



ARIZONA WATER RESOURCE

Volume 7, No. 1

September-October 1998

The University of Arizona Museum of Art featured the photographs of Ann Simmons-Myers and the paintings of David Andres in an exhibit titled "Immersion," shown May 17 - August 9. The theme of "Immersion" was water, and the exhibit was scheduled to provide relief during the hot summer months. Ms. Simmons-Myers often photographs southwestern water scenes — lakes, pools, or arroyos — and even her dry desert photos often show evidence that water was once present. The shrouded models she includes in her photographs are an important element in her compositions. Lacking distinct features, they almost seem abstract, but yet are very recognizably human. The human form becomes part of the waterscape.

The photo to the right is titled "Oasis." The shrouded figure posed on the stone structure in the midst of the pond resembles a statue on a pedestal. The darkness of the background vegetation blends with the darkness of the water. Water lilies are in the foreground. In this scene, the human form seems not so much to blend into the natural setting as to be a distinct feature within the composition. The figure, however, does not contrast with the natural features — trees, water, water lilies, clouds — but takes its place among them. The human form is seen as part of the natural world. At the same time, the scene also has a mysterious, almost gothic mood to it.



Safe Yield Goal Proving Elusive

Achieving safe yield, the fundamental objective of Arizona's 1980 Groundwater Management Act (GMA), may prove to be a more elusive goal than once expected. The GMA mandated that the Phoenix, Tucson and Prescott Active Management Areas (AMAs) achieve safe yield, a balancing of groundwater withdrawals with recharge, by the year 2025. Some of the assumptions and projections used to set the goal, however, have not held up after 20 years, with the result that safe yield may be a difficult target for some AMAs to reach.

A note of warning was sounded during recent Arizona Department of Water Resources (ADWR) efforts to draft third management plans for the AMAs. The draft plan for the Tucson AMA concludes that "given current projections, the AMA will not reach safe-yield by 2025." Estimates show that overdraft will still be 46,600 acre-feet per year. The draft plan for the Phoenix AMA shows potential overdraft of 372,932 acre-feet in 2025.

This concern has caused safe yield to become a topic for renewed discussion,

continued on page 2



C O N T E N T S

Water Vapors	3
News Briefs	4-5
History/Conservation	6
El Niño Supplement	7-10
Special Projects	11
Publications	12
Web Sites	13
Announcements	14
Calendar	15

Safe-Yield...continued from page 1

with various questions now arising such as: How likely is it that Arizona's metropolitan areas will be at safe yield by 2025? If safe yield is not reached by 2025, can it be achieved later? Even if safe yield is reached in 2025, will population growth cause overdraft to resume shortly thereafter? How important is reaching safe yield, if overdraft is substantially reduced? Does ADWR need new regulatory tools to assure safe yield, or does the goal need to be redefined?

Meanwhile, it is becoming more evident how later developments threw off GMA water demand and supply projections. Unfortunately, from a water management perspective, nearly all such deviations have either increased water demand or slowed the switch from groundwater to renewable supplies. Both factors affect the ability to reach safe yield.

A critical determinant of water demand in the urban AMAs is population. Municipal water demand is the largest category of usage in the Tucson AMA and is second to agriculture in the Phoenix AMA. More importantly, it is the water demand component that is growing over time. As official population projections have been revised over the last two decades, the population forecast for Maricopa County in 2025 has continually been adjusted upward. Current projections show 4,948,423 Maricopa County residents by 2025. By contrast, population projections for Pima County have been revised downward, with the 2025 population pegged at 1,290,966.

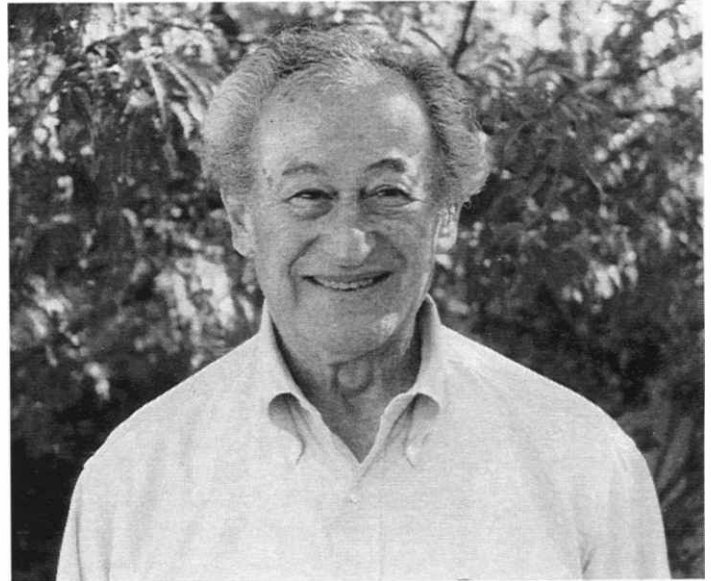
Equally important is average municipal water demand, measured in gallons per capita per day (gpcd). In the 1980s, certain demographic trends seemed to guarantee significant reductions in gpcd rates. Conservation efforts were expected to yield further reductions. Existing residences were primarily single family homes, many with turf and pools, and most with evaporative coolers. By contrast, new housing was primarily multi-family rental units and townhouses with much less landscaping. Also, new construction favored refrigeration air conditioning over evaporative coolers.

These "trends" didn't last. An expanding economy and low interest rates have helped push home ownership rates to record levels, and reduced the number of apartments being built. Also, some of the apparent water savings among apartment dwellers proved to have been merely shifted off-site, to Laundromats and car washes.

New apartment complexes tend to be larger, have lush landscaping, and offer more water-using amenities like pools, spas, gyms, garbage disposals and laundry facilities. Many new and existing single family residences have new water-using devices, such as outdoor misting systems. Pools, Jacuzzi, and whirlpool tubs continue to grow in popularity.

Water conservation has not lived up to its early promise in many areas. Significant reductions in gpcd rates occurred initially, as the easiest, most cost-effective measures were undertaken. But now conservation gains are coming harder, and some conservation devices lack durability. For example, many drip irrigation systems deteriorate after five to 10 years, as do some models of ultra-low-flush (ULF) toilets. The lack of available parts for repair and maintenance of some ULF toilets has forced many homeowners to simply use the toilet as is or replace with non-ULF parts, which can render the toilet a virtual water guzzler.

The human element has proven problematic as well. Studies now indicate that residents who irrigate their landscapes manu-



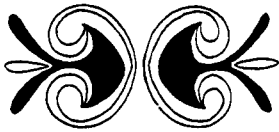
The Arizona Hydrological Society presented Dr. Sol Resnick its Life Time Achievement Award during its annual symposium September 23-26. The AHS presents the award each year to an outstanding member of the Arizona hydrologic community. Dr. Resnick was appointed associate director of the University of Arizona's Water Resources Research Center in 1964 and director in 1972. He has a worldwide reputation among hydrologists and water managers. Dr. Resnick, who retired in 1983, is WRRC professor emeritus. He currently teaches in the UA Elderhostel Program and represents the university in an Israeli-sponsored project teaching Hopi Indians to irrigate with brackish water.

ally may be more water efficient than those using drip systems because the systems need to be well managed and carefully maintained to provide efficiency. The average homeowner, or the average landscape worker isn't doing either. Timers are not regularly being re-set, and systems are not being repaired and upgraded as needed and are therefore less efficient over time. Swimming pool covers are used primarily in spring and fall to prolong the swim season, but not in summer when potential water savings are the greatest, because a covered pool becomes too warm for comfort.

Another prediction that hasn't borne out was that municipal water rates would rise significantly faster than the inflation rate, providing a financial incentive to conserve. While rates have gone up in some areas, rates in other areas, such as Tucson, have actually gone up more slowly than overall inflation, thereby reducing the real price of water. Also, incomes have risen, making people less sensitive to the price of water. In addition, with refrigeration largely replacing evaporative cooling in new residences, summer electric bills now may be so much higher than water bills that the latter may not seem excessive.

Water demand in non-municipal sectors likewise has deviated from expectations. In the 1980s, Arizona copper mines appeared unable to compete with foreign companies, which had the advantage of cheaper labor, higher grade ore bodies and fewer environmental restrictions. Copper mining was viewed as a temporary activity, likely to disappear as early as the year 2000, as existing ore bodies played out or became uneconomical to mine. Thus, copper mines were granted the right to pump groundwater without much restriction.

continued on page 16



Water Vapors

El Niño's numerous and severe impacts on global weather clearly establish the phenomenon as water event of the year. In honor of the event — or more precisely to provide El Niño news and information relevant to Arizona and the Southwest — the Water Resources Research Center published four issues of a special *El Niño News*.

This edition of the *Arizona Water Resource* contains a bonus *El Niño News*, with information summarizing events and research throughout the past year. Future editions of *AWR* will contain other centerfold supplements, to better provide various kinds of water information to our readers.

Something New

Also new to this edition of *AWR* are several features that will appear as regular columns. Each deals with a different water theme and all are written by WRRC staff members. "Stream of History," by Barbara Tellman, will discuss some aspect of water in history. Val Little's "H2O Conservation Notes," another new column, is concerned with water conservation as a public policy issue. Ken Seasholes' "Water on the Web" column reviews web sites containing particularly relevant or useful water information.

Email — Reach Out and Touch Someone

Among its many and varied services, from producing a CD-ROM and an Arizona water map to incidental and regular publications, the WRRC also responds to inquiries about water. At one time, most of the inquires were made by phone. People who called for water information generally had relatively simple and uncomplicated requests. "Where can I get my water tested?" "Does the Santa Cruz River really flow north?" "How is CAP water treated?"

Changes are occurring with the use of email as a communication tool. For one, we get requests from all over the world, from people who have become acquainted

with us through our home page. We received email from someone in France interested in bottled water use in the United States, from a man in Rome who was interested in decorative water fountains of the Southwest, and a student in Belgium with questions about fish farming in the desert.

Not only are requests coming from farther afield geographically, but some email requests are seeking vast quantities of information, much more than would usually be requested by phone. For example, a single email message requested the annual rate of evaporative loss for the Arizona Canal, Central Arizona Project, Colorado River Aqueduct and California Aqueduct, the economic loss this evaporation represents, along with the method of computation to determine the loss, and the total surface area of each of the above projects.

That we receive such robust information requests might in some ways be expected. Email has greatly increased access to many and varied resources including the WRRC, and those in search of water information can easily get in touch with us. But there is more to the situation than that.

Part phone call and part written message, email is a media very well suited for conducting extensive information searches. Inquiries arriving by phone, an accessible and informal means of communication, tend to be relatively undemanding. In contrast, when a message or inquiry is put in writing, greater purposefulness is implied. When a written message gains the fluidity and accessibility of telephoning, heavy-duty requests make the rounds.

Also, email partakes of the aura of the

much vaunted communications and information revolution. The movement encourages expectations that great pools of information are forming and are readily accessible. Email is viewed as a way to dip into that pool.

Drink Your Water

Being human, people usually have no trouble coming up with reasons why they do not do what is good for them. The Cornell Medical Center and the International Bottled Water Association looked into why Americans do not drink recommended quantities of water. They found that six percent prefer other beverages; seven percent forget to drink water; eight percent do not like the taste; and 11 percent do not feel thirsty. The reason that 27 percent of Americans do not drink enough water, however, is the same reason often provided to explain a multitude of other shortcomings, from a failure to write letters to broken marriages; i.e., they don't have enough time.

If I had a Hammer

Sledgehammer-toting Secretary of Interior Bruce Babbitt has given new meaning to the term "hit list." Once mainly a figure of speech — e.g. President Carter's infamous hit list of western water projects — hit list has taken on a more forceful physical meaning in water affairs, thanks to Babbitt's crusade to rid the country of harmful dams. On a recent western trip Babbitt said, "I arrive with sledgehammer in hand to celebrate the destruction of dams." Critiquing the dams on the Colorado River, Babbitt said their effect on the river is to give it, "the regularity, and the predictability of a giant toilet."



Arizona Water Resource is published 6 times per year by the University of Arizona's Water Resources Research Center. *AWR* accepts news, announcements and other information from all organizations concerned with water. Subscriptions are free upon request.

Arizona Water Resource Staff

Editor: Joe Gelt
Reporters: Jim Henderson
Barbara Tellman
Ken Seasholes
Val Little
Publisher: Gary Woodard

WRRC Acting Director: Peter Wierenga

Arizona Water Resource

Water Resources Research Center
College of Agriculture
The University of Arizona
350 North Campbell Avenue
Tucson, Arizona 85719
520-792-9591; FAX 520-792-8518
Email: wrrc@ag.arizona.edu



News Briefs

Santa Cruz AMA Delays Management Plan

A dispute between the Santa Cruz and Tucson Active Management Areas (AMAs) has contributed to a one-year delay in the release of the Santa Cruz AMA's Third Management Plan. At issue is the surface flow of the Santa Cruz River and its allocation in the water budgets of each active management area. The controversy has roots in the founding of SCAMA when it split off from the Tucson AMA in 1994 and allocation of Santa Cruz River flow was left unsettled.

At its July meeting, the Santa Cruz Groundwater Users Advisory Council questioned future TAMA claims on the Santa Cruz River, including effluent outflow from the international wastewater treatment plant. TAMA claiming surface flow as part of its "natural water" could limit SCAMA's management options.

In response, the Santa Cruz GUAC voted 3-0 to recommend a one-year delay in promulgating its Third Management Plan. Large water users in the area already had requested a delay. Arizona Department of Water Resources Director Rita Pearson approved the request.

Meanwhile work is underway to resolve the controversy of surface flows entering the TAMA from the SCAMA. Tucson AMA Director Katharine Jacobs is scheduled to meet with SCAMA staff to explain the accounting in TAMA's management plan. The bulk of Santa Cruz flow entering the TAMA is stormwater discharge, with minimal amounts originating from the international wastewater plant. SCAMA GUAC members, however, are concerned about legal precedents that could be set.

The management plan delay also was motivated by expectations that a groundwater model for the AMA would soon be completed. Also, Director Alejandro Barcenas indicated that an *ad hoc* group of large water users, including the City of Nogales, has been working on a settlement of surface water rights. Though Barcenas indicated that major obstacles have to be overcome, a settlement would be a significant boost to long-range plan-

ning efforts and would affect the management plan.

The state's five active management areas originally were to complete third management plans by September.

Beavers to Return to San Pedro River

Beavers soon will be seen on the San Pedro River, after an absence of 100 years. Their return is the result of a final environmental study report recently issued by the U.S. Bureau of Land Management. The beavers are expected to be released this fall or winter.

The beavers' homecoming to their former habitat raises some concerns with the U.S. Fish and Wildlife Service however. The service is concerned that the beaver's activities benefit and not harm the endangered southwestern willow flycatchers' habitat. To that end, the bureau must monitor the beavers' work.

Beavers at first make themselves at home at a river site by cutting down willow and cottonwood trees for food and building dams. Once dam building is complete, however, bureau biologists say beavers will eat just enough trees to ensure survival. They say their activities actually improve wildlife species numbers and diversity. For example, a study showed that when beavers arrived in the nesting territory of a willow flycatcher species in Idaho, the birds' numbers increased.

Beavers disappeared from the San Pedro River in the 1890s. Some say cattle grazing reduced vegetation and caused the decline of the beavers

DDT Found in Fish, Wildlife on Lower Gila

Although banned for over 25 years, DDT residues have been found in fish, birds, and other wildlife on the lower Gila River according to a study by the U.S. Fish and Wildlife Service. Concentrations are sufficiently high to possibly harm wildlife.

A follow-up to a 1986 report that documented contaminants in the area, the study focused on the effects of organochlorine pesticides and metal contaminants in fish and wildlife between Phoenix and Painted Rock Dam. The study indicated that concentrations of DDE, a metabolite of DDT, exceed fed-

Author's Query

For a history of water conservation in Arizona, I would appreciate receiving any information relevant to the topic. The history is to be based on the premise that water conservation is not strictly a modern movement and that conserving water has been a concern long before the invention of low-flow toilets and drip irrigation. I would be grateful for information about personal, domestic, agricultural and industrial practices, early laws and public policy, social or cultural attitudes, strategies, reminiscences and anecdotes that have to do with water conservation in the state, especially during the nineteenth and early 20th centuries. Joe Gelt, Water Resources Research Center, University of Arizona, 350 N. Campbell, Tucson, Arizona 85721; 520-792-9591; email: jgelt@ag.arizona.edu

eral and state human health guidelines.

Discovering unmetabolized DDT in fish concerns officials because it indicates that fish continue to be exposed to the banned compound. This could pose a human health risk if fishermen consume their catch. The report did not identify the source of the unmetabolized DDT.

Further, the study found that although high levels of aluminum and copper were found in fish, mercury levels in fish were generally low. High accumulations of mercury, however, were found in fish-eating herons.

Fish and wildlife were found to contain 11 potentially toxic metals, with concentrations of most metals remaining unchanged from 1985 to 1994-95. Carp from Allenville, however, contained the second highest level of aluminum ever recorded in Arizona. Also, copper concentrations in most fish were sufficiently high to cause concern.

Some good news was reported. The presence of pesticides other than DDT/DDE significantly declined in local wildlife over the past decade. Of the 16 organochlorine pesticides found in fish, lizards, turtles and birds in 1985, only six were detected in the recent study, and they were found in fewer animals than a decade earlier. An exception was chlordane, now found in a greater number of

carp and turtles.

The Arizona Department of Environmental Quality designated portions of the Gila River study area as eligible for Arizona's Water Quality Assurance Revolving Fund. This fund was established to identify pollution sources and clean up hazardous substances.

The report is available from the U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office, 2321 W. Royal Palm Rd., Suite 103, Phoenix, AZ 85021; <http://ifw2es.fws.gov/arizona/>

State Agency Supplies Water Works Bonds

The state Water Infrastructure Finance Authority issued \$38 million in bonds to fund drinking water and wastewater construction projects across Arizona. Bullhead City, Tucson, Safford, Williams and Cave Creek will use the funding to up-

date and improve existing systems.

A \$24.4-million loan will enable Bullhead City to fund portions of the first phase of construction of a collection and transmission system for wastewater. The project will enable some residents to switch from septic tanks to the centralized treatment system. Bullhead City's contribution to the project is \$2.2 million, funded by property assessments.

Tucson will receive \$6 million to be used to replace 20 miles of galvanized steel water lines. This is part of a larger project to replace 275 miles of water lines. The replacement project is underway because Arizona soils are corrosive to galvanized steel.

Safford is pooling its \$2 million WIFA funding with \$3.5 million received from the Rural Development Division of the U.S. Department of Agriculture to improve the city water system. Improvements include constructing approximately seven miles of 24-inch transmission main

from the well field to a storage reservoir.

Williams is undertaking a \$5-million project funded equally by WIFA and USDA's Rural Development Division to replace most of its sewer lines and manholes. The project is in response to an ADEQ consent decree.

With \$2.7 million received from WIFA, Cave Creek will construct a new 233,000 gallon-per-day wastewater treatment plant and rehabilitate the sewer collection system.

WIFA administers the Clean Water Revolving Fund (CWRF) for wastewater facilities and water reclamation construction projects and also the Drinking Water Revolving Fund (DWRF) for community drinking water construction projects. Qualifying communities can seek low interest subsidies for eligible projects. In 1998, the Arizona Legislature appropriated \$4.3 million to match federal contributions to CWRF and \$4.9 million for the state's share of DWRF.

Prescott Debates Safe Yield Status

A public hearing in response to the Arizona Department of Water Resources's (ADWR) preliminary declaration that the Prescott Active Management Area (PAMA) is not at safe yield — i.e., it is now pumping more groundwater than is naturally and artificially being recharged — has attracted varied opinions. Many speakers requested an independent review of opposing studies and/or a delay in the final decision. Others called the potential declaration "overdue" and urged ADWR to make the determination. A final determination is expected by April.

ADWR is required by law to declare groundwater mining in PAMA if data for three consecutive years show more groundwater is being pumped than is replenished. A groundwater mining declaration would force PAMA to follow Assured Water Supply (AWS) rules, requiring developers of new subdivisions to prove the availability of sufficient water supplies for at least 100 years. This in effect forces them to use renewable or imported supplies.

ADWR has determined that since 1995 groundwater overdraft has occurred in PAMA at an average rate of 10,800 acre-feet per year. Its report also indicated that in the last five years water levels have declined in more than 73 percent of monitored wells, with groundwater use increasing in PAMA by 25 percent during the 1990s.

Meanwhile, the State Legislature passed a bill this spring modifying the timetable for implementing the groundwater mining declaration. The bill set interim guidelines restricting groundwater use until final determination of groundwater mining is made. The interim guidelines include a grandfathering provision to allow approval of a final subdivision plat if a preliminary plat was approved before the effective date of the act, Aug. 21, 1998. These newly-approved subdivisions can reserve groundwater as "committed demand" under AWS rules.

In response to the August 21 deadline, and due to expectations that the City of Prescott would declare a moratorium on certain types of new development, there was a "mad rush" by developers to submit requests for approval of preliminary subdivision plats and annexation applications. When the dust finally settled, new subdivision approval created 8,338 acre-feet of committed demand, bringing the total potential committed demand to almost 13,000 acre-feet, or almost double the current municipal groundwater use in PAMA.

At the September 26 public hearing, Southwest Groundwater Consultants' hydrologist William Greenslade, commissioned by Shamrock Water Co. of Prescott Valley, presented a study concluding that PAMA is in fact at safe yield. The study estimates that natural groundwater recharge is occurring in PAMA four times greater than the amount ADWR used in its calculations. In another major departure from ADWR calculations, the consultants' study does not consider underground flow discharges in determining safe yield. ADWR has hired an outside consultant to review its data and other data submitted at the hearing.

The public has until October 26 to submit written comments, and ADWR will then have up to 180 days to review comments and challenges and to issue a final decision.

Prescott was one of four original Active Management Areas under the 1980 Groundwater Management Act, and was one of three original AMAs with safe yield as a management goal. With agricultural groundwater demand declining in the late 1970s and early 1980s, moderate population increases, and above-average precipitation, groundwater levels appeared to stabilize. In the early 1990s, ADWR found no clear evidence either way to determine whether the stabilization of groundwater levels was a result of achieving safe yield or a combination of short-term factors. ADWR now believes that PAMA never reached safe yield.

The topic of water is multifaceted, with subjects ranging from augmentation to the zebra mussel. WRRC expertise may not cover the entire gamut from A to Z, but it does include such specialities as water history and conservation. In each issue of AWR Barbara Tellman, WRRC senior research specialist, will contribute a column about water history, and Val Little, water conservation specialist, will discuss some aspect of water conservation.

Stream of History

by Barbara Tellman

"The Water's In!"

Before there were government agencies, rules, regulations and management plans, there was water. The following is from an article by Juanita Brooks that appeared in *Harper's*, May 1941, and tells of life along the Virgin River in Bunkerville, Nevada, a few miles from the Arizona border. It appears to describe a much simpler time when rules and regulations were few. Despite the great difference between that era and the present, both share a concern about the wise use of water.

"You who live in cities and need only turn a tap to have all the clear water you need will wonder at my theme. You have probably accepted water as one of the essentials, like electricity, which comes to you for a small monthly fee. You who live on farms where there is plenty of rainfall will scarcely understand either. But all who live in the arid lands of the West will appreciate the significance of the words, 'The water's in!'"

"In my childhood that shout was the most welcome news we ever heard. We children would gather on the banks of the town canal to watch the water's arrival and to throw in sticks and boards. Some of the most daring would get into the ditch and wait until the first little waves, darting into the low places, licked at their bare toes, then run on again. ..."

"As far back as I can remember, the whole routine of my chores was determined by whether or not the water was in the ditch. When it was, my duty was to fill the barrels from the little stream which ran along the sidewalk. We always had our drinking barrel, swathed in burlap, set under the cottonwood trees to keep cool. ..."

"To what economies we were forced! Water was literally measured by the drip. You must never dip a full cup from the barrel; you should take only a little bit, just what you could drink. If you were handed a full cup you drank what you wanted and gave the rest back to the host to dispose of. Usually he handed it to the next person, or poured it carefully into a bucket kept for waste water, to be given later to the chickens. ..."

"The Saturday bath water had an interesting history. Forced to serve more than one person, it must be used to wash out socks or overalls or to wipe up the floor before it was finally poured into the hollow around discouraged rosebush or young tree. ..."

"Such water as it was! Always muddy, sometimes it seemed fully one-fourth silt. Not for hours did it become clear. Usually we just dipped it up and gave it its time; but we learned that a tablespoon of milk would separate a flaky, red precipitate, or a bit of the inner pulp of cactus would settle it quickly without affecting the taste. Worse than the silt was the mineral dissolved in the water which gave it such a peculiar taste and earned for it the title 'Virgin Bloat.' ..."

H2O Conservation Notes

by Val Little

Water CASA — Dedicated to Save Water

Research, education and friendly persuasion are the water-saving strategies adopted by the Water Conservation Alliance of Southern Arizona, a consortium of five Tucson area water providers. Organized last year by the University of Arizona's Water Resources Research Center, Water CASA pools the resources and interests of Avra Water Co-op, Community Water of Green Valley, Flowing Wells Irrigation District, Town of Marana Water Department and Metro Water District. Pima County Wastewater and the U.S. Bureau of Reclamation also are members.

To better target conservation programs to individual water customers, Water CASA developed Welcome Packets for new customers of its member utilities. The Welcome Packets contain a wealth of print material to help residents manage their water use more effectively and also include coupons for a variety of discounts. For example, the Water Resources Research Center offers a coupon for a 50-percent discount on its acclaimed Desert Landscaping CD-Rom.

Water CASA also arranged bulk ordering of conservation devices such as low-flow shower heads and faucet aerators, to be given to interested customers. Customers moving into residences

with old, high-water-use fixtures also are provided without charge a leak detection kit for their toilets and also a displacement device for the toilet.

Also involved with public policy issues, Water CASA hosted a Conservation Alternatives Workshop for water providers throughout Arizona to clarify the following Arizona Department of Water Resources options: Gallons Per-Capita per Day (GPCD), Non-Per-Capita (NPC), and the Alternate Conservation Program (ACP). Background information was provided on each program. Sessions outlined characteristics of water providers most likely to benefit from each program option.

Water CASA is responding to a Pima County request to suggest ordinance and policy language to increase countywide water conservation efforts.

Water CASA's agenda also includes research. ADWR provided funding for the alliance to conduct a one-year study to determine which conservation measures (e.g. toilet rebates, xeriscape retrofits, public education, rate structures) are most effective for water providers with certain customer profiles. For example, if water customers are primarily Snow Birds, how can a utility best encourage them to save water during their winter stay.

Water CASA also is about to embark on a residential graywater reuse study. This will provide valuable data about residential use of graywater and determine whether health risks increase with graywater use.

El Niño News Supplement

No. 5

September-October 1998

Studies Focus on El Niño and Beyond

Of all the effects attributable to El Niño, the most significant is an increased awareness that climate has a complicated, far-reaching influence on human affairs. This raises the question whether adequate information and resources were available for citizens to prepare for various El Niño occurrences.

To determine if sufficient El Niño information was provided, the Office of Global Change at the National Oceanic and Atmospheric Administration conducted a pilot project in California during the recent event. The agency provided information packets with El Niño forecasts, along with instructions on interpreting them, to representatives of public agencies and private companies.

The government agency conducted a July postmortem session to determine whether access to this information enabled participants to better cope with El Niño hazards and thereby reduce risk and financial loss. Participants affirmed

continued on page 10



(Photo: Educational Communications and Technologies (ECAT), University of Arizona)

Arizona Cotton Growers Cope With El Niño

If not the sole cause of all their woes, El Niño certainly contributed to problems besetting Arizona cotton farmers this year. The much-heralded El Niño rains finally arrived in Southern Arizona in December, at a time when cotton farmers usually prep their lands in anticipation of a spring planting. As a result, some farmers were unable to properly work their land for the next planting season.

The February-March rains then further contributed to the problem. March 1, the official date for cotton planting in Arizona, came and went, with only about 11 percent of cotton farmers able to plant their crop. According to the Arizona Agricultural Statistics Service, 23 percent had planted their crop by that time last year. Cotton farmers try to plant relatively early since this ensures an optimal crop. This year much of the cotton was planted two to four weeks late compared to normal due to wet conditions.

Possibly more troublesome to cotton growers than the spring precipitation was the cold air that followed the storms. Cotton responds best to warmth and heat, with its most favorable planting time occurring when soil temperature is between 55 and 60 degrees. The colder conditions this year adversely affected germination of the cotton plant.

The cumulative effect of these various factors was to delay spring development of the state's cotton plants. This can set the plant up for further damage later in the season by delaying the bloom cycle, possibly causing the cotton bolls to develop during the monsoon season. The added heat of the monsoon produces heat stress and fruit shedding, further lessening cotton yields.

C O N T E N T S

El Niño Studies	7
Cotton Growers Cope	7
Ski Resorts Receive Bonus ...	8
Cold Boosts AZ Energy Sales .	8
Streamflows Spiked	9
USGS Studies Recharge	9
El Niño Overrated	10

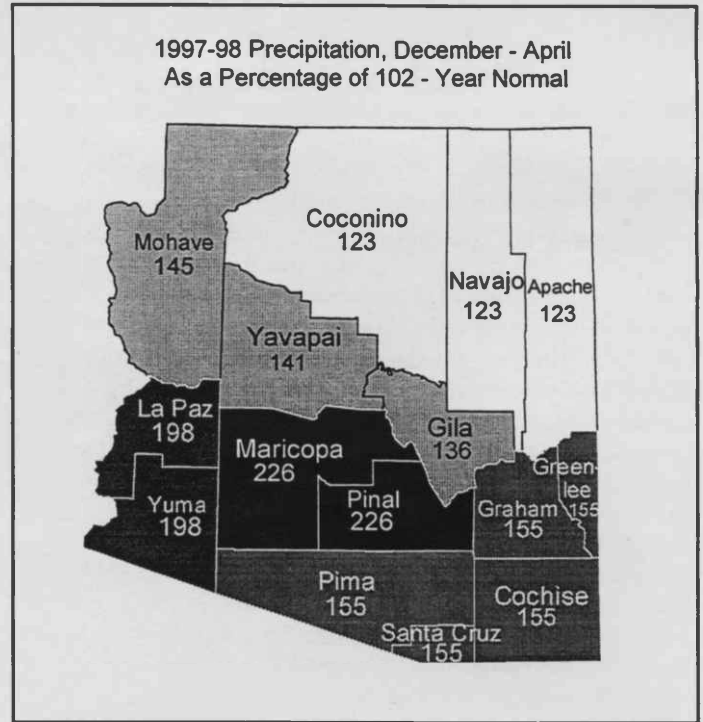
El Niño Snow Brightens Arizona Resorts

Thanks to El Niño, Arizona ski resorts got plenty of snow last season, with Arizona's three biggest resorts – Sunrise, Arizona Snowbowl and Mt. Lemmon Ski Valley – each recording among their highest total snowfall and visitor counts in recent years. Levels of snowfall conformed to El Niño precipitation pattern, with Southern Arizona exceeding its average precipitation by more than other areas of the state.

Mt. Lemmon Ski Valley, located in the Santa Catalina Mountains north of Tucson, may have received the greatest El Niño snow bonus. Total snowfall for the year reached 301 inches, or 115 inches greater than normal, and snowpack remained high throughout the ski season. Because of these ideal conditions, 98 to 99 percent of ski days were high quality compared to the more usual 75 percent, according to George Davies of Mt. Lemmon Ski Valley. Ski season was 20 days longer than in normal years. It was not a lack of snow that finally closed the area, but a lack of skiers. Skiers do not normally think of Mt. Lemmon as having good snow so late in the year. Skier visits increased 240 percent over last year.

Sunrise Ski Area, located in the White Mountains near Greer, Arizona, reported more frequent, smaller storms during the winter. Good snow brought over 300,000 skier days, the highest total in 28 years, which was 50,000 skier days over the previous record. Sunrise also closed with good snowpack due to lack of late-season skier interest.

Arizona Snowbowl, located outside of Flagstaff, had over 300 inches of snow, compared to an average of 260 inches. The effect of El Niño came late to Snowbowl, which opened on Christmas day – several weeks late. The arrival of storms later in the year, with fewer large storms and more wind than normal,



made up for the slow start at Snowbowl. Snowbowl closed several weeks later than normal with over 160,000 visitor days, the third highest visitor count under current ownership. The highest visitor count was during 1992-1993 with about 180,000 visitor days. Good snow was reported at closing.

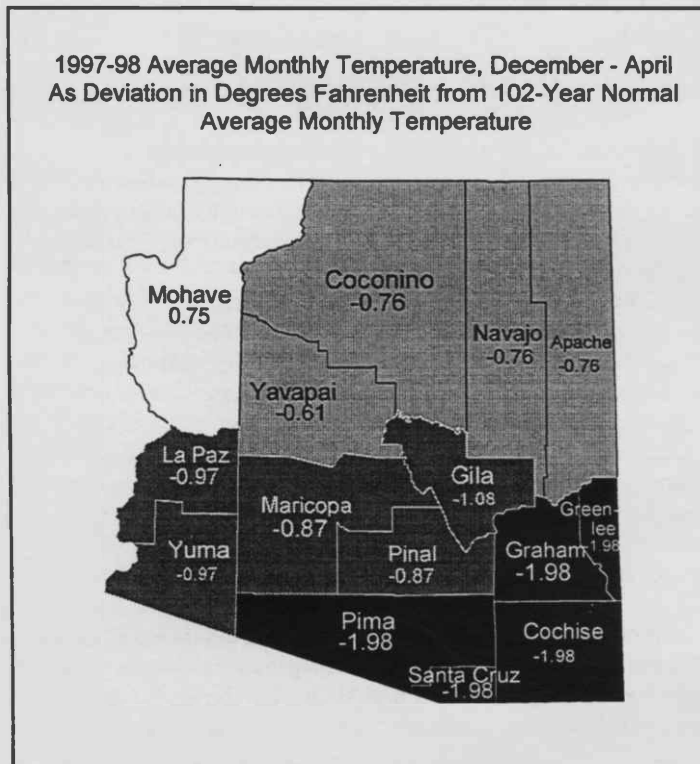
Colder Winter Boosts AZ Energy Sales

Arizona utilities recorded increased revenue this winter, partially due to El Niño conditions which brought cooler, wetter weather to the state. While much of the country was experiencing record warm temperatures, Arizonans used more natural gas and electricity compared to the previous winter.

Arizona electricity end-use was up 5.6, 3.9 and 0.2 percent for December, January and February respectively compared to the same months a year earlier, according to the Energy Office of the Arizona Department of Commerce. End-use of natural gas in Arizona was up 16.7, 10.8 and 7.1 percent for December, January and February compared to the same months a year earlier. Sales of both natural gas and electricity were down nationally during the winter 1997-1998 compared to the same months in 1996-97.

Southwest Gas Corporation had record first quarter net income in 1998. Operating margin increased 21 percent over the same quarter in 1997, with one quarter of that increase attributed to colder than normal weather during 1998. Southwest Gas serves customers in Arizona, Nevada and California.

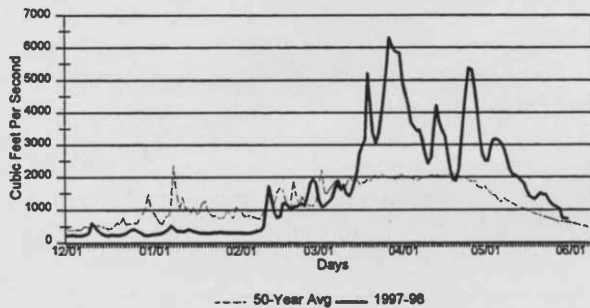
At Arizona Public Service, \$3 million of increases in operating revenue in first quarter 1998 was attributed to weather effects. Similarly, Tucson Electric Power's operating revenue from sales to customers increased 7.8 percent in first quarter 1998 compared to the same quarter in 1997. The company attributed higher sales to colder than normal weather during February and March, as well as continued customer growth.



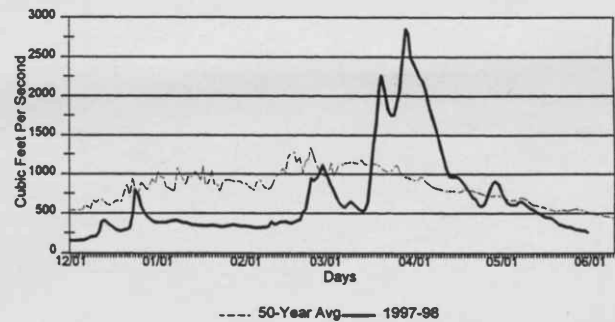
El Niño Spikes AZ Streamflows

Streamflow in the Salt, Verde and Gila rivers was above normal for much of the spring runoff period and snowpack was above normal. The timing of the rains and the snowmelt was optimal for operation of Salt River Project reservoirs, according to Dallas Reigel of SRP, partially because SRP had drawn down its reservoirs in anticipation of increased El Niño-related runoff and partially because cooler weather prevented a quick melting of snowpack.

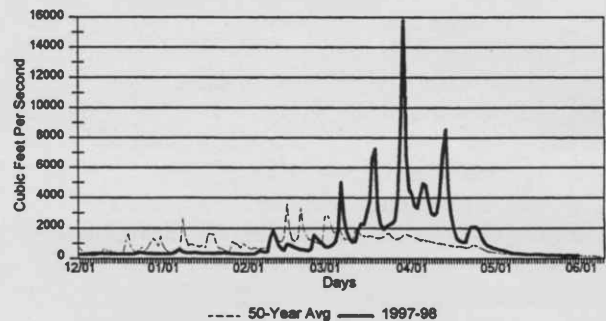
Salt River Above Roosevelt Dam



Gila River Above San Carlos Dam



Verde River Above Horseshoe Dam



USGS Studies El Niño's Recharge

El Niño holds promise of replenishing the water resources of the state, but the question is to what extent? Surface flows are directly measurable, but figuring out El Niño's contribution to groundwater recharge is a greater challenge. U.S. Geological Survey scientists have taken on the task.

In their work they are relying on a new application of geophysical technology for assessing the effect of El Niño precipitation on groundwater storage in the Tucson Active Management Area (TAMA). First used during the 1992-93 El Niño and again applied during the current event, the microgravity studies not only provide data about each El Niño, but also enable USGS scientists to make comparisons between the two events.

Microgravity methods are based on the principle of Newton's Law of Gravitation, according to which acceleration due to gravity within an object's gravitational field is directly related to the mass of the object and inversely related to the distance to the center of the object. In other words, the greater an object's mass, the stronger its gravitational field. The principle has proven useful for measuring changes in an aquifer.

Groundwater is stored within the pore spaces of aquifers. As an aquifer is drained by pumpage or filled by recharge, its mass changes. This fluctuation of water volume results in slight changes in the strength of its gravitational field. These extremely small gravitational changes can be measured thanks to recent technological advances in geophysical techniques.

Microgravity studies in the TAMA began in 1992, with 50 measuring stations established in a 6-square-mile area centered on Rillito Creek along the north edge of Tucson. This was a cooperative project involving USGS and the Pima County Department

of Transportation and Flood Control District. The heavy El Niño-related precipitation in the area during the winter of 1992-93 provided a timely opportunity for using microgravity to measure the amount of recharge resulting from the precipitation.

El Niño precipitation contributed to sustained high streamflows throughout southern Arizona, including Rillito Creek. The normally dry creek had substantial streamflow from December 1992 to March 1993. Repeated gravity measurements at the 50 stations within the study area between December 1992 and January 1994 enabled scientists to calculate changes in groundwater storage and to estimate recharge for each period.

Microgravity studies showed that the greatest initial recharge occurred in normally unsaturated surficial deposits along Rillito Creek as a direct result of the winter streamflows. Throughout the winter of 1992-93, gravity values increased over a 0.5-mile-wide strip of flood plain adjacent to Rillito Creek and reached their maximum by April 1993. Microgravity data enabled USGS scientists to estimate that about 10,900 acre-feet of recharge occurred along the Rillito Creek during the winter of 1992-93.

In anticipation of the return of El Niño conditions in late 1997, USGS scientists surveyed 9 of the stations established in 1992-93 and established 11 new stations. This work enabled USGS scientists to estimate groundwater storage changes related to infiltration in Rillito Creek alluvium that resulted from precipitation during the winter of 1997-98.

The recent El Niño did not result in widespread flooding, but above-average precipitation caused normally dry washes to flow for days to weeks. Although final data are not yet available, a preliminary evaluation indicates that gravity changes adjacent to Rillito Creek were similar to changes in 1992-93. The same

continued on page 10

USGS Studies El Niño Recharge...continued from page 9

pattern of recharge occurred, with the large bulge in gravity values at Rillito Creek caused by saturation of surficial deposits adjacent to the channel.

A basinwide network established prior to the 1997-98 El Niño will be surveyed annually to monitor changes in groundwater conditions throughout the Tucson Basin and Avra Valley.

Skeptic Claims El Niño is Overrated

A Canadian sociologist claims that American scientists are exaggerating El Niño's effects to better garner more research monies. Addressing the 14th Congress of Sociology in Montreal in July, University of Toronto professor John Hannigan said that oceanographers and meteorologists have fueled an El Niño media blitz, to the extent the phenomenon has become a cultural fixation. "(It) probably wouldn't have reached this level if (El Niño) hadn't been promoted by a powerful group within the scientific community," said Hannigan.

He noted that although scientists have known about the phenomenon since the 16th century, El Niño has not become



Special El Niño editions of *Arizona Water Resource* were published during the 1997-98 El Niño season with financial support from the U.S. Geological Survey, Water Resources Division, Arizona District.

newsworthy until the last quarter-century. With more studies providing more information to an eager public, El Niño has become visible, easy to understand and spectacular.

"El Niño has been given almost human identity," Hannigan said. "It's become an invader that menaces our peace and stability."

Hannigan is not denying the occurrence of El Niño, but believes it has been unduly exploited to profit certain segments of the scientific community. He noted that the event has provided a boost to oceanography and climatology, two fields that have been moribund of late.

Hannigan believes that since it was the United States that expected to experience strong El Niño effects this event gained the spotlight. Further, that El Niño especially threatened Southern California, a major media center, made the event a super star.

Hannigan is an author of textbooks used in many environ-

Studies Focus on El Niño...continued from page 7

that the information was valuable. For example, emergency management and wastewater management personnel were able to reduce flooding and avert sewage/storm water processing problems. An agribusiness official relied on the forecasts to decide whether to plant in California, Arizona, New Mexico or Mexico.

Thomas Pagano, a graduate student in the University of Arizona's Department of Hydrology and Water Resources, is studying the responses of Arizona water managers to El Niño. He is identifying what sources of El Niño information Arizona water managers consulted — e.g., commercial TV, Internet, government agencies, newsletters — and determining how the information was used, specifically whether it was used to decide a particular course of action. Part of his study also is to find out whether managers were satisfied with the information they received.

Pagano is concentrating mainly on Southern Arizona, interviewing officials in Nogales and Santa Cruz County, Tucson, Safford, and Phoenix and Maricopa County. He is seeking a broad range of information, including managers' general understanding of the El Niño phenomenon, the type of El Niño information available to them and the processes involved for agencies to apply the information to their operations. The goal of his study is to determine El Niño's effect on people of this region and to identify what kind of information they need to cope with such events.

Officials he has interviewed thus far have expressed satisfaction with the amount of El Niño information that was available to them. He also found that most officials had access to the Internet and made extensive use of it, although not always with complete satisfaction. Some officials described

information on the Internet as a mixed blessing. Abundantly available from many and varied sources, the information at times was difficult to keep track of and interpret. (Pagano's research is ongoing. He can be reached at pagano@hwr.arizona.edu.)

Pagano's research complements the efforts of the University of Arizona's Southwest Climate Assessment Project which is cooperating with him in his work. Funded by NOAA, the project is concerned with identifying the kinds of climate information that best serves the needs of people in Arizona and New Mexico.

Initially funded for three years, the UA project will build upon the heightened awareness of climate and its effects that now prevails in the wake of El Niño. Part of the project involves researchers interviewing community members and representatives of various economic interests in Arizona and New Mexico to determine how climate events, such as El Niño, affect them and their activities. The goal of the research is to determine what kinds of forecasts and other climate information are needed to enable people to reduce risks from drought, flooding and other climate conditions or, conversely, what information would enable them to profit from such events; e.g., knowing when to shift cropping patterns.

The project also will involve other research, including an analysis of the vulnerability of ranchers and urban water utilities to climate processes. Also, existing climate and hydrologic forecasts are to be evaluated, and information on the history of climate in southern Arizona from ancient times to the present will be collected.

(For more information about the Southwest Climate Assessment Project visit its web site at <http://geo.ispe.arizona.edu/swclimate/>)



Special Projects

UA Researcher Develops Method to Detect Viruses

Waterborne microbial contaminants, once thought to be under control, are attracting renewed attention. An awareness of the presence of previously undetected microbial contaminants in drinking water is increasing. By developing an improved methodology for testing for viruses in water, a University of Arizona microbiologist is contributing to this expanded awareness.

Kelly A. Reynolds, University of Arizona Department of Soil, Water and Environmental Science, developed a method capable of quickly and precisely detecting low levels of enteric viruses in large volumes of water concentrates, thus overcoming limitations of previous testing strategies. Her method is considered a major breakthrough in detecting viruses in drinking water.

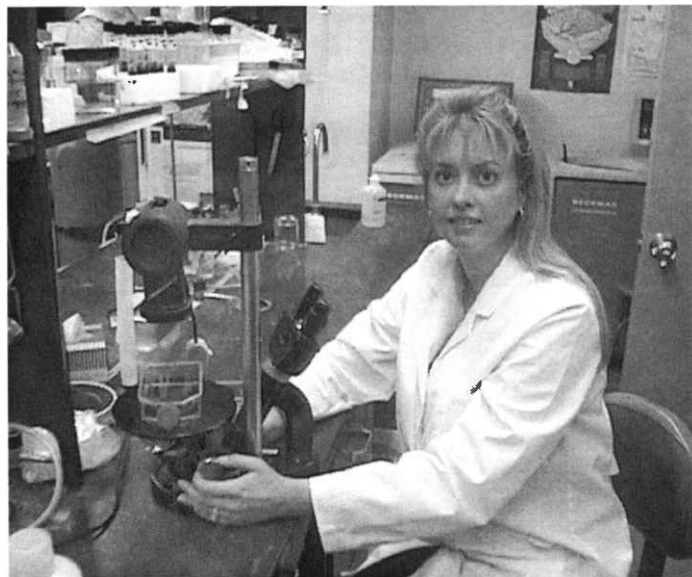
Viruses are not easily detected. Often present in water in very low numbers, viruses still can pose a health risk since it takes only one virus in a water system to infect a person with a waterborne disease. (Bacteria are different. Some require only 10, but usually the infectious dose is closer to 1,000.) A challenge in testing for viruses therefore is to be able to detect very low levels of viruses in very large water volumes.

Since human viruses generally occur in very low numbers in the environment, water samples need to be concentrated before analysis. The conventional methods for virus detection that are then applied rely on animal cell cultures. Water sample concentrates are added to culture flasks containing monkey or human cells that support virus growth. The cells are then observed for periods of a few days to weeks to detect signs of cell destruction indicating virus growth.

The advantage of cell culture is that it detects only infectious strains of viruses and can test large sample volumes, after concentration. Cell culture, however, can require long periods of time. Some strains of enteric viruses may need two weeks of growth for preliminary results, with confirmed results possibly requiring as long as three weeks or more. Also some strains of viruses, although growing in cells, do not show any visual signs of cell destruction and therefore go undetected. Examples of such viruses, called noncytopathogenic viruses, are certain strains of rotavirus and hepatitis A.

The limitations of cell culture have prompted scientists to turn to molecular detection methods to routinely monitor for viruses. The distinct nucleic acid sequences of different organisms can be differentiated at the genetic level, and molecular methods can detect the presence of a pathogen's genetic material (RNA or DNA). The most commonly used molecular method, the polymerase chain reaction (PCR) can quickly detect enteric viruses, with only 24 hours needed for definitive results. In many respects, PCR is more effective than conventional cell culture and has proven to be a rapid, sensitive, specific and inexpensive method for detecting viruses.

Molecular methods, however, also have shortcomings. Their detection sensitivity often is decreased by inhibitory compounds



University of Arizona microbiologist Kelly A. Reynolds

often present in environmental concentrates. False negatives can result. Also, PCR does not distinguish between noninfectious and infectious virus particles, thus complicating interpreting a PCR positive result and its implication to public health.

It is within this context — i.e., in response to the limitations of both cell cultures and molecular methods — that Reynolds developed the integrated cell culture/PCR method to routinely monitor for infectious enteric viruses. ICC/PCR retains many of the advantages of both conventional cell culture and molecular methods but without their limitations.

After adding sample concentrates to cell culture flasks, Reynolds applies PCR on the cell culture medium. By applying PCR to the medium, lengthy incubation times are unnecessary because PCR is capable of detecting low levels of virus growth in the cell culture. If PCR were not used, results would be delayed until visual signs of cell destruction become apparent.

Further, by integrating the molecular method with cell culture, PCR results are more reliable. No confusion exists about whether a PCR-detected virus is infectious or not since only infectious viruses develop in the cell culture. All viruses detected by ICC/PCR then are infectious — and results are available in 24-48 hours, compared to days or weeks required by cell culture alone. Also, ICC/PCR overcomes the effect of PCR inhibitory compounds that otherwise could lead to false negative results and is able to detect noncytopathogenic viruses — e.g., certain strains of rotavirus and hepatitis A — that grow in cells without visual signs of cell destruction.

With improved, viable virus detection sensitivity and reduced assay times, ICC/PCR is the future for effective environmental virus monitoring. Even with samples that are suitable for direct PCR amplification monitoring, having low inhibitory compounds and sufficiently high levels of target organisms, subsequent use of ICC/PCR would aid evaluation of the viable nature of the target, with minimal cost and time involvement.

The implications of the ICC/PCR method will gain importance as water quality testing increasingly includes more frequent monitoring of viruses. Also the method will serve to evaluate the effectiveness of various water treatment and disinfection methods concerned with removing or inactivating human enteric viruses.



Publications

Arizona WET, Grades 9-12 Curriculum on Nonpoint Source Water Pollution

The University of Arizona's Water Resources Research Center has completed an Arizona-specific water quality curriculum for high school students. Funded by the Arizona Department of Environmental Quality, the curriculum consists of three books, an envelope of pamphlets, and WRRC's Arizona Water Map. The curriculum is designed as a 4-6 week unit. Its hands-on activities and portions of the student reading material also can be used separately to supplement an existing high school science curriculum.

Book 1 consists of the *Water Resources and Nonpoint Source Water Pollution* (student reading), a glossary and student reading questions. Book 2 includes the curriculum overview and teacher information, a demonstration, laboratory, classroom and field activities, fact sheets, an answer key to the student reading questions, and a resource list. Book 3 contains *Starnet* articles: Arizona cases of nonpoint source water pollution, supplemental water quality studies and other information, and excerpts from the *Arizona Department of Environmental Quality 1996 Water Quality Assessment*.

For information on the curriculum's distribution, send a post card with name and address to Education Coordinator, Water Resources Research Center, The University of Arizona, 350 N. Campbell Avenue, Tucson, AZ 85721. Your name will be added to the WRRC's Arizona WET (Water Education for Teachers) mailing list.

Care of Desert-Adapted Plants

Della C. Fletcher and Patricia H. Waterfall

Low-water use is an essential characteristic of plants suitable for desert landscaping. This booklet provides a range of information about such plants, including what to look for when making a selection from a nursery, planting techniques, pruning, mulches and insect/disease control. The publication was made possible through a grant provided by Tucson Water to the University of Arizona Pima County Cooperative Extension's Low 4 Program. For more information about obtaining a copy, contact Patsy Waterfall, Low 4 Program, University of Arizona, 350 N. Campbell Ave., Tucson, AZ, 85721; 520-622-7701; fax: 520-792-8518; email: patwater@ag.arizona.edu

Preliminary Estimates of Waters Use in the United States, 1995

Estimates indicate that U.S. water use decreased from 1980 to 1995 despite continued population increase during the same period. The estimated 400 billion gallons of fresh and saline water withdrawn per day during 1995 for all offstream uses is 2 percent less than estimated use in 1990 and 10 percent less than in 1980 when water use seems to have peaked, since U.S. Geological Survey five-year compilations began in 1950. The report

presents estimates of water withdrawn from surface and groundwater sources for various water use categories prepared by state. Copies can be purchased from U.S.G.S. Information Services, Box 25286, Federal Center, Denver, Colorado 80225.

Water Resource Data Arizona Water Year 1997

S. Tadayon, N.R. Duet, G.G. Fisk, H.F. McCormack, G.L. Pope and P.D. Rigas

Prepared in cooperation with the state of Arizona and other agencies, this U.S. Geological Survey report includes a compilation of surface-water, chemical-quality, and groundwater data. The report contains discharge records for 192 gaging stations, annual peaks for 19 crest-stage partial-record stations; contents only records for eight lakes and reservoirs; stage and contents for one lake; elevation only for one streamflow station; 20 supplementary records, included with gaging-stations records, consisting of month end or monthly stage; contents and evaporation of lakes and reservoirs, diversions, and return flows; water-quality records for 27 continuous record stations; and water quality data for water from 286 wells. The report may be purchased from the National Technical Information Service, Springfield, Virginia 22161. Copies are available for examination at U.S.G.S. offices in Tucson, Tempe, Flagstaff and Yuma.

The following two publications discuss extreme climate conditions in the West — floods and drought.

An Action Plan for Reducing Flood Risk in the West Western Governors' Association

In response to costly and hazardous flood events, the Western Governors' Association released *An Action Plan for Reducing Flood Risk in the West*. Containing 25 recommendations for achieving safer communities, the report calls for gubernatorial leadership, including organizing public/private summits to focus on ways to reduce risk; establishing a cabinet-level office to develop and implement state plans to reduce flood risk; and issuing executive orders or using other means to support the National Flood Insurance Program and flood mitigation in general. Copies of the plan can be obtained from Bruce Flinn, Western Governors' Association, 600 17th Street, Suite 1705, South Tower, Denver, Colorado 80202; 303-623-9378; fax: 303-534-7309; web site: <http://www.westgov.org>

Improving Drought Management in the West: The Role of Mitigation and Preparedness

Donald Wilhite

This report to the Western Water Policy Review Advisory Commission summarizes drought and drought management issues in the West. The status of drought planning efforts is reviewed, and the range of options available and the mitigative actions employed by states is analyzed. Also several recent drought studies are reviewed. The author provides conclusions and recommendations, including the need for government agencies to be more proactive in dealing with this threat. \$21.50 paper and \$10 microfiche from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161; 800-553-6847 or 703-605-6000; fax 703-321-8547; email: orders@ntis.fedworld.gov; web stie: <http://www.ntis.gov>

Water on the Web

by Ken Seasholes
Surfing the Lower Colorado River

The legal, technical and political issues surrounding the Lower Colorado River are notoriously complex. Fortunately there is a wealth of information on the World Wide Web to help make sense of that complexity.

One of the best places to start is the Colorado River Water Users Association's website (crwua.mwd.dst.ca.us). This recently created site does an excellent job of organizing and summarizing issues both topically and geographically. The "At A Glance" summary for each basin state is a handy reference, while the "Profile" sections for states and issues are well written.

The site is attractive, and uses graphics to good effect. However, the main frame on the right can be quite cramped, and navigation can be awkward.

The next recommended stop is the Bureau of Reclamation (www.usbr.gov), and in particular, the Lower Colorado Regional Office (www.lc.usbr.gov). Large, and at times cumbersome, BuRec's site is a major repository of source material. Typical of a number of federal sites, BuRec gets high marks for content, but mixed marks for design and ease-of-use.

Many of the relevant documents are put up as single, minimally formatted files. Scrolling through such large documents is difficult and inefficient. Access to data, including reservoir levels and releases, is a bit better. The sheer volume of material, and quirky navigation can be frustrating, but usually worth the inconvenience.

The USGS (www.usgs.gov) is another significant source of data and reports. Though server-response can be slow, real-time stream flow data are available at the Arizona Water Resources District (www.daztcn.wr.usgs.gov). Results from the spring 1996 controlled flood are also available.

At the state level, the Arizona Department of Water Resources' site (www.adwr.state.az.us) contains summaries of Colorado River management, as well as specific issues such as Indian water rights. The director's comments on off-stream storage are archived as well. The Arizona Water Banking Authority (www.awba.state.az.us) has a separate set of comments on the storage proposal, and includes some background on storage efforts. The California Department of Water Resources' otherwise strong web site (www.dwr.water.ca.gov) is surprisingly anemic in covering Colorado River issues. However, Chapter 9 of the California Water Plan does address key management options.

There are many other resources (Altavista lists 26,000 for "Colorado River"), so below are a few more.

www.acwanet.com

The Association of California Water Agencies site has a breezy overview of current issues, with some useful legislative updates.

www.cvwd.org

Coachella Valley Water District has quick-loading graphics and news on the "illegal" transfer of water between the Imperial ID and San Diego (www.sdcwa.org)

www.mwd.dst.ca.us

Metropolitan Water District of Southern California has lots of solid resources, including "Aqueduct 2000," but some bloated graphics and no search utility detract.

www.cap-az.com

The CAP's site is light on content, but information on subcontracts and history help.

www.iid.com

Elegant and well organized, the Imperial Irrigation District's Website has concise descriptions of technical and policy issues.

www.snwa.com

Colorado River issues are a small part of the Southern Nevada Water Authority site, but the Multi-Species Conservation Program, and its Water Resource Plan are decently reviewed.

www.state.nv.us/colorado_river/

The site has very basic information about the Colorado River Commission of Nevada.

www.cbrfc.gov

Colorado Basin River Forecast Center's unassuming site is packed with valuable hydrologic data.

ag.arizona.edu/AZWATER/arroyo/

Joe Gelt's "Sharing Colorado River Water" provides an overview of the Colorado River Compact.

www.glencanyon.org

This site includes the Glen Canyon Institute's perspective on the dam and related issues, along with selected testimony.

www.grand-canyon.az.us

No hydrology or policy, just lots of photos that will make you want to go hiking.

Arizona Water Resource is financed in part by sponsoring agencies, including:

Arizona Department of Environmental Quality

Arizona Department of Water Resources

Arizona Hydrological Society

Arizona Municipal Water Users Association

Central Arizona Water Conservation District

Geraghty & Miller

Metro Water District

Salt River Project

Tucson Water

USGS Water Resources Division

Water Conservation Alliance of Southern Arizona

Water Utilities Association of Arizona

Their contributions help make continued publication of this newsletter possible.



Announcements

Call for Abstracts

The U.S. Committee on Irrigation and Drainage has issued a call for papers for the International Conference on the Challenges Facing Irrigation and Drainage in the New Millennium, to be held June 20-24, 2000, at Colorado State University in Fort Collins, Colorado. The theme of the conference will be "Meeting Human and Environmental Needs Through Sustainability, Rehabilitation and Modernization." The conference will provide an opportunity to learn of the latest solutions, innovations, and technological advances practiced in the United States. Professionals involved in water resources, agriculture and environmental issues are invited to submit abstracts. Abstracts, due by Jan. 1, 1999, should address identified topics and sub-topics and be submitted with abstract form. Flyers listing topics and sub-topics can be obtained from U.S. Committee on Irrigation and Drainage, 1616 17th St., # 483, Denver, Co 80202; phone: 303-628-5430 or from the USID web site: www.uscid.org/~uscid

Upcoming Groundwater Conference

The Groundwater Foundation is sponsoring a conference, "Bringing Groundwater to Life," Nov. 12-15 at Anaheim, CA. Representatives from Groundwater Guardian communities will share their groundwater experiences, and water educators from across the country will relate their successes in groundwater education. Fees vary depending on sessions attended, with attendance for the entire conference \$315 for Foundation and Guardian members and \$349 for non-members. For additional information contact: The Groundwater Foundation, P.O. Box 22558, Lincoln, NE 68542-2558; phone: 402-434-2740; fax: 402-434-2742; email: info@groundwater.org; web site: www.groundwater.org

Conflict Resolution Workshop

The Environmental Conflict Resolution Program of the Udall Center for Studies in Public Policy at The University of Arizona is sponsoring a 40-hour advanced training session titled "Environmental and Public Policy Mediation." The session, which will be conducted by senior professionals from CDR Associates, Boulder, Colorado, will be held at Biosphere II Center, Oracle, Arizona, from November 16-20. The training sessions will include instruction, demonstration and role playing activities. Topics to be covered include the dynamics of conflict and conflict analysis; negotiation, mediation, and facilitation and complex public mediation and multi-party environmental mediation. Enrollment will be limited to approximately 30 people. Training fee is \$600. For more information contact Susan Moodie, The Udall Center for Studies in Public Policy, The University of Arizona, 803/811 E. 1st St., Tucson, AZ 85719; phone: 520-621-7189; email: smoodie@u.arizona.edu

National Wetlands Award Nominations Sought

Nomination forms are currently available from the Environmental Law Institute for the 1999 National Wetlands Awards Program. The deadline for submission is Dec. 15. The 1999 National Wetlands Awards Program is co-sponsored by the Environmental Law Institute, EPA, Natural Resources Conservation Service, U.S. Fish and Wildlife Service and National Marine Fisheries Service. The program is designed to honor exceptional individuals who have demonstrated extraordinary effort, innovation and excellence in wetland conservation through programs or projects at the regional, state, or local level. Federal employees and organizations are not eligible. The five award categories are: education and outreach; science research; volunteer leadership; land stewardship and development; and outstanding wetlands program development. To receive a copy of the 1999 National Wetlands Awards nomination forms, or if you have any questions, contact Heidi Hallman (phone: 202-939-3250; email: hallman@eli.org) or write to the National Wetlands Awards Program, Environmental Law Institute, 1616 P Street NW, Suite 200, Washington, D.C. 20036. The nomination form is also available on the ELI web site: www.eli.org



Energy Management Conference Set

The 1998 Energy Management Conference will be conducted Nov. 4-6 in Prescott, Arizona. Included on the agenda is a two-part workshop on water/wastewater. Part I provides an overview of and applications of energy-efficient motors in water/wastewater operations and developing maintenance plans for new technologies; Part II looks at variable speed drives, precision controls and optimization of pumping systems for both gas and electric applications. Registration fee is \$95 before Oct. 23; \$115 after Oct. 23. For additional information contact Gloria Castro, Arizona Department of Commerce, Energy Office, 3800 N. Central Ave. Suite 1200, Phoenix, AZ 85012; phone: 620-280-1426.

AWPCA Call for Papers

The Arizona Water and Pollution Control Association requests papers for its 1999 annual conference to be held in Tucson, May 5-7, 1999. Attendees wanting to make a presentation at the technical program should submit an abstract to: Vance Lee, Carollo Engineers, 3877 N. 7th Street, Suite 400, Phoenix AZ 85014; phone: 602-263-9500; fax: 602-265-1422; email: vlee@carollo.com Attendees wanting to make a presentation at the operators forum should submit an abstract to: Sami Kader, Damon S. Williams & Associates, 3838 N. Central Ave., Suite 17 Phoenix, AZ 85012; phone: 602-265-5400; fax: 602-265-5632; email: dswallc@aol.com Abstracts must be submitted by Nov. 26.



Calendar of Events



RECURRING



Arizona Hydrological Society (Flagstaff). 2nd Tuesday of the month (during the school year), 7:00 pm NAU, Southwest Forest and Science Complex, 2500 S. Pine Knoll Dr., Room 136, Flagstaff. Contact: Abe Springer 520-523-7198.

Arizona Hydrological Society (Phoenix). Usually 2nd Tuesday of the month. Contact: Cortney Brand 602-371-1110.

Arizona Hydrological Society (Tucson). Usually 2nd Tuesday of the month. Contact: Marla Odom 520-881-4912.

Arizona Water Protection Fund Commission. Contact: Perri Benemelis 602-417-2400, ext. 7172.

Arizona Water Resources Advisory Board. Contact: Kathy Donoghue 602-417-2410.

Central Arizona Water Conservation District. Usually 1st and 3rd Thursdays of the month, time to be determined one week before. CAP Board Room, 23636 N. 7th St., Phoenix. Contact: Ardis McBee 602-869-2210.

City of Tucson Citizens Water Advisory Committee. Usually 1st Tuesday of the month, 7:00 am - 9:00 am 310 W. Alameda, Tucson. Contact: John O'Hare 520-791-5080 ext. 446.

Maricopa Association of Governments / Water Quality Advisory Committee. Contact: Lindy Bauer 602-254-6308.

Maricopa County Flood Control Advisory Board. Usually 4th Wednesday of the month, 2:00 pm, 2801 W. Durango, Phoenix. Contact: 602-506-1501.

Phoenix AMA, GUAC. Sept. 15, 9:30 am, Conference Room A, 500 N. 3rd St., Phoenix. Contact: Mark Frank 602-417-2465.

Pima Assoc. Governments / Water Quality Subcommittee. Usually 3rd Thursday of the month, 9:00 am 177 N. Church St., Suite 405, Tucson. Contact: Greg Hess 520-792-1093.

Pinal AMA, GUAC. Usually 3rd Thursday of the month, 3:00 pm. Pinal AMA Conference Room, 1000 E. Racine, Casa Grande. Contact: Randy Edmond 520-836-4857.

Prescott AMA, GUAC. 2200 E. Hillsdale Rd., Prescott. Contact: Phil Foster 520-778-7202.

Santa Cruz AMA, GUAC. Usually 3rd Wednesday of the month, 9:00 am, Santa Cruz AMA Conference Room, 857 W. Bell Rd., Suite 3, Nogales. Contact: Alejandro Barcenas 520-761-1814.

Tucson AMA, GUAC. Usually 4th Friday of the month, 9:00 am, Tucson AMA Conference Room, 400 W. Congress, Suite 518, Tucson. Contact: Kathy Jacobs 520-770-3800.

Verde Watershed Association. Contact: John Parsons and Tom Bonomo, VWA Newsletter Editors, Verde Watershed Association, P.O. Box 280, Camp Verde, AZ, 86322. 520-567-2496. email: verde@sedona.net

Water Users Association of Arizona. 2nd Friday of the month at noon (except in September). Call for reservations and exact location. Contact: Bob O'Leary, 602-234-1315.

Yavapai County Flood Control District Board of Directors. Every other Monday in Prescott, 1015 Fair St.; Every other alternating Monday in Cottonwood, 75 S. Paula. Contact: Ken Spedding, 520-771-3197.

UPCOMING



October 19-22, 14th Annual Conference on Contaminated Soils, Murray D. Lincoln Campus Center, University of Massachusetts at Amherst. Registration fee is \$545. For conference information, contact: Denise Leonard 413-545-1239; for registration information, contact: 413-545-0172.

November 16-19, AWRA's Annual Conference on Water Resources, Marriott's Grand Hotel, Clear Point, Alabama. Registration is \$335 member and \$405 non-member before October 30, \$385 member and \$455 non-member afterwards. Contact: AWRA, 950 Herndon Pkwy., Ste. 300, Herndon, VA 20170-5531; 703-904-1225; fax: 703-904-1228; email: awrahq@aol.com

March 21-25, 1999, Third Inter-American Dialogue on Water Resources, Hotel El Panama, Panama City, Republic of Panama. For information contact CATHALAC (Centro del Agua del Tropico Humedo para America Latina y el Caribe) Calzada de Amador, Casa 152-A; PO Box 873372, Zona 7, Panama, Republica de Panama; 507-228-7072; fax: 507-228-3311; web site: <http://www2.usma.ac.pa/~cathalac/>

June 29 - July 3, 1999, 6th Conference of the International Water and Resource Economics Consortium, "Water and Environmental Resource Management: Focus on Asia and the Pacific" at the Royal Waikoloan in the Big Island of Hawaii. Contact: Prof. Ujjayant Chakravorty, Agricultural and Resource Economics, Gilmore 112, 3050 Maile Way, University of Hawaii, Honolulu, HI 96822. phone: 808-956-7279; email: unc@hawaii.edu

Submit calendar, announcement, or publication information to Jim Henderson, WRRRC at 520-792-9591 x51; fax 520-792-8518; email wrrrc@ag.arizona.edu.

Safe Yield...continued from page 2

Instead, copper mining in Arizona has rebounded with a vengeance, aggressively utilizing new technologies to efficiently extract more copper from lower-grade ore. Today, eight new copper mines or major expansions to existing mines are planned in Arizona, with several of them sited in the Tucson and Pinal AMAs.

Also agricultural water demand was projected to decline over time as irrigation efficiencies increased and farmland on the urban fringe was urbanized. What agriculture remained was projected to switch from pumped groundwater to Central Arizona Project (CAP) water.

Many agricultural irrigators however are finding it difficult or impossible to achieve 85 percent irrigation efficiencies. Agricultural lands have been largely urbanized in some areas, but in other areas, including the Tucson AMA, much development remains concentrated in the foothills, not in the flatter, agricultural portions of the AMA. Incentives to steer development toward agricultural lands or buy out farmers have not been put into place.

As water demand has remained stubbornly high, efforts to switch to renewable supplies have encountered unexpected difficulties. Cities were expected to accept and directly deliver large quantities of CAP water, with farmers and irrigation districts taking the rest. But CAP water has proven too expensive for many irrigators, who continue to pump groundwater.

CAP usage has failed to meet expectations in other areas, too. The City of Tucson, which holds the largest single municipal contract, treated and delivered CAP water for only a short period, when a combination of acidic water and aging water mains produced corrosion problems and brown water at the tap. The treatment plant was shut down, and the community contin-

ues to debate how best to use its CAP allocation. Copper mines remain leery of using CAP water because of its fluctuating water quality, and in some cases, fear that a cessation of groundwater pumping could cause localized chemical plumes to spread through the aquifer.

Use of effluent has increased enormously since 1980, but a 1989 court decision that concluded it was neither surface water nor groundwater has reduced ADWR's ability to regulate its use. The biggest category of effluent use is turf irrigation. While a growing number of new and existing golf courses and other large turf facilities now use reclaimed water, many still are built and, at least initially, irrigated with groundwater.

Ironically, most of the developments that have made safe yield a more difficult goal to achieve are good news when not viewed from the narrow perspective of a water resource manager. More affordable housing, a profitable copper industry, relatively cheap water, and a state economy that continues to attract new business and people in huge numbers all add up to a rosy economic scenario. Conversely, this makes the increased water demands associated with prosperity more difficult to attack.

That safe yield might not be reachable by 2025 has long been acknowledged. The state auditor general in 1989 stated that the AMAs might not achieve safe yield by 2025, and recommended the Legislature convene a groundwater code study commission. ADWR director Bill Plummer disagreed, stating that safe yield was still achievable under the existing code, and opining that such a study "could generate divisive attempts to alter the basic structure of the Code which, the draft report finds, has served Arizona so well."

Nine years later, fears of re-opening the code remain, and water demands continue to deviate from earlier projections. While the fate of the safe yield goal is far from clear, the issue appears to be moving to the forefront.



The University of Arizona
Water Resources Research Center
Tucson, Arizona 85721
Address Correction Requested

PLANNING

NON-PROFIT ORG.
US POSTAGE
PAID
TUCSON, ARIZONA
PERMIT NO. 190

2*1*****5-DIGIT 85701
MICHAEL GRASSINGER
450 W PASEO REDONDO STE 202
TUCSON AZ 85701-8275