Inspire Changes in Thinking

By Sharon B. Megdal



For almost 20 years, Arizona has been preparing for a shortage on the Colorado River through the Arizona Water Banking Authority (AWBA). As I see it, the Legislature created the AWBA in 1996 for two primary purposes. The first was to put our Colorado River allocation, particularly that portion delivered through the Central Arizona Project (CAP), to full use. The second purpose was, given CAP's low priority in times of shortage, to store water

for the future time when a Colorado River shortage would prevent delivery of subcontract water. This latter purpose had several elements to it, namely firming up or making deliveries more reliable for municipal & industrial uses, Indian water, and some on-river communities in times of shortage. The AWBA was also authorized to perform interstate water banking, which it has, pursuant to agreement with Nevada, and store for water management purposes.

The AWBA, one of the best-kept secrets of Arizona government, has been working diligently. About 3.2 million acre feet (MAF) of Colorado River water have been stored for intrastate purposes, with another 700,000 acre feet stored on behalf of Nevada. The history and activities of the AWBA are well documented on the agency's web site, azwaterbank.gov.

Despite more than a decade of drought in the Colorado River watershed, a Colorado River shortage has yet to be declared. Water stored in Lakes Mead and Powell and one very wet winter a few years ago have postponed a declaration. While researchers have been offering probabilities of shortage for some time, the Bureau of Reclamation's December 2012 Colorado River Basin Water Supply and Demand Study provides a clear reminder that Colorado River flows are expected to be variable. The future gap between water demand and supply was projected for the basin for several scenarios based on data provided by the seven basin states. Arizona's imbalance in demand and supply has itself been documented in the 2011 report of the Arizona Water Resources Development Commission (WRDC) and is projected to reach 1 MAF by 2060.

While Reclamation's Basin Study may have been referred to as a "call to action", a report on Colorado River operations released by Reclamation on August 16, 2013 has been termed a "wake-up call". Based on the methodology agreed to by the seven basin states and adopted by the U.S. Secretary of the Interior, releases from Lake Powell into Lake Mead in 2014 are projected to be 750,000 acre feet less than in 2013 and the lowest release since Lake Powell was filled. This means that we are more likely to reach the trigger point for a shortage declaration, which is a Lake Mead elevation of 1,075 feet. In

fact, the report projects a two percent probability of shortage declaration in 2015, and a 50 percent chance in 2016.

What would a shortage declaration in 2016 mean for Arizona cities and towns relying on Colorado River water? Actually, the water supplies for the cities and towns would not be affected by a shortage of the magnitude envisioned. Those impacted would be farmers and users of what is termed excess CAP water – water under contract to some entity but not actually ordered in a given year. It has been the existence of excess CAP water that has allowed the AWBA to store the water stored to date.

Though the AWBA has stored a significant amount of water for authorized purposes, its activities are not meant to address imbalances between supply and demand identified by the WRDC. Additional strategies are needed. One approach that should be high on our list is matching water quality with the intended use. Why should we be using potable quality water for outdoor uses when lesser quality water can do? Many communities already match quality with use to some extent by reusing effluent for outdoor irrigation. Individual property owner use of harvested rainwater and grey water is another way of reducing demands on potable water supplies.

A more radical change in water utilization would be reuse of highly treated effluent for meeting potable water demands. The investigation and implementation of this once-shunned option is noteworthy. Not only are communities considering indirect potable reuse, where the highly treated wastewater is blended with other waters through groundwater recharge or mixing with surface water, but direct potable reuse is subject to more active discussion. The WRDC report projected the availability in the year 2100 of between .7 and 1.3 MAF of additional reclaimed water.

But has the public gotten over the "yuck factor"? Will Orange County soon be joined by San Diego and El Paso? What about communities in Arizona? We may be observing changes in thinking as we experience extended drought and better understand wastewater treatment technologies. The National Research Council highlighted potable reuse as one of the many options considered in its 2012 report, *Water Reuse: Potential for Expanding the Nation's Water Supply through Reuse of Municipal Wastewater*.

During my annual summer get-away to San Diego, I visited the San Diego Water Purification Demonstration Project. The city whose citizens rejected a "toilet to tap" proposal in the late 1990s has a pilot project that is treating wastewater to very high standards using reverse osmosis and ultra violet/advanced oxidation. This extremely high quality water is being mixed with surface water – of lesser quality actually – in a reservoir and then put through a conventional surface water treatment plant for eventual delivery to customers. The pilot plant was designed for public accessibility; people can easily sign up for a tour. An Independent Advisory Panel has had a key role in this effort.

San Diego's approach should be watched carefully by others, including Arizona communities. It is important to keep our minds open to the full range of water management and utilization options as we consider strategies for meeting future water demands. 



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Plume Activity and Tidal Stresses on Enceladus

M. M. Hedman, C. M. Gossamer, P. D. Nicholson, C. Sotin, R. H. Brown, R. N. Clark, K. H. Baines, B. J. Buratti and M. R. Showalter *Nature*, 500, 182–184 (08 August 2013)

Data obtained by NASA's Cassini spacecraft recorded Saturn's moon Enceladus ejecting plumes of water regularly depending on how close the moon is to its planet. A study published in the journal *Nature*, including significant contributions from UA scientists, reports that the geysers can be explained by the existence of a reservoir of liquid water that is subject to tidal stresses by Saturn's gravity. Because Enceladus's orbit around Saturn is an eccentric ellipse, gravitational pressure varies regularly between compression and tension as the moon orbits the planet. Cassini has been orbiting Saturn since 2004 and uses various instruments to monitor the planet's surface. It first discovered the water geysers in 2005 and later flew the spacecraft through one to determine its contents. Mostly made up of tiny water particles, they also include some organic, carbon-based, molecules. The plumes find their way out through "tiger stripes" that are long deep cracks at the moon's south poles.

The UA team at the Lunar and Planetary Laboratory controls operation of the Visual and Infrared Mapping Spectrometer (VIMS) an instrument aboard the spacecraft Cassini. VIMS detects the plume's brightness. Analyses of its data revealed that the plume is much brighter when Enceladus is at the end point of its ellipse farthest from Saturn than the end point when it is nearest. The article, which appears in *Nature/Letters*, is highly technical; but interested readers can access it at <http://www.nature.com/nature/journal/v500/n7461/full/nature12371.html>.

An Observed Correlation Between Climate Change and Indigenous Peoples in the United States: Impacts, Experiences and Actions

Maldonado, Julie Koppel, Rajul E. Pandya, and Benedict J. Colombi, eds. Special Issue, Climatic Change. Vol. 120, Issue 3, 2013

This Special Issue of *Climatic Change* shines a light on the impacts of climate change on tribal natural and cultural resources across the United States, the first time a peer-reviewed scientific journal has devoted an entire edition exclusively to this important topic. A collaborative effort by over 50 authors representing tribal communities, academia, government agencies, and NGOs, it explores such impacts as loss of traditional knowledge, forests and ecosystems, food security and traditional foods, water, Arctic sea ice loss, permafrost thaw, and relocation. Articles also highlight how tribal communities and programs are responding to the changing environments.

With a long history and deep connection to the Earth's resources, indigenous peoples have an intimate understanding and ability to observe the long-term impacts from climate change. Traditional ecological knowledge and tribal experience plays a key role in developing future scientific solutions to adapt to climate impacts. The research presented in this Special Issue supplements the "Impacts of Climate Change on Tribal, Indigenous, and Native Lands and Resources" chapter in the Third National Climate Assessment, to be released in early 2014. Released on-line on September 15, 2013, this issue of *Climatic Change* is available at <http://link.springer.com/journal/10584/120/3/page/1>. 