

### Evidence of Water Found on Mars

#### UA has role in space mission

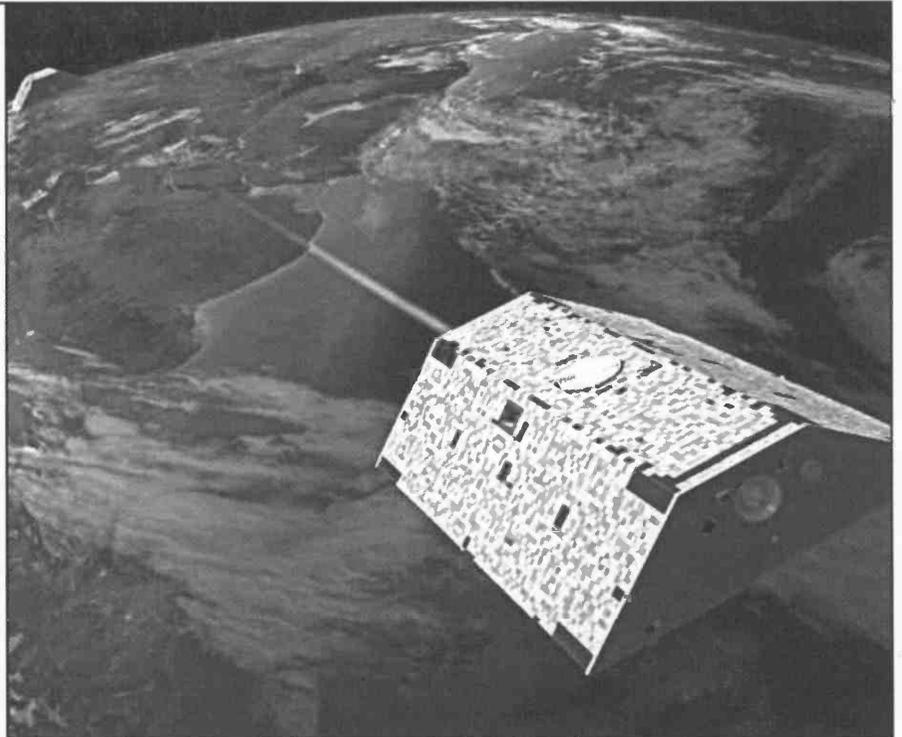
*On Earth we say water is life. On Mars evidence of water shows the potential for life. Scientists therefore have taken special note of recent satellite images showing that water may have existed on Mars for a long enough period of time to create an environment supportive of the evolution of microbial life.*

*The images are the work of the highest-resolution camera ever to orbit Mars, having 30 centimeters per pixel and capable of showing small features, approximately three feet across. Known as the High Resolution Imaging Science Experiment or HiRISE, the camera is on board NASA's Mars Reconnaissance Orbiter. University of Arizona planetary science professor Alfred McEwen is the HiRISE principal investigator*

*Attracting special attention is the area on Mars known as Candor Chasma, a canyon of craggy terrain, with swirls and slashes of ridges and crevices. The terrain is not unlike areas found along Arizona's Colorado Plateau.*

*UA geologist Chris Okubo sees the area's geological patterns with their deep fractures as evidence that liquid, possibly water or gas, once flowed on ancient Mars and penetrated underground. The contrast of light-colored features crossing dark bands seems to*

Continued on page 4



*From divining rod in upturned hands to a satellite in the sky, the technology of locating water has greatly changed. The increased technological sophistication that enables satellites to be used as a water research tool has various payoffs, in outer space and on Earth. Arizona scientists are involved in both kinds of projects. See story at left about a project discovering evidence of water on Mars. For a story about using GRACE satellites to study Earth's water resources, including the resources of the Colorado River Basin, see Special Projects, page 9. Above photo is of the GRACE satellites -- also called Orbiting Twins -- that is sending back data measuring global water storage. Photo: NASA GRACE Mission, University of Texas Center for Space Research.*

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### U.S. Supreme Court to Hear Arizona Case Challenging ESA Primacy

by Joe Gelt

A situation in Arizona is garnering national attention with the U.S. Supreme Court agreeing to hear a pair of consolidated appeals — EPA v. Defenders of Wildlife and the National Association of Homebuilders v. Defenders of Wildlife. The appeals raise the issue whether federal agencies must comply with the Endangered Species Act when implementing other laws.

This is considered a landmark case with national implications and one of the most significant ESA cases to come before the Court in a decade. Oral arguments are expected to begin next month.

At issue is whether the U.S. Environmental Protection Agency erred in 2002 when it allowed Arizona primacy to administer its own storm water discharge program. With state primacy, the National Pollutant Discharge Elimination System program or NPDES became AZPDES. A NPDES or AZPDES permit is required to

Continued on page 2

*Supreme Court...continued from page 1*

discharge wastewater into a navigable stream.

Environmentalists sued EPA arguing that the agency did not consider the effect the transfer decision might have on endangered species. EPA claimed it lacked the authority to consider such impacts.

**Are species protected?**

In taking on what was previously a federal responsibility, the state does not have the same ESA enforcement authority and responsibilities as EPA. When EPA administered the program the agency would consult with U.S. Fish & Wildlife Service about any threat to a species, with the result that a permit might be withheld or mitigating activities required. The state does not confront the same stringent requirements

The 9th U.S. Circuit Court of Appeal agreed with the environmental interests stating, "that the EPA did have the authority to consider jeopardy to listed species in making the transfer decision, and erred in determining otherwise. For that reason among others, the EPA's decision was arbitrary and capricious."

The 9th Circuit Court denied a petition for rehearing, and the original ruling stood; the case was appealed to the Supreme Court.

Michael Ford, an environmental attorney with Bryan Cave says, "The basic issue we hope the court will decide is whether ESA requirements trump those of other laws ... in the face of a program or statute that does not call for it. It is whether the ESA is an overarching piece of regulation that applies to all other environmental laws."

EPA and NAHB argue that Congressional approval for EPA to transfer the permitting authority to the states required that the states meet nine criteria of the Clean Water Act when issuing their permits. The storm water runoff program essentially evaluates CWA compliance. Since ESA compliance is not included among the criteria, they say it would go beyond the law's intent to require it.

**Case has broad implications**

At issue is not just AZPDES; all the other CWA-delegated programs throughout the country could be challenged. Ford says, "A lot of the programs have been delegated since the 70s. The 45 other states, and I don't know how many Indian Tribes, that already have delegation ... could these be challenged if the court rules in favor of the environmental groups on this one?"

Implications could go beyond the CWA to affect other state permitting programs with a federal lineage. If the 9th Circuit ruling were to stand, some lawyers argue it could be applied to state involvement in hazardous waste and federal housing permitting. Other delegated programs such as the Clean Air Act and the Resource Conservation and Recovery Act also could be affected.

By taking the case, the Supreme Court has settled one issue, at least for the time being. If it had refused the case, questions would

**Rapanos Case Muddies Navigable Waters**

When the *Defenders of Wildlife v Arizona National Pollutant Discharge Elimination System* case is decided some fear a possible repeat performance as when the Supreme Court ruled on joint cases of *Rapanos v. United States* and *Carabell v. U.S. Army Corps of Engineers*. The cases addressed the question: Does the Clean Water Act protect wetlands adjacent to small tributaries that flow into larger water bodies?

A plurality of five justices agreed in principle that the EPA and the Army Corps of Engineers misinterpreted the Clean Water Act when they denied permits to developers wanting to build on wetlands a considerable distance from "navigable waters" as defined by the act.

Associate Justice Antonin Scalia wrote the plurality opinion that found that the Corps' "expansive interpretation" of the Clean Water Act was not "based on a permissible construction of the statute."

Associate Justice Kennedy, however, wrote a separate concurring opinion that sharply diverged from the majority by calling on the Corps to consider whether the wetlands in question possess "a significant nexus" with navigable waters.

Some legal experts say the decision raised more questions than it answered about the course of environmental regulations. It set off a series of lower-court battles in efforts to determine its meaning. Some look to Congress to decide the issue by redefining its definition of "navigable waters" under the Clean Water Act, stating clearly which waters and wetlands qualify for protection. Meanwhile the Corps and EPA are expected to issue guidance on the issue.

This is the same court that will rule on *Defenders/AZPDES*, with four justices generally favoring a broad interpretation of environmental laws, four with a strict constructionist view and a swing vote. Some observers refer to *Rapanos* as a "4-1-4" decision.

have been raised about ADEQ-issued permits: which remain valid and for how long and also the status of pending applications. That the court is taking the case means that Arizona will maintain the program, at least until a decision is issued which is expected later this year. ADEQ is still issuing permits.

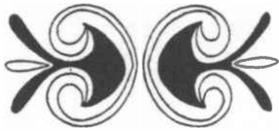
**Other environmental cases**

This is one of this year's Supreme Court cases that court watchers with an environmental interest have followed with special attention as having particular significance in the making of environmental law. In *Rapanos v. United States* the Court addressed the federal government's authority over wetlands. (See above sidebar)

Another case is *Massachusetts v EPA*. Environmental groups faulting the federal government's response to global warming petitioned EPA to regulate carbon dioxide and other greenhouse gases from new motor vehicles. They argued that greenhouse gases are air pollutants and regulated under the Clean Air Act. They cited Section 202 of the act which states that the federal government is to regulate "any air pollutant" that can "reasonably be anticipated to endanger public health or welfare."

EPA denied the petition in August 2003 stating that the act does not authorize the agency to regulate greenhouse gas emissions. And even if it did, EPA said it would not because the link between greenhouses emissions and global warming is not unequivocally established.

The U.S. Supreme Court accepted the case for review on June 26, 2006. The case has not been decided. ■



## Water Vapors

### Water Expo Offers Info to AZ Lawmakers

Water Expo 2007 was a special event to inform Arizona Legislators about water education, outreach and research projects occurring throughout the state and enable them to meet some of the people involved in the activities. Conducted Feb. 27 on the Senate lawn of the Arizona State Capitol, the event provided an informal setting for 55 Legislators and staff members to peruse some of the 40 exhibits.



Photo: Joe Gelt

Exhibitors participating in the event included the Agri-Business Council of Arizona, the Arizona Municipal Water Users Association, the three state universities and Gateway Community College, as well as government agencies at the federal, state and local levels. Legislators got information about research, conservation, water education, environmental enhancement and other water-related issues.

The event also provided an opportunity to express appreciation to Legislators for their support. During the luncheon Kathy Jacobs, executive director of the Arizona Water Institute, thanked lawmakers for supporting the AWI, a collaboration of the University of Arizona, Arizona State University and Northern Arizona University,

### WRRC Conference Marks Anniversary of Environmental Quality Act

Work continues on the Water Resources Research Center's annual conference scheduled June 5 in Phoenix. The title of the conference is, "The 20th Anniversary of the Environmental Quality Act and ADEQ: Assessing and Protecting the State's Water Quality." The event is co-sponsored by the Arizona Water Institute and the Arizona Department of Environmental Quality.

The conference will feature panels on the genesis and history of the Environmental Quality Act and ADEQ; the

Water Quality Assurance Revolving Fund; emerged and emerging contaminants; emerging policy challenges; and the future of ADEQ. ADEQ Director Steve Owens' luncheon presentation will be "State of ADEQ"; former directors will offer their insights. Governor Napolitano has been invited to kick-off the day.

To include your name on a mailing list to receive additional information about the event contact us at [wrrc@ag.arizona.edu](mailto:wrrc@ag.arizona.edu). Check the WRRC web site for conference planning updates.



*Despite the seemingly noncommittal looks on the faces of the gathered dignitaries surrounding Governor Bruce Babbitt as he signs Arizona's Environmental Quality Act, they more than likely are feeling a collective sense of satisfaction, even relief. Why should they not? The debates, negotiations, compromises and voting are over; the bill is to become law.*

established to more fully utilize the water expertise of the three faculties.

Charlene Saltz of Maricopa County Cooperative Extension organized the event. She says, "I think overall the event was a success. ... A lot of people were milling about and having good conversations. From the exhibitors perspective it was a good networking opportunity; the Legislators had a chance to stop and learn more about water

issues in our state."

The event was sponsored by the University of Arizona's Water Sustainability Program, with support from UA Cooperative Extension, the Central Arizona Project and the Salt River Project. (The Water Resources Research Center along with three other UA water centers make up the Water Sustainability Program.) This was the third year for Water Expo.



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## News Briefs

### NM Plans Major Adjudication Proceedings

Over 20 years after Arizona commenced its adjudication proceedings, its neighboring state, New Mexico, is taking steps to begin adjudicating water claims on the Middle Rio Grande.

The amount of river water that the city of Albuquerque, thousands of farmers and six pueblos each use as it flows through Middle Rio Grande Valley is unknown, although total depletions are about 405,000 acre feet per year. Drought and population growth add to the urgency to settle water claims on the Middle Rio Grande. Concerns about endangered species and water deliveries to Texas further urge action.

Most water rights in New Mexico have not been adjudicated. The need to adjudicate has become especially apparent in the Middle Rio Grand Valley where rapid population growth is straining water supplies, and water right disputes threaten to lead to legal actions. Thousands of water rights in the area cannot be enforced until they are adjudicated by the courts.

Indian water rights along the Middle Rio Grand are the oldest and most senior rights, held by six pueblos: Isleta, Santa Domingo, Cochiti, San Felipe, Santa Ana and Sandia. Settling these claims is key to quantifying all the other rights in the Middle Rio Grande. The Middle Rio Grande Conservancy District is the other dominant right holder in the area providing water to thousands of farmers and other users.

Three bills are before the New Mexico Legislature that would help get the adjudication process off the ground. One bill would establish a "pre-adjudication bureau" to do some preliminary work before the actual adjudication. Another bill would appropriate \$7 million to conduct a hydrographic survey needed for the process; the third bill sets aside \$30 million for adjudication proceedings.

Meanwhile Arizona's adjudication, in process now for over 20 years, is being criticized that it is not working. At a fall University of Arizona College of Law water conference, Joseph M. Feller, Arizona State University law professor, delivered a paper titled, "The Adjudication That Ate Arizona Water Law."

In other New Mexico water news, Governor Bill Richardson declared 2007 as the "Year of Water." His \$100-million package of water initiatives sets an ambitious water agenda unique among arid, drought-weary western states.

### Water Bills Proposed for Legislative Session

A number of water-related bills are making the rounds in the Arizona Legislature. House Bill 2693 essentially allows cities and counties outside Active Management Areas to require a determination by Arizona Department of Water Resources that a proposed subdivision has an adequate water supply before approval. Senate Bill 1575 contains the same provisions as HB 2693 except with an amendment that a unanimous vote by the county board of supervisors is

### Californians Go to the Beach

There's nothing like a day at the beach. A peaceful snooze in the sunshine on white sands, some sandcastle building, a little swim through the raw sewage, rocked by warm waves of concentrated fecal bacteria...

*The above was the lead to a Jan. 28 Los Angeles Times editorial critical of health officials for not providing adequate notification about beach conditions.*

required to adopt local water adequacy requirements.

Similar legislation seeking to empower rural areas to enforce adequate water supplies have been introduced in the Legislature over the past four years without success.

HB2692 creates a Water Supply Development fund to provide financial assistance to rural water providers to develop resources and infrastructure. Funds would be limited to water providers located within a county or municipality that has adopted adequate water supply requirements for new subdivisions. Enactment of the loan fund bill is contingent upon enactment of the adequacy bill.

Other water-related bills heard in committee include: HB2494, establishing a grant fund to encourage water conservation projects in schools and HB2496, encouraging partnerships between utilities and schools for supporting water-or-energy conservation programs.

Water bills not heard in committee include: HB2534, requiring cities to meet a 25 percent water use reduction by 2020; HB2582, requiring new homes larger than

### Water on Mars...continued from page 1

*show the chemical alteration of rock caused by the flow of fluids. The fluids would have had to been present for a long period of time for this geochemical processes to take place. Erosion over millions of years then exposed the mineralization that occurred along the underground faults and fissures and that now show in the HiRISE images.*

*Protected from radiation and atmospheric hazards, the underground rock could have provided a sheltered environment for microbes to develop.*

*Scientists are also using another satellite tool for studying the surface of Mars for evidence of water. Okubo describes CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) as "sort of a companion instrument*

*to HiRISE." CRISM is a spectrometer that splits visible and near-infrared light of its images into hundreds of "colors" that identify minerals, especially those likely formed in the presence of water. It can focus on relatively small surface areas of Mars, not much larger than a football field on Earth.*

*Okubo says CRISM is used to determine the chemical composition of the ground surface. "Using both those data sources we can look at areas where there are some sort of alterations, alterations most likely due to water flow, and try to work out what was the chemistry of the fluids."*

*The HiRISE Operations Center at the UA Lunar and Planetary Laboratory is responsible for the majority of the ground data system work for the HiRISE instrument. Observation planning, uplink, downlink, data processing, and instrument monitoring are all performed at HiROC.*

## Award-Winning ASU, UA Student Water Projects Show Expertise, Initiative

### ASU Students Develop and Plan to Market Atmospheric Water Generator

An Arizona State University team of students has won several entrepreneurial competitions for its water resource product; they now hope to reap rewards by marketing it in Africa.

It is an interdisciplinary team made up of engineering and business graduate students and a religious studies graduate student. The six students, Lionel Metchop, Wahid Dejjakh, Ronald Gahimbare, Usaju Lemiso, Nnditsheni Madavha and Chris Ndungutse, all members of the ASU African Students Association, developed an atmospheric water generator.

The students organized a company in September called Watel Solutions — they combined “water” and “electricity” to come up with Watel — to market the product and entered the ASU Technology Entrepreneurship Challenge.

Sponsored by Intel Corp., the competition invited students with business proposals based on emerging technologies developed through research at ASU. Watel Solutions beat out eight other teams from ASU’s Ira A. Fulton School of Engineering and the W. P. Carey School of Business for first place and a \$20,000 award.

Working with engineers at Alter-Air Corp. in Tempe, the students developed the Watel40, an atmospheric water generator, based on a modification of existing technology that produces drinking water from humidity in the air. Humid air circulating through a coil cooled by a refrigerant cause the moisture to condense. Stored in a tank the water is then treated to kill any harmful bacteria by being pumped through a charcoal filter and an ultraviolet light chamber.

What sets Watel40 apart from other such devices is its energy efficiency; it is able to produce up to 40 gallons of water using a single kilowatt of energy.

### UA Students’ Water Harvesting Project Intended as Part of a Broader Effort

University of Arizona students are encouraging water conservation at the university by building a water harvesting project to demonstrate its water-saving potential. The innovative project makes the case that water harvesting techniques offer potential savings for the overall water budget of the university and the city of Tucson.

PARASOL, a student organization stressing sustainability, initiated the water harvesting project and worked with James Riley, associate professor of the Department of Soil, Water and Environmental Science in the College of Agriculture and Life Sciences.

PARASOL President Emilie Brill-Duisberg says the project does not break any new technological ground but relies on standard water harvesting techniques. She adds, “What is innovative about [the project] is the level of collaboration it took to get it done. We had students, faculty and staff all working together ... dealing with part of the physical campus. That was very unique.”

Work on the project led the students to take on a broader rainwater harvesting study. Brill-Duisberg, who majors in anthropology and environmental science, says, “We are mapping the water harvesting potential across the entire UA campus. We see it as a continuation. Whatever map we produce will be a good reference tool for anyone who wants to complete further water harvesting projects.”

Brill-Duisberg’s work on the project earned her a national award: the Association for the Advancement of Sustainability in Higher Education awarded her the Student Sustainability Leadership Award. AASHE presents only one such award each year.

The work was partially supported by Section 104B funds from the Water Resources Research Act, funded by the U.S. Geological Survey, and awarded by the UA Water Resources Research Center.

2,500 sq. ft. to include water harvesting equipment; and SB1113, requiring new homes to have low-water use yards.

### Options Discussed to Protect Upper Verde River

Lively discussion continues in the Prescott area over ideas for increasing recharge into the Big Chino aquifer as a strategy to protect the flow of the Upper Verde River. American Rivers, a conservation organization, listed the Verde River as the 10th most endangered U.S. river last year due to plans for a 30-mile pipeline to draw groundwater from the Big Chino aquifer to deliver to rapidly-developing Prescott and Prescott Valley. Studies indicate that the aquifer provides about 80 percent of the base flow into the upper Verde River.

Pumping plans are proceeding, with Prescott having purchased a Big Chino ranch and hired consultants to design a pipeline. As much as 8,700 acre-feet could be pumped from the Big Chino aquifer to deliver to the Little Chino aquifer.

To protect the flow of the river, the Upper Verde River Watershed Protection Coalition was formed, made up of Yavapai County and the municipalities of Prescott, Prescott Valley, Chino Valley and Dewey-Humboldt.

Proposals that the coalition are considering for supplementing Upper Verde groundwater include buying and protecting land areas recharging into the aquifer, water conservation projects, recharging the two aquifers with wastewater, reducing or removing vegetation in areas overgrown due to a policy of wildfire suppression, constructing

flood detention structures and monitoring groundwater use.

Some have questioned the stated intent of the coalition, to protect the flows of the Upper Verde River, saying it should be doing more to reduce demand for Big Chino groundwater.

The coalition seeks a total of \$200,000 from its members to use during the first year to analyze the project.

Other responses to the pipeline include a threat of a law suit by the Center for Biological Diversity to halt the project. Also proposed is that council write up a mitigation plan as part of an environmental impact study and request an “incidental taking” permit from the U.S. Fish and Wildlife Service. An applicant would then be allowed to create habitat conservation plans to reduce the project’s impact on wildlife.



## Guest View

# A Sierra Vista/Cochise County Water Authority Needed to Meet Sustainability Mandate

## *Legislation In Works to Create Upper San Pedro Water District*

*Carol Sanger, Executive Director, Upper San Pedro Partnership, contributed this Guest View.*

The residents of the Sierra Vista Subwatershed have a difficult challenge — achieve sustainability in the Sierra Vista Sub watershed by September 2011 or lose their economic engine, Fort Huachuca, and very likely the beautiful, San Pedro Riparian National Conservation Area (SPRNCA). This is because the residents are ultimately responsible for meeting the 2011 deadline affirmed by Congress in the Defense Authorization Act in 2004.

In 1998, a core group of organizations and agencies created the Upper San Pedro Partnership, binding themselves to “assist in meeting the water needs in the Sierra Vista Subwatershed...” From this, a 21-member consortium emerged, one that has been successful in securing federal funding to inform itself and others about the scientific nature of the problem so that member agencies might undertake appropriate management measures, develop reuse and recharge options, and reduce groundwater pumping.

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*Remaining project options are large and complex and cannot be achieved within the current levels of delegated authority by the State.*

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The Partnership has many accomplishments to its credit. It has identified sensitive hydrologic locations appropriate for recharge and protection from development. Collaboration with U.S. Geological Survey and the University of Arizona’s SAHRA Institute has resulted in a state-of-the-art groundwater model and a companion user-interface Decision Support System. Dry wells, detention basins, toilet rebate programs, business conservation grants and Water Wise, the conservation outreach effort of the UA’s Cooperative Extension, are examples of ongoing Partnership programs.

A current project will reduce groundwater pumping by over 500 acre-feet per year through the transfer of treated effluent from Bisbee to water a golf course in Naco. In the fall, Huachuca City will start work on its wastewater ponds, building a pipeline to Fort Huachuca so that its treated effluent can be reused or recharged. The Partnership has developed a model water conservation ordinance, supported the County’s Water Overlay District that requires a high level of water conservation in new development.

Since 2002, these efforts have reduced the deficit in water budget terms by over 60 percent but they are not enough. Sustainability can only be achieved by moving water around within the basin or

by importing it from outside. Remaining project options are large and complex and cannot be achieved within the current levels of delegated authority by the state.

In 2005, the Partnership entered into an agreement with the U.S. Bureau of Reclamation to conduct an appraisal level study of 12 augmentation alternatives. After many months of meetings, the Partnership accepted its work group’s recommendation of three preferred alternatives. These are: capturing stormwater for reuse and/or recharge in an urbanized area of Sierra Vista; dewatering Bisbee’s Copper Queen Mine, treating and transporting the water to recharge or reuse near the SPRNCA; and seeking a Central Arizona Project allocation when the distribution is re-opened for negotiation which would require an extension of CAP from its terminus in Tucson into Cochise County.

Apart from the obvious cost, complexity and political sensitivity of these options, neither the City of Sierra Vista nor Cochise County has the authority to develop, own or operate this kind of infrastructure. This is the urgent issue that the Upper San Pedro Water District legislation seeks to address.

The issue of local water management authority has been identified in the Partnership’s annual report to Congress as a known legal impediment since 2004. It is widely recognized by civic leaders that without authority to develop and maintain water infrastructure, the congressionally mandated goal of sustainability cannot be achieved by 2011 and the loss of Fort Huachuca and the SPRNCA are likely.

At this writing it is too early to predict the chances for passage of this legislation, or what changes may be negotiated to create the district. If the Upper San Pedro Water District is established this legislative session, then what will be its relationship with the Partnership? How will it build on our tradition of using the best available science to inform decision making? There are many unknowns.

As the bill works its way through the legislative process, the Partnership stays focused on the goal of achieving sustainability in the subwatershed. We have not lost sight of the SPRNCA and how urgent it is to keep the San Pedro River wet. With over 350 species of birds nesting, migrating and wintering in the region, the SPRNCA has hemispheric importance. Nor have we lost sight of the economic impact of Fort Huachuca — \$1 billion locally, \$2 billion statewide. Our verification and monitoring activities continue. We are pursuing opportunities for conservation easements, supporting action by member agencies on conservation ordinances and overlay districts, and working hard to increase resources for residential and local business conservation programs.

2011 is only 42 months away! 🏗️



## Legislation and Law

### New Law Refocuses Efforts From Drought Coping to Preparedness

*AZ's Drought Efforts Compatible With Law's Intent*

Officials burdened by drought worries can look forward to assistance from legislation passed last year establishing the National Integrated Drought Information System. Arizona may be in position to especially benefit from the new law, as a Colorado River Basin state and as a forerunner among states in building hydrologic databases.

Located within the National Oceanic and Atmospheric Administration, NIDIS is to boost national drought preparedness by creating reliable and timely drought forecasts and assessments to assist decision makers prepare for anticipated droughts.

Kathy Jacobs, executive director of the Arizona Water Institute, who formerly served on the Governor's Drought Task Force executive committee, says, "The act is going to do something different. Historically there has been almost no investment at the federal level in preparing for drought; it has all been after-the-fact response. The purpose of [NIDIS] is to have better observing systems, better early warning systems, so the impacts are not as great in the first place."

"Integrated" is the key word. Much drought work has been done throughout the country, with information gathered, studies conducted and drought and emergency plans implemented, at various levels: local, state, regional and national. What has been lacking and sorely needed are the means to gather and organize this information or, in other words, integrate it, so that it can be accessed by those who could use it. In brief, the intent of the law is to share drought information and enhance preparedness.

Or as stated in the language of the law NIDIS shall provide a drought early warning system that "is a comprehensive system that collects and integrates information on the key indicators of drought in order to make usable, reliable, and timely drought forecast and assessments of drought, including assessments of the severity of drought conditions and impacts."

Integrating drought information among all interests will be formidable task, calling for the participation of wide range of units, organizations and agencies across the nation. Consider just the varied federal agencies to be involved: NOAA, Department of Agriculture, Army Corps of Engineers, Bureau of Land Management, Bureau of Reclamation, Geological Survey, the Environmental Protection Agency and National Aeronautics and Space Administration.

Jacobs believes Arizona, having greatly invested in building hydrologic databases, has something important to offer NIDIS. Significant drought preparedness work has been done in the state, particularly by University of Arizona researchers Gregg Garfin and Mike Crimmins. The drought monitoring systems they have developed for stakeholders would have broad application to NIDIS efforts.

Arizona also has other drought preparedness achievements.

More personnel participate in its statewide drought program than in any other state drought effort in the nation. Arizona also is unique among states in organizing local drought impact groups with strong participation from Cooperative Extension and the universities. Further, state law requires all water systems to work out plans for conservation, drought and water supply.

Some officials believe Arizona's commitment to drought planning might qualify the state to conduct a NIDIS demonstration project, possibly a project coordinated with other Colorado River Basin states. The Colorado River Basin will likely be a priority drought study area. ■

### Bill Seeks "Wild and Scenic" Designation for Fossil Creek

Legislation was recently introduced to designate Fossil Creek a "wild and scenic river." The designation would be a significant achievement for a river that only recently had its full flow restored when the Arizona Public Service Company decommissioned its Childs-Irving Hydroelectric Project in 2005.

Rivers recognized by the Wild and Scenic Rivers Act are protected from any "new hydropower projects, federal water projects, and other federally assisted water-resource projects — defined as grants licenses, permits or funding — that would alter the rivers free-flowing characteristics or have a direct effect on the river's outstanding resources."

The wild-and-scenic designation would protect the creek's hard-won gains. Designations of wild-and-scenic rivers require congressional action on a case-by-case basis. The only wild-and-scenic river now in Arizona is a 40-mile designated reach of the Verde River, a river with the dubious distinction of having also been identified as one of U.S. most endangered rivers by American Rivers.

Located in the Mogollon Rim country, Fossil Creek provides habitat for several rare desert fish species. The Yavapai-Apache Tribe also supports the designation; the watershed has tribal spiritual sites as well as hunting and gathering grounds.

Until recently a legal controversy complicated efforts to designate Arizona rivers as wild and scenic. Before a river could be designated, secure water rights were needed to protect the river's instream flow. The Arizona's Department of Water Resources' ability to recognize and grant instream flow rights, however, was legally challenged by Phelps Dodge.

The case ended up in the Arizona Supreme Court that ruled against the mining company in March 2006. This decision smoothed the way for obtaining WSRA designation for Arizona rivers such as Fossil Creek.

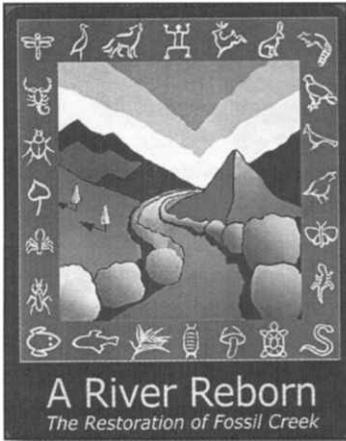
A step along the way to a WSRA designation is for a river to be listed in the Nation River Inventory. Maintained by the National Park Service, the NRI is a national listing of potentially eligible river

*Continued on page 12*



## Publications & On-Line Resources

### Fossil Creek Has Starring Role in River Restoration Film



ally critical watershed. Viewers get a behind-the-scenes view of a 15-year struggle over the future of Fossil Creek as environmen-

**A River Reborn: The Restoration of Fossil Creek**, a public television documentary, is the story of students, scientists, environmental advocates and businesses working together to return a creek to its natural conditions. Produced by Northern Arizona University and the Museum of Northern Arizona, the documentary covers the decommissioning of Arizona's first hydroelectric dam and the restoration of a biologi-

tal advocates and a major utility work out differences to achieve a stunning environmental success story. Also playing a major role in the story is a group of NAU scientists.

More than just of local interest, the Fossil Creek story is shown to be a significant development in current U.S. river affairs.

Rivers and dams are being reassessed throughout the country. Fossil Creek presents both the challenges and opportunities of river restoration. Also highlighted is the critical role of science in restoring native fish populations in Fossil Creek and in environmental restoration projects generally. Study and resource guides are available for use with the documentary in various educational settings.

*A River Reborn* is produced by Emmy Award-winning producer Paul Bockhorst and narrated by Ted Danson. The one-hour DVD can be purchased for \$19.95 at <http://www.mpcer.nau.edu/riverreborn/>

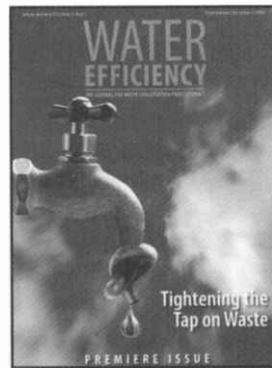
### Adaptive Governance and Water Conflict: New Institutions for Collaborative Planning

John T. Sholz and Bruce Stiffler, editors; 300 pp.; \$60 hardback, \$23.96 paperback; for ordering information contact Resources for the Future Press, [www.rffpress.org](http://www.rffpress.org)

This book investigates new types of water conflicts among users in the seemingly water-rich Eastern United States. Eight case studies of water quality, water quantity, and habitat preservation or restoration in Florida were chosen to span the range of conflicts crossing fragmented regulatory boundaries. Each begins with a history of the conflict and then focuses on the innovative institutional arrangements — some successful, some not — that evolved to grapple with the resulting challenges. Scholars and practitioners in urban planning, political science, engineering, law, policy, administration, and geology then offer different theoretical and experience-based perspectives on the cases.

### EPA Watershed Restoration Guide

*The Handbook for Developing Watershed Plans to Restore and Protect Our Waters* is a resource to help communities, watershed organizations, and local, state, tribal, and federal environmental agencies develop and implement watershed plans to meet water quality standards and protect water resources. The document is structured so that it can be followed step by step through the watershed planning process. A free copy can be obtained from the National Service Center for Environmental Publications at 800-490-9198 or by e-mail, [ncepimal@one.net](mailto:ncepimal@one.net). When requesting a copy, refer to EPA document number: EPA 841-B-05-005. Handbook can be download at: [http://www.epa.gov/owow/nps/watershed\\_handbook/](http://www.epa.gov/owow/nps/watershed_handbook/)



### New Water Efficiency Publication

*Water Efficiency*, The Journal for Water Conservation Professionals, is a new publication for persons professionally involved with maximizing water efficiency.

Published bi-monthly, its first issue was September/October. Complimentary subscriptions are available to qualified professionals; current and past issues are available at the web site: <http://www.waterefficiency.net/we.html>. Also check the web site for subscription and other information.

### Arizona Water Policy, Now in Paperback

*Arizona Water Policy: Management Innovations in an Urbanizing, Arid Region* is now available in paperback. Edited by Bonnie G. Colby and Katharine L. Jacobs, the publication provides a broad perspective of the multifaceted water supply/population growth dilemma. What water resources are available to Arizona? What historic, economic and social conditions have determined state water policy? What institutions have been devised to enable Arizona to more efficiently manage its scarce water resources? These are some of the major questions the 15 articles or chapters within the volume discuss. The paperback edition is 39.95 and is available from Resources for the Future Press. Check its web site: [www.rffpress.org](http://www.rffpress.org)



## Special Projects

# Twin Satellites Measure Water Storage Change in Colorado River

*Researchers seek to apply GRACE's big-picture data to region, subregion*

A perennial quest of hydrologists is determining water availability for water resource planning and management purposes. If hydrologists, for example, could better predict Colorado River flow, the job of dividing its waters among seven states and a foreign country, often a troublesome and contentious issue, might go more smoothly.

The Gravity Recovery and Climate Experiment is providing hydrologists a new tool that some day might help them predict the availability of water supplies: a pair of satellites is sending back data measuring water storage over large areas of the globe. The next step is to find ways to apply the data on a smaller scale. Researchers, including some in Arizona, are working at this task.

GRACE data is the result of team work performed by twin satellites measuring changes in the Earth's gravity field. In March 2002, the two satellites were launched in the same orbit about 700 kilometers above the Earth's surface, with one following the other at a distance of about a few hundred kilometers.

Radio signals emitted from the second satellite are transmitted back from the first, with the signal's travel time a measure of the distance between the two satellites. This distance is a vital indicator of the land mass below, whether it is solid and dense or whether it has changed its density due to water storage.

The lead satellite will experience a stronger gravitational pull when flying over a dense land mass because gravity is related to mass. This will cause the satellite to travel faster increasing its distance from the second satellite which is not yet feeling the effects of the land mass. When the first satellite flies over land of lesser density, it will travel slower decreasing the distance between the two satellites.

By tracking the distances over time between the two satellites, which is constantly changing as they circle the Earth, scientists are able to reproduce the changes in the gravitational field from one month to the next. Such changes are mainly related to water storage, including water stored in rivers, lakes and reservoirs or as snow and ice in floodplains or as subsurface water in soils and aquifers.

Not only can researchers figure out the amount of water stored, but GRACE's five-year data record enables them to estimate water storage variations over time in more than 50 river basins, including the Colorado River Basin. They can also distinguish between long-term trends and seasonal variations. The basins cover most of the Earth's land surface.

Peter Troch, University of Arizona hydrologist, is using GRACE data to infer water storage changes in the Colorado River

basin. He is attempting to interpret differences between the upper and lower basin to get the big picture. The lower Colorado drainage basin includes most of the state of Arizona. The entire Colorado River Basin covers 637,000 kilometers.

Troch explains that a fundamental hydrological equation is the water balance of a river basin. On one side of the equation is precipitation, the rain or snow that falls in the basin; this is input that increases storage. Part of the precipitation will evaporate; some will

runoff and discharge into the river. This is output. Depending upon whether input or output is greater determines water storage in a basin during a particular month, whether it increased or decreased.

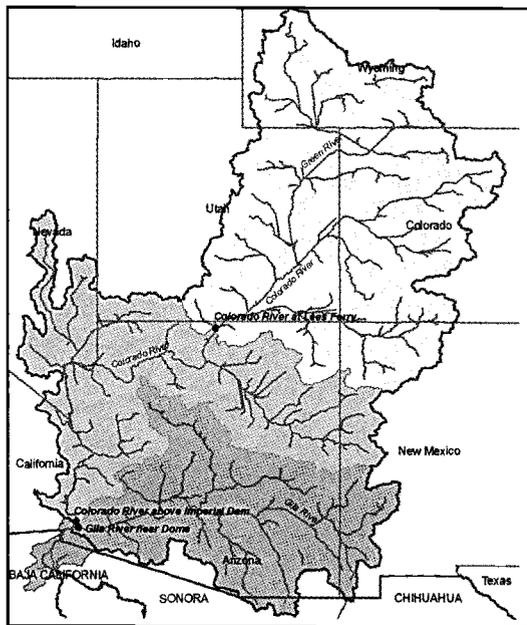
Troch explains the present difficulty of measuring input and output at the large scale of the Colorado River basin, an area that includes seven states. He says on-the-ground rain gauges do not do the job. "Think of the snow that falls on the top of Rocky Mountains where there are no stations. We don't measure that. The same is true for evapotranspiration. It is done only at a few points in the landscape.

"With GRACE you have

a direct measurement of the storage changes; therefore you can better estimate what is going on in the basin in terms of the fluxes."

Using gravity to determine water storage changes is not a new technique. Don Pool of the Tucson office of the U.S. Geological Survey has conducted in situ gravity monitoring since the 1980s in various areas of the state, including Tucson and Avra Valley. Absolute gravity is regularly measured at various locations that are part of a monitoring network. Gravity changes that occur are then related to storage changes in the subsurface. This allows hydrologists to focus at the local level. Pool says GRACE researchers have expressed an interest in comparing the ground-based measurements with GRACE data.

GRACE is capable of measuring differences within a centimeter of water stored on the land surface or the subsurface. This accuracy, however, applies only to large areas, 100,000 to one million square kilometers. GRACE's specialty is the big picture, its accuracy greatly diminishing at smaller scales. Troch says, "What GRACE is



*Colorado basin and river network*



## Announcements

### Project WET Tucson Workshops

Arizona Project WET, (Water Education for Teachers) a program of the Water Resources Research Center and the Arizona Cooperative Extension, announces its Tucson workshops. The workshops are designed for educators and agency personnel. The dates and locations of Tucson workshops are: Mar. 10, the Tucson Water Department; April 14, a "Healthy Water, Healthy People" Workshop, Aqua Caliente Park; and June 18 - June 19, a two day, "Discover a Watershed: The Colorado" Workshop, Central Arizona Project Office, Marana. For additional information contact: Josie Tanner [josie@cals.arizona.edu](mailto:josie@cals.arizona.edu) or 520-792-9591 ext. 27 or Nishita Agarwal [nishita@cals.arizona.edu](mailto:nishita@cals.arizona.edu) or 520-792-9591 ext. 26 or check the web site: <http://cals.arizona.edu/azwater/wet>

### Climate and Riparian Areas Workshop, April 11 - 13

Join leading scientists and educators to learn more about emerging climate and riparian area ecology research at the Case Grande workshop "Connecting the Dots— Climate Change/Variability and Ecosystem Impacts in Southwestern Riparian Areas." The workshop provides participants the opportunity to interact with scientists to help create practical tools for natural resource managers, decision-makers and practitioners, as well as a forum for training, education and discussion regarding climate variation and its impacts on Arizona riparian areas. Full agenda and registration information

is available at: <http://cals.arizona.edu/gila/naturalresources/Riparianpage.html> or <http://azriparian.asu.edu/2007/registration.htm>

### Arizona Water Protection Fund

The Arizona Water Protection Fund Commission is initiating its FY 2008 grant cycle on Mar. 12. The Commission provides funding for projects that directly maintain, enhance and restore river and riparian resources; implement innovative river and riparian research; and implement water conservation measures or programs outside the five Active Management Areas. Anticipating that approximately \$4 million will be available for grant awards, the Commission will be accepting applications under all funding categories (capital, research and water conservation).



The FY 2008 Grant Application Manual can be downloaded from the AWPf web site at: [www.awpf.state.az.us](http://www.awpf.state.az.us) beginning Mar. 12. To have a copy mailed to you, contact Mary Lou DeLeon or Michelle Moreno at 602-771-8528. Check web site for information about workshops to be held in Phoenix, Tucson, Flagstaff, Show Low, Sierra Vista, Lake Havasu, Prescott and Safford.

Grant applications will be due no later than June 13. The Commission will make grant award selections on Oct. 15.

#### *Satellites Measure Basin...continued from page 9*

capable of doing is measure over large regions the changes of storage of a vertical column of water from groundwater to the surface at scales of, say, the Colorado River Basin or the state of Arizona."

This greatly limits GRACE's application. Hydrologists generally focus on the regional or subregional, not so much on the global. For example, GRACE would not be very helpful to hydrologists concerned with the flow of the San Pedro or Verde rivers. A priority task of GRACE researchers is to work out applications on a smaller scale where it would be of more direct use to hydrologists.

Troch work's is breaking ground in this direction. He is studying the different components that make up changes in water storage in a catchment area. Using hydrological modeling he has been able to interpret GRACE's signals to partition incoming rainfall, whether released into the atmosphere through evaporation or stored in the soil and the aquifer.

He says, "If we take that work further we would probably be able to say something about aquifer storage, but at larger scales. We can't zoom in, for example, to the Tucson basin or see what happens in the Phoenix area."

The question then remains: Can GRACE data be used to assist hydrologists in their quest to determine available water supplies? Will Bureau of Reclamation officials be able to use the data to better allocate Colorado River water. GRACE would be making a major contribution to that effort if its data enabled Reclamation to improve estimates of water availability over the next six months to a year.

Troch says, "We are still a long way from [establishing] a direct link between GRACE-derived estimates of storage change and something the Bureau could use for planning. ... The next step is to see if we can take the signal and disaggregate it into its different fluxes and hopefully also its different components, like surface storage, soil water storage, groundwater storage, snow; all these different things need to be figured out."

"It will take some years to convince first ourselves and then stakeholders that they can actually start using it. But it is a matter of time; ten years ago no one paid attention to information such as El Niño and La Niña. Now the scientific evidence of links between those signals and water availability has grown."

Part of Troch's research is funded by the University of Arizona's Water Sustainability Program Technology and Research Initiative Funds. 



## Public Policy Review

by Sharon Megdal

### WRRC Strives to Provide Useful Outreach — Do we serve your needs?



I was recently in Washington for the annual meeting of water center directors from across the country, and I participated in a panel on outreach. My assignment was to describe the Water Resources Research Center outreach efforts and offer some thoughts about what makes an effective outreach program. As I organized my comments, I thought to Google “outreach” to see what

comes up. The website [www.thefreedictionary.com](http://www.thefreedictionary.com) provided two definitions, with the first laughably obvious: (1) The act or process of reaching out; and the second with more substance: (2) A systematic attempt to provide services beyond conventional limits, as to particular segments of a community.

High on the list of search results were comments on the Continuing Education portion of the University of Colorado at Boulder web site. Here the term outreach is used “to describe the various ways in which the University extends its expertise for the direct benefit of Colorado communities and other external audiences.” The site goes on to state: “Outreach has traditionally been considered a service activity. However, within a research university, outreach can occur as scholarship that cuts across the University’s teaching, research and creative work, and service missions. Successful outreach is rooted in scholarship and highlights faculty expertise. It draws on knowledge developed through other forms of scholarship and contributes to the knowledge base. Further, federal research agencies such as NSF and NASA increasingly insist that investigators make the outreach component of their research explicit. Outreach activities provide reciprocal benefits to both the community and the academy.”

Outreach is a fundamental to everything we do at the WRRC, a research and extension unit within the UA College of Agriculture and Life Sciences. Extension and outreach are not synonymous, but they do go hand in hand. As I see it, outreach is a two-way process involving various kinds of expertise and activities. Whether I am in the field making presentations or attending meetings, I am gathering, as well as sharing, information and perspective. In addition, outreach is not separable from research and/or teaching. All can be complementary activities. My work may be helpful to practitioners and policy makers, and what I learn from them can help define research and writing projects. I call on experts from the “real world” to review reports and papers and to provide guest lectures in my graduate course in Arizona water policy. I reach out to them for their expertise. Others reach out to me to gain mine. It is all about sharing knowledge and improving understanding.

Effective outreach takes time, a commodity in short supply for many of us, and requires that we be responsive and accessible. We are responsive when we reply to requests from the media or the public. A response also might be working with a potential project partner to design a study or project to meet its needs as well as

WRRC’s programmatic objectives. To be accessible is important as well. WRRC is fortunate to have a location slightly off campus; individuals from the community have easy access to us.

Effective outreach also requires “vehicles,” and the WRRC is fortunate to have several vehicles or outlets. This newsletter is one of our best vehicles. This column provides me an opportunity (with deadline!) to communicate with readers and invite feedback. The *Arizona Water Resource* newsletter provides broad coverage of water affairs and issues. Reaching out is prime activity of newsletter editor Joe Gelt when preparing the publication. After a five-year hiatus, we recently published an *Arroyo* newsletter on artificial recharge. Examining the role of artificial recharge in meeting water policy objectives is a focal point of my research. This single-issue newsletter format is one we will increasingly use for outreach.

Our annual conference provides participants an opportunity to learn and discuss. We try, when appropriate, to join with others in developing the conference program. Participating in Water Expo at the Capitol on Feb. 26 provided an opportunity to reach out to our Legislators. Our brown bag seminar series offers additional opportunity for two-way dialogue and for community-university interaction. We focus on topics we believe to be of broad interest to academics from multiple disciplines and members of the water community. We showcase basic research as well as “real-world” happenings.

An oft used outreach vehicle is the Internet, and we at the WRRC endeavor to make effective and extensive use of our web site, now being redesigned, as part of our outreach effort. We post papers and presentations and link to many other water sites. Of course, conference and community presentations are an essential part of effective outreach.

Outreach may be accomplished through vehicles created for a specific purpose. In partnership with the Water Education Foundation, for example, we are writing a *Layperson’s Guide to Arizona Water*. The Southern Arizona Leadership Council is our partner in developing a fall 2007 Tucson regional water forum. This may take the form of stakeholder meetings focused on a research project. This list of vehicles is long.

Outreach requires “outreachers,” preferably people who like to reach out and interact. To effectively reach out requires hard work and careful planning. Our limited financial and personnel resources means we must be strategic in our outreach, not duplicating what others are doing. It means taking the initiative and seizing available opportunities to deliver needed projects or programs.

I will close this column by reaching out to you and asking you to help the WRRC be a more effective outreach by sharing your thoughts. How can we better reach out? What projects do you want us to consider undertaking? Effective, two-way communication is essential to effective outreach. Call me at 520-792-9591, ext. 21 or email me at [smegdal@cals.arizona.edu](mailto:smegdal@cals.arizona.edu). I thank you in advance! 📧

*Fossil Creek...continued from page 7*

segments. To be listed in the NRI a river segment must be free-flowing and have one or more "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance. For a list of Arizona river segments included in the NRI check: <http://www.nps.gov/rtca/nri/>

American Rivers lauded the Fossil Creek wild-and-scenic effort as meeting the organization's "40x40 Challenge." The goal of the challenge is to designate 40 new wild rivers by the 40th anniversary of the WSRA in 2008. American Rivers calls Fossil Creek "one of the best remaining free-flowing desert streams in America." Along

with Arizona, Massachusetts also is seeking approval this session for WSRA designation of a river. Connecticut and Oregon also are expected to introduce legislation to protect rivers in their states.

According to American Rivers 165 rivers comprising 11,358 river miles are in the system, with at least 3,400 other rivers meeting criteria for designation under the law. In the past five years nine rivers have been designated.

The restoration work at Fossil Creek, much of which was done by Northern Arizona University researchers, is the subject of a video documentary produced by NAU in collaboration with the Museum of Northern Arizona. See Publications, page 8, for information about the video. 

### Time to Think About Spring Planting Desert Landscaping: Plants For a Water-Scarce Environment A Multimedia CD-ROM



One of the truly pleasurable satisfactions of the approaching spring season is gardening. It is the time to add a vegetative flourish to your landscape area, whether a large lot or a small, midtown yard. Being true to our desert environment means choosing trees,

shrubs and flowers that make sense in a water-scarce environment.

**Desert Landscaping, Plants for a Water-Scarce Environment, Version 2** is a valuable tool for the creative, desert-sensitive gardener. By identifying plants with the desired characteristics to meet specific landscape conditions, this multimedia CD-ROM enables gardeners to custom design their landscape

areas to be desert-smart and water-wise. Not only does it provide a range of information — landscape tips, interactive plant selector, description of soil and sun requirements, identification of places of origin, reviews of plant books, plant trivia quiz — but the CD-ROM is also fun to use.

Produced by the Water Resources Research Center, **Desert Landscaping 2.0** can be purchased for \$30, including shipping and tax. To order, send a check or money order for \$30 made out to the Water Resources Research Center, The University of Arizona, 350 N. Campbell Ave., Tucson, AZ 85719. Call the WRRRC at 520-792-9591 for purchasing CD with credit card and for quantity pricing. The WRRRC web site includes a walkthrough of Version 2 demonstrating various features of the new CD (<http://cals.arizona.edu/AZWATER/>).

WRRRC produced **Desert Landscaping 2.0** as part of its educational outreach program. Sensible desert landscaping means water savings.



Arizona Water  
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