ARIZONA
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U.S., Mexican Researchers Study Monsoon

by Joe Gelt

Eagerly anticipated and vitally needed, the North American monsoon is also elusive and difficult to predict. When will it arrive? How much precipitation will it deliver? How long will it last? Research is underway to study the workings of the monsoon to find answers to these and other monsoon questions.

The work is being undertaken as part of the North American Monsoon Experiment, an eight-year international research project led by the National Oceanic and Atmospheric Administration and Mexico's national weather service, the Servicio Meteorológico Nacionale. The project's overall goal is to improve monsoon forecasting on varying time scales, from just a few hours to a few months in advance, or in the words of David Gochis, one of the principal NAME investigators: "We're exploring the limits of predictability." The project is the most extensive study yet of the North American monsoon.

(Although Arizona obviously has much at stake in studies of the monsoon, the state occupies a relatively small section of the total

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Coping with the monsoon season requires knowledge and ingenuity. The above unfortunate situation is the result of human folly. What may seem to be a puddle at the bottom of an underpass may be a pool of water about four-feet deep. The North American monsoon is the subject of a major U.S.-Mexican research project as scientists seek a better understanding of the workings of the monsoon. (See article at left.) Whether the scientific study reduces such acts of human folly as the above remains to be seen. (Photo: Arizona Daily Star *photo file)*

Basin States Consider Ways to Share Colorado River Shortages

Drought is cause to cooperate

by Joe Gelt

"Drought drum" is a particularly apt expression now making the rounds since one can sense a building intensity and a foreboding beat in the sound of a drum.

The drought drum beats along the Colorado River, and officials of basin states are meeting to work out plans for sharing the dwindling resources of a drought-struck river. Whereas basin states once negotiated ways to fairly and equitably share Colorado River water (or at least achieve as close an approximation as possible) they are now discussing ways to fairly and equitably share water shortages.

Also, the sides are realigned. At one time, the defining Colorado River conflict pitted California against the other six basin states. Now the drought has each state turning inward to focus on its own water needs and warily eyeing other basin states.

A new water management day is dawning on the Colorado River.

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Officials of the seven basin states are determined to seize the day by taking the initiative to work out a plan to share and manage river shortages. The federal government has put the states on notice that if they do not devise a plan among themselves, federal officials will step in and impose water restrictions along the river.

One action the states would prefer not to occur is for the Secretary of the Interior to declare a shortage on the river. Each year the Secretary, in her role as "river master," evaluates the Colorado River water supply to determine whether it is normal or whether surplus or shortage conditions prevail.

Since only normal and surplus conditions have been declared to date, shortage criteria have not been developed to guide state and federal officials when taking action. There is even a question about what should trigger a shortage declaration. Some officials believe the secretary could act when Lake Mead's surface level drops to a level interfering with power generation. The lack of specificity in the law of the river invites speculation.

Off in the future is yet another possible concern to provoke anxiety among officials and promote efforts at cooperative action. In the event that Lake Powell runs dry, the law allows the lower-basin states to issue a "compact call." The upper-basin states would then have to release water downstream to ensure that 75 million acre feet were released over the previous ten years, even if it means sacrificing their own supplies. All basin states would prefer that such a call is never made, fearing the consequences. Water war would be likely, with legal challenges and court actions the order of the day.

Events are therefore aligned for states to cooperatively work out a shortage sharing strategy. The Arizona Department of Water Resources is conducting a series of public meetings to discuss shortages on the river. The next meeting is scheduled for Sept. 28. Also, a technical group made up of representatives of all seven basin states has been meeting. Its role includes working out strategies for addressing shortage and shortage criteria. A principals' group with high-ranking officials from all the basin states also meets.

(Meanwhile Arizona has embarked on developing its own drought management plan to enable the state to better cope with drought internally. See side bar below for information about the state plan.)

Issues are being identified that are likely to arise as cooperative drought planning and negotiation progress. At this stage, much of the discussion might be stamped "rough draft," its intent speculative and exploratory.

Law of the River

Speculation persists about what effect the drought will have on the law of the river. The law of the river, actually a mix of compacts, congressional acts and legal decisions, has been viewed as the ultimate authority in allocating and using Colorado River water. In that sense, speculation might more appropriately focus on what effect the law of the river will have on drought planning and management. But that is not the case.

The prolonged drought is causing various ambiguities and uncertainties to arise challenging the law of the river. Not securely in place are the necessary legal and institutional mechanisms to interpret the priories, define various options and devise strategies for dealing with drought. Yet the law of the river remains sacrosanct, its authority upheld and protected against those wanting to change or modify it to accommodate developing conditions, such as emerging drought conditions.

States have mixed feelings about the law of the river. Arizona, which is generally protective of the law, would like it rethought to give the state a more advantageous position in sharing the river with regards to priority during shortages on the river. The Central Arizona Project has junior status and would be the first to suffer water cutbacks during shortage. In fact, CAP could possibly have its entire 1.5 million acre feet allocation cut before California loses a drop.

Improved River Management

Water better managed could mean more water available. Moving Colorado River water to the lower river south of Parker Dam for use by U.S. farmers is an unwieldy process, with a three-day interlude between when orders are placed and deliveries received. Inefficiencies result, and water is lost.

The amount of water lost due to the inefficiencies of the process is significant. In 2000, more than 300,000 acre feet flowed to Mexico over the country's basic allocation. Since 2000, a total of about 600,000 acre-feet has been lost. Due to U.S. Bureau of Reclamation efforts to work with farmers to use water more efficiently and place more accurate orders, total water lost fell to an estimated 60,000 acre feet last year.

Also, better river management would result in officials cracking down on farmers who intentionally overuse their water entitlements. Further, the activities of unauthorized users who tap into the river would be halted.

Yuma Desalter

The drought has brought the Yuma desalter to the forefront. Built to control the salinity of agricultural runoff entering Mexico, the $280-million plant was deemed too expensive to operate; nor was it needed with the river at normal flow and the reservoirs at Lake Powell and Lake Mead at capacity. Bypassing saline return flows from agricultural districts

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Arizona Drought Plan

A draft of Arizona's first drought plan is available for public comment. The drought planning process sought to answer the question: What conditions create vulnerability to drought, and what potential adaptive responses can be taken to cope with the effects of drought? The plan emphasizes monitoring, preparedness, mitigation and emergency response. Experts from the National Drought Mitigation Center contributed to the development of the plan. Also, the drought planning experiences of other states was considered.

The draft drought plan and accompanying statewide conservation strategy document can be obtained at http://www.water.az.gov/gdtf/ Public meetings will be conducted at the following locations: Prescott, 9/8, Show Low, 9/9; Safford, 9/14; Nogales, 9/15, Yuma, 9/21, Kingman, 9/22. Comments can be submitted via e-mail: dtf@adwr.state.az.us. The public comment period ends September 24.

Water Vapors

Dr. Seuss on Rain

With the monsoon season upon us, our thoughts quite naturally turn to rain. For at least some of us, this calls to mind a Dr. Seuss quote: "The storm starts when the drops start dropping. When the drops stop dropping then the storm starts stopping." The quote comes from his book "Oh Say Can You Say."

(Water writing relies on a number of old reliable quotes called into service way too frequently. Too often we have heard or read about whiskey's for drinking and water's to fight about. And then there is water, water everywhere but not a drop to drink. Coming across an untrampled quote about water, like the Dr. Seuss quote, is like encountering a breath of fresh air or, rather, a spray of fresh water.)

Drought is the water topic of the day, and the Dr. Seuss quote, although not about drought, is relevant to the situation. What the quote nicely expresses is that rain begins and after a while it ends. This also is very much on the mind of drought watchers — the occurrence of rain, its beginning, ending and, of course, how much. The quote sounds a whimsical note amidst our continuing drought worries.

Rain Begins With Raindrops

The long-running drought has caused raindrops to be on just about everybody's minds, especially with the monsoon season raising expectations of rain. Aspects of raindrops that previously had gone unnoticed might now attract greater appreciation; for example, what goes into determining the size of raindrops. According to Randy Cerveny, associate professor of geography at Arizona State University, the thickness of clouds has a lot to do with the size of a raindrop. A raindrop falling through a thicker cloud is more likely to combine with another raindrop to form a larger raindrop.

Although of lesser importance, temperature also is a consideration. Since cold air does not hold as much moisture as warm air, raindrops falling from cold clouds are smaller. The great big monsoon raindrops that fall and splatter are the result of the warm summer temperatures.

Raindrops vary in size, with some getting as large as a quarter-inch in diameter but most being about one-fiftieth of an inch or smaller. To be heavy enough to fall with the force of gravity a raindrop must be at least one-hundredth of an inch. The tear-shaped raindrop is a popular misperception, not unlike the belief that groundwater exists in a subsurface pool. The actual shape of falling raindrops is round and flattened. Raindrops generally fall at about 7 mph but can fall as fast as 18 mph.

Observations at the microscopic level reveal further characteristics. The average drop of water has 1,700,000,000,000,000,000 molecules or, in other words, 1.7 quintillion.

Looking ahead ...

Photo: Joe Gelt

The Water Resources Research Center has begun planning its next annual conference. The conference topic will be "Water and the Environment" and will be conducted at the Radisson Hotel City Center, Tucson, April 6, 2005. The full-day program will feature a mix of key note speakers, panel discussions and commentary. Additional information will be provided in future issues of the "AWR" and on the WRRC web site or contact us at wrrc@ag.arizona.edu to have your name added to the conference email list.

USGS Sponsors Supplement

This edition of the "AWR" contains a 4-page supplement sponsored by the U.S. Geological Survey, to provide information about two of its research projects. At the same time, USGS, by sponsoring the supplement, is supporting the publication of the newsletter. We appreciate the opportunity to work with USGS and for the agency's generous support.

Other agencies and organizations are invited also to sponsor a newsletter supplement. They would provide the text, and we format it for publication and mail it out as part of the newsletter. The fee we charge for the service helps support continued publication of the newsletter. Contact Joe Gelt, editor, for information about sponsoring a supplement with information about your organization.

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News Briefs

ADEQ Completes Source Water Assessments

The Arizona Department of Environmental Quality recently fulfilled a Safe Drinking Water Act requirement by completing its Source Water Assessments. Required of each state, SWAs evaluate public drinking water sources, with the information then made available to the public for use in protecting community source waters from contamination. The Arizona SWAs analyze drinking water sources for the more than 1,500 public water systems throughout the state.

Safe Drinking Water Act guidelines specify what a state must to do to complete its SWAs. Source water assessment areas must be delineated, with potential sources of pollution within the areas identified. Also, the susceptibility of an area's water supply to the identified pollution must be evaluated.

A final and very crucial step of the SWA process is to release the information to the public. A prime purpose of SWAs is to expand community awareness of the importance of source water protection and to provide citizens the means to be involved in protection activities.

"Source water protection is important for preserving clean, safe drinking water," ADEQ Director Steve Owens said. "When communities better understand the nature of their drinking water sources and what types of activities could threaten the integrity of source waters, they are better equipped to protect those resources."

The intent of the SWA program to make readily available a wide array of information about source waters was questioned after 9/11 when security issues were raised. The U.S. Environmental Protection Agency and the states then confronted the challenge of ensuring SWA data was available to appropriate parties and at the same time restrict its access to those who would misuse it.

Arizona is ensuring the security of its SWA information by requiring that an application be submitted to obtain any information deemed sensitive, such as specific location of water sources and facilities. Jeff Stuck, manager of the ADEQ Safe Drinking Water Section, says an applicant will have to state " ... how they will use the information and equally important how they will not use the data."

For draft reports for various areas of the state or for more information contact ADEQ's Source Water Assessment unit at 602-771-4561; toll free 800-234-5677; email: dml@ev.state.az.us

Two New AMA Directors Announced

The Arizona Department of Water Resources recently announced the appointment of two new Active Management Area directors, for the Tucson and the Pinal AMAs, and is presently advertising for a Water Resource Specialist IV, a senior level position at the Phoenix AMA office.

The Tucson AMA's new director is Ken Seasholes. Seasholes started at the agency four and a half years ago as a water resource specialist, moving up to be assistant area director before being appointed AMA director. Prior to joining ADWR, Seasholes worked at the University of Arizona's Water Resources Research Center as a senior research specialist.

Randy Edmond has been appointed the Pinal AMA director. Edmond has been at the Pinal office since it began in 1981,.starting as a water resource specialist, becoming the assistant director in 1985 and then director in April. He has a bachelors degree in mathematics from the University of Arizona and earned a masters at the UA in agricultural economics in 1973.

Applicants are currently being sought for a water resource specialist IV position. The person will have an agency-wide role in reviewing the ADWR's municipal water conservation program. See Announcements, page 10, for job announcement.

CA's Water Savings is Mexico's Loss

California's plans to limit its use of Colorado River water to its allotted 4.4 million acre feet have consequences up and down the river, and even into Mexico where Mexicali farmers will face dwindling groundwater supplies.

To conserve Colorado River water, California is planning to line segments of the All American Canal that deliver water to the Imperial Valley. Mexican farmers will feel the unintended consequences of the action since water from the unlined canal has been percolating into the soil to recharge the underground water supply across the border.

Mexicali farmers in Baja California's richest agricultural regions have relied on the recharge benefits for more than 50 years, ever since wells were dug in the area in early 1950s. It is an area of rural agricultural communities, with more than 14,000 families relying on canals and wells.

Long on the drawing boards, California's plan to line the 23-mile stretch of the canal with concrete is taking shape, with a 2006 groundbreaking scheduled and a completion date set for 2008. The U.S. Bureau of Reclamation estimates that the project will save California about 67,000 acre feet of Colorado River water, an amount about equal to the annual needs of 134,000 families in San Diego County.

San Diego's gain, however, is Mexico's loss, with the Mexican federal government estimating that about 40,000 acres and 1,000 families with water rights will be affected by the California project. An additional 3,000 acres partially watered by seepage as well as wetlands located near the canal are also expected to be impacted by the project.

The project is expected to have consequences to water quality in Mexico. Groundwater fed by canal seepage contains less salt than Colorado River water, the other water source for irrigation in the area. As a result, groundwater is preferred by many farmers in the area.

Growers also fret about other consequences of the canal-lining project. They worry about having to dig deeper wells with

Cities Win/Lose Some in Efforts to Restore River Flow

A Tale of Two Cities

Tucson's plans to restore flowing water in segments of the Santa Cruz and Rillito rivers encountered a setback recently when a U.S. Army Corps of Engineers' three-year study concluded that running water in either river year-long is not feasible. Instead of water, a corps report scheduled to be released next month will propose planting trees and shrubs along the rivers.

Named Paseo de las Iglesias, the Santa Cruz River project calls for planting 718 acres of large mesquite trees and 356 acres of smaller mesquites along with such shrubs as saltbush, wolfberry and brittle bush. Also to be planted would be 18 acres of cottonwood and willow trees and 6 acres of marsh reeds and grasses. The revegetated area will cover 7.5 miles of the Santa Cruz at a cost of about $90 million. Another $100 million would have been needed if water were to be put into the river.

The corps proposal for the Rillito includes the planting of 115 acres of mesquites, 99 acres of cottonwoods and willows, 62 acres of shrubs and 7 acres of marsh grasses. The revegetation project would benefit 4.8 miles of the Rillito River at a cost of about $66.6 million.

Stored rain water and effluent will probably be used to water the vegetation. The corps' report means that federal funds will not likely be available to restore water in the Tucson rivers.

Once flowing with water and bordered by varied vegetation, the rivers lost their flow and much of their vegetation about a half a century ago when groundwater tables dropped. The river restoration cause has been variously argued as an act of environmental rescue, an urban/natural amenity for locals and a feature to attract tourists.

Plans for restoring the flow of Tucson rivers have been an item in various campaigns and government plans in the past. Early plans for Rio Neuvo, a current project to develop the Santa Cruz River area, included creating a "River of Blue."

Santa Cruz River
Photo: Joe Gelt

That the rivers would be revegetated rather than rewatered attracted varied responses, with some agreeing that it was a sensible proposal while others expressed disappointment and suggested that other funding sources be sought.

Meanwhile Tucson's rival city, Phoenix, also a town with a dry riverbed, is having more success in restoring river segments with both water and vegetation. Upstream dams have depleted water flow to the Salt River, turning a once running river into a barren strip now defaced by gravel mines and accumulated trash and junk.

Rescue work is underway, with the corps and local governments cooperating to return water to the riverbed and vegetation to the banks. Studies or actual restoration projects are in progress on sections of the Salt River, totaling about 40 miles, all located within the metropolitan area. Effluent, shallow groundwater and storm or irrigation water runoff will supply water for the projects.

a higher energy cost for pumping and possibly cutting back on acreage.

The issue has been on the horizon for years, with Mexico voicing opposition to it and the United States asserting its right to line the canal. One of the points argued by Mexican officials is that the farmers have established user rights to the water after having relied on it for more than five decades.

Mobil to Pay $5.5 Million for Clean Water Violations on Navajo Lands

The U.S. Environmental Protection Agency and the U.S. Department of Justice recently announced a settlement with Mobil Exploration and Producing U.S. Inc. worth over $5.5 million for numerous oil and produced water spills from its oil production activities on the Navajo Nation. The settlement includes a $515,000 penalty and requires the company to spend about $4.7 million on field operation improvements to reduce spill incidences.

Mobil also will spend approximately $327,000 on environmental projects. These include sanitation facilities and the construction of a drinking water supply line extension to provide running water to 17 of the remote residences located on the oil production fields. Local residents currently may drive as long as an hour to fill 55-gallon drums with drinking water.

Undertaking these projects was not mandated by the settlement, and the government viewed the commitment as a goodwill gesture and somewhat reduced the oil company's penalty.

"This settlement brings Mobil's oil production activities into compliance with water pollution control requirements, and also brings much-needed public health benefits to residents of the area who still lack an in-home drinking water supply," said Wayne Nastri, the EPA's regional administrator for the Pacific Southwest region.

The settlement is in response to a March 1998 EPA and the U.S. Department of Justice lawsuit claiming that between December 1991 and March 1999 approximately 83 spills at Mobil's oil fields reached tributaries of the San Juan River.

Mobil's violations include unauthorized discharge of oil and oil and water mixtures into tributaries of the San Juan River; failure to prepare and fully implement an adequate spill prevention and control plan; failure to implement existing plans; failure to prepare a facility response plan or conduct drills and training; and failure to notify the EPA of discharge events

Mobil's oil production fields are located on both sides of the San Juan River in southeast Utah. The Navajo Nation Environmental Protection Agency first brought the spills to EPA's attention in 1996, and EPA worked closely with the tribal agency in addressing the issue.

Guest View

Take Care When Providing Environmental Information to Public

Suzanne Pfister, vice president, Environmental and Community Outreach Division, BJ Communications, contributed this Guest View. She will be conducting a workshop on this topic Sept 15 at the Radisson Hotel, Tucson, as part of the Arizona Hydrological Society Symposium, Sept. 15 - 18. Check web site for additional information (http://www.azhydrosoc.org/symposium.html)

"Corporations fined millions of dollars for groundwater contamination."

"Public policy leaders debate the health risks of spraying pesticides throughout neighborhoods to protect citizens from waterborne diseases."

"Strange amoeba in groundwater are linked to the deaths of two boys in a rare occurrence. Officials say chlorine kills the amoeba, yet it's still found in some chlorinated test results."

All of these are real-world situations that Arizonans have struggled with during the past year or so, and they clearly bring home the fact that communicating scientific information — particularly with regard to water quality issues — can be extremely challenging. Unfortunately, there are no easy answers for how to handle these situations, but research and practical experience have shown us some ways to approach the difficulties that can help practitioners achieve a more balanced public discussion.

In America, acceptable water quality is something we take for granted. Anyone who has traveled abroad knows that we are incredibly blessed with standards that, for the most part, allow you to travel anywhere in the country and not worry about whether it is safe to "drink the water." Because of this near universal acceptance, the threat of unsafe water is considered particularly egregious in our society, and generates strong outrage from the public if they do not understand, or do not trust, information they are being provided.

So just how do you communicate this difficult and often complicated information? There has been a great deal of research conducted about how people perceive risk; here are some suggestions when you are the one who must communicate the information.

- Keep it simple and human: Countering emotional feelings with data is deadly because it shows a lack of compassion and ignores people's feelings. Throw out the jargon, put the terms in understandable English, and use examples relating to real-world experiences.

(One example I often use is avoiding the word "contamination." It is a regulatory term, but for most of us, the constituents are often gasoline and cleaning solvents, and we understand that better because these are things we use. I also use the term "impacted groundwater" instead of "contaminated groundwater" because it is a more value-neutral statement.)

- Use visuals to support the information: We are a society that is conditioned to receive our news and information visually. The "MTV" generation wants it quick, visual and with impact. You are competing with this in order to get your message across, so support your information with visuals whenever possible.

(I once had to describe a situation when a process wastewater tank released water used to clean electronic wafers into a "secondary containment" unit. I had to get the message out that it was not a "spill," since all the water had been contained. With the media pressing for a response, I drew a simple picture and described it as a tank in a concrete bathtub, and the bathtub was big enough to hold all the water that had been released. The environmental manager was aghast at my description, but the media understood it and communicated the situation in a less dramatic way. Two days later, we had a great diagram depicting the entire containment process.)

- When you can't talk content – talk process: There are many situations when a complete technical analysis isn't ready when the public wants to react. Rather than the "no comment" mistake, express compassion, and then explain the process by which the tests are being conducted, what the time frame is to know more information, and what steps are being taken to protect public health in the interim. The more you don't talk, the more it appears that you are hiding something, rather than the real fact that you don't yet know. So explain the process, and develop ways to update interested people as you move through it.
- Don't rely on just one communication technique to get the word out: A common mistake is to develop a fact sheet, distribute it to neighbors, and then wonder why people still feel they have not been communicated with. The reality is people have differing levels of interest, and communicate most effectively in different ways. You need to account for this, and provide both formal and informal lines of communication.

(An open house meeting is a good example of providing information in a way that allows people to consume at their own speed and in ways that work best for them. There is a lot of informal interaction, the level of "political drama" is often reduced because opponents can't take over the meeting, and people can ask the questions they are seeking answers to. Another key is to be as responsive to the inquiries as you can.)

- Release the bad news early to best manage the message: If there is a good chance that the news will be made public, you are more likely to succeed in framing the message on your terms if you release as much as you can as early as possible. It even appears less newsworthy if you release it. If you wait, and it gets leaked, it tends to be a bigger story, and you are more apt to lose trust and credibility. You also can better control the accuracy of the information if you are the first to present it. In addition, you can focus on the steps to resolving the situation as well as the problem.

The most important goal is to maintain your credibility and reassure people that you are working toward a good resolution to the problem. And that you will keep them informed and engaged as you do it.

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Studies Examine Historical Water-use Trends, and Climate-Groundwater Interaction

Following are two recent U.S. Geological Survey reports from Arizona District hydrologists. The first report summarizes information in U.S. Geological Survey Scientific Investigations Report 2004-5148, by A.D. Konieczki and J.A. Heilman, (in press). The analysis provides a record of historical trends for agricultural, domestic and industrial water use. Contact A.D. Konieczki at 520-670-6671 ext. 270 or via email at alicek@usgs.gov if you have any questions or comments.

WATER USE TRENDS IN FIVE SOUTHWESTERN STATES—1950–2000

by A.D. Konieczki

Every 5 years since 1950, the U.S. Geological Survey has compiled and published water-use data in Circulars entitled "Estimated use of water in the United States." The Circulars include water use for several categories including public and domestic use, agricultural use, and industrial use. These reports also include population and irrigated-acreage data. The most recent Circular (available at http://water.usgs.gov/pubs/circ/2004/circ1268) summarizes water use for 2000.

In this study, data from these 5-year reports were compiled for 1950 to 2000 and examined to identify changes over time in ground-water and surface-water withdrawals for agricultural, domestic, and self-supplied industrial water uses for Arizona, California, Nevada, New Mexico, and Utah as part of the Southwest Ground-Water Resources project that is supported by the Ground-Water Resources Program of the U.S. Geological Survey (USGS) Office of Ground Water. Comparisons of water use, water-use trends, and sources of water among the Southwestern States may assist in the distribution management of limited water resources. Estimated withdrawals for domestic use include reported public-water supply as well as self-supplied domestic use. Withdrawals for industrial water use include self-supplied water used for mining, thermoelectric, and other general industrial and commercial purposes. Withdrawals for agricultural use include water used mainly for crop irrigation and, when reported, for livestock.

Water-Use Trends

The estimated amount of surface- and ground-water withdrawals from 1950 to 2000 for all purposes in Arizona, California, Nevada, New Mexico, and Utah increased 58 percent, from 39.6 to 62.8 million acre-ft. Individually, estimated withdrawal increased 81 percent in Nevada, 72 percent in California, 46 percent in Utah, 40 percent in Arizona, and declined 4 percent in New Mexico from 1950 to 2000 (fig. 1). Water-use trends in these five States are dominated by withdrawal in California, which has the largest withdrawal of any State in the country. Crop acreage in California is about twice as large as the combined crop acreage of Arizona,

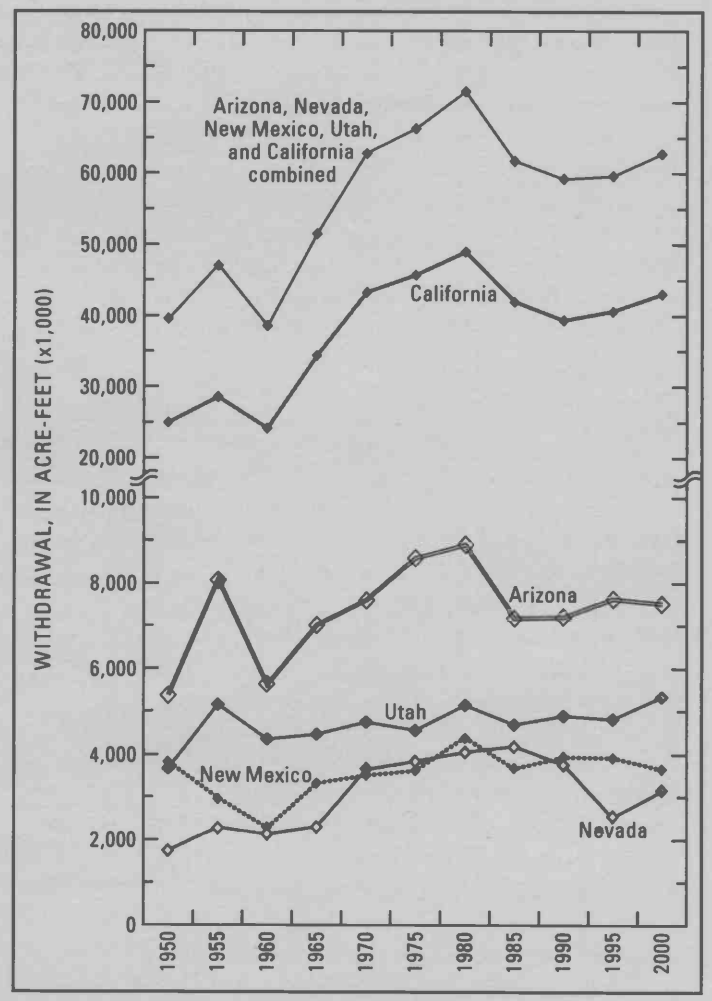

Figure 1 *Total water withdrawal in Nevada, New Mexico, Utah, Arizona, and California, 1950-2000.*

Nevada, New Mexico, and Utah, and the population of California in 2000 was three times larger than the combined population in the four other States.

Changes in ground-water withdrawal varied in the five States from 1950 to 2000. Ground-water withdrawals increased 324 percent in Nevada, 208 percent in Utah, 147 percent in New Mexico, and 52 percent in California, and decreased 15 percent in Arizona. Overall, estimated ground-water withdrawals for all five States increased 62 percent.

Agriculture

More water is used for agriculture than for domestic and industrial purposes in Arizona, California, Nevada, New Mexico, and Utah; however, the percentage of total withdrawal for agriculture decreased from 94 percent in 1950 to 80 percent in 2000. From 1965 to 2000, estimated water withdrawal for agriculture increased 14 percent in the five States, from 44.0 to 50.2 million acre-ft. Ir-

rigated acreage data for the five States were available only as far back as 1965, and since then irrigated acreage increased 12 percent from 12.6 to 14.1 million acres. Withdrawals for agriculture in California accounted for 62 percent of the water withdrawals for agriculture in the five States in 1950 and 68 percent in 2000.

Statewide average of crop-application rates (water withdrawn for irrigation of crops divided by irrigated crop acreage) from 1965 to 2000 ranged from 2.29 acre-ft per acre in Utah in 1975 to 6.21 acre-ft per acre in Arizona in 2000 (table 1). More water is used per acre of irrigated land in Arizona than in the other four States. This is due to several reasons, including differences in climate, type of crops grown, conveyance losses, growing season, and crop rotation during the year. Nearly all the agricultural land in Arizona requires irrigation because it is in the southern half of the State where the climate is arid. Another reason for the higher crop-application rate in Arizona is that a large portion of the crops are cotton and alfalfa, which have a high water use.

Domestic

Withdrawals for domestic water use, which included self-supplied domestic and public supply (all deliveries to residential, commercial, and some industrial users), increased 410 percent from 1950 to 2000. During that same period the total population in these five Southwestern States increased 250 percent. The percentage of total withdrawal for domestic water use increased from 5 percent in 1950 to 16 percent in 2000.

Estimated withdrawals for domestic use in California declined from 82 to 70 percent of the total domestic-water withdrawals in the five States from 1950 to 2000, indicating that the need for domestic use increased more in Arizona, Nevada, New Mexico, and Utah combined than in California. From 1950 to 2000 the population of California increased 220 percent and the combined population in the four other States increased 390 percent.

Public supply per-capita use (water provided by public water suppliers divided by reported population served) in the five States is generally in two distinct groups. Per-capita use is generally about 300 gal/day in Utah and Nevada and about 200 gal/day in Arizona, California, and New Mexico (table 2). Data prior to 1960 were not available.

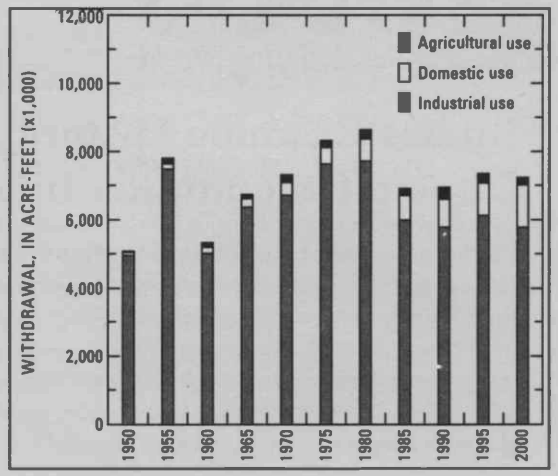

Figure 3. *Water withdrawals for agricultural, domestic, and industrial use in Arizona, 1950-2000*

Industrial

Trends of water withdrawals for industrial use are difficult to identify because of differences in data reporting from year to year. From 1950 to 2000, withdrawal for industrial use in the five States was generally less than 6 percent of the total water withdrawal. Withdrawal for industrial use was less than 4 percent of the total withdrawal in Arizona, except in 1990; industrial withdrawal was less than 6 percent in California and less than 7 percent in Nevada, New Mexico, and Utah, except in 1980, when it was almost 12 percent of the total withdrawals in Utah.

Table 2. *Per-capita use in Arizona, California, Nevada, New Mexico, and Utah—1960–2000. (In gallons per day. Dashes indicate no data.)*

State	1965	1970	1975	1980	1985	1990	1995	2000	Average
Arizona	145	147	207	213	230	200	208	206	219
California	198	231	182	186	184	218	228	184	204
Nevada	346	285	306	316	323	326	344	325	338
New Mexico	163	126	205	236	240	226	226	225	203
Utah	301	290	296	334	--	285	308	269	293

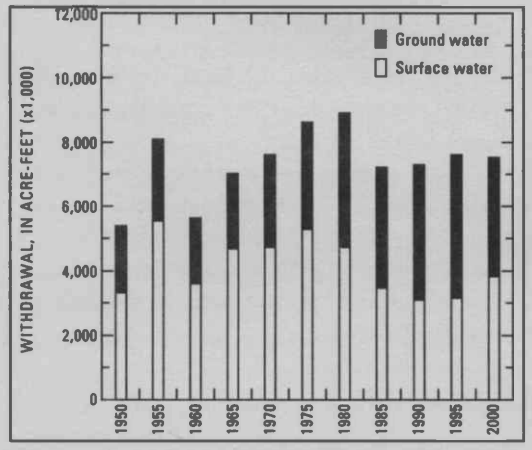

Figure 2. *Ground-water and surface-water withdrawals in Arizona. 1950-2000*

Arizona

Ground-water and surface-water withdrawals for use in Arizona increased from 5.4 million acre-ft in 1950 to 7.5 million acre-ft in 2000; the withdrawals peaked at 8.9 million acre-ft in 1980. Ground water was the primary source of water from 1950 to 1980 (fig. 2). In 1985 more surface water than ground water was used because of deliveries of Colorado River water through the Central Arizona Project. Agriculture is the dominant water-use category in Arizona; however, the portion of total withdrawal used for domestic use has increased. Estimated withdrawal for agriculture was 97 percent in 1950 and 80 percent in 2000 (fig. 3). During that time period the population in Arizona increased almost 600 percent and withdrawals for domestic water use increased more than 1,100 percent.

The following article, written by Jesse Dickinson, summarizes results from a recently published paper in "Water Resources Research" describing the relations between climate fluctuations and groundwater elevations. Contact J. Dickinson at 520-670-6671 ext. 306 or via email at jdickins@usgs.gov if you have any questions or comments.

INVESTIGATING THE EFFECTS OF CLIMATE VARIABILITY ON GROUNDWATER LEVELS AND RECHARGE RATES IN SOUTHWESTERN BASINS

by J. Dickinson

Ground water is a significant part of the water supply for the Southwest's growing population. For instance, ground water accounts for about 60 percent of Arizona's water withdrawals. Historically, development of ground-water resources has outpaced natural recharge, resulting in water-level declines in many of the agricultural and densely populated regions of the Southwest. In order to ensure that ground water will be available for use in the future, water managers have to plan for sustainability. Ground-water sustainability is defined as developing and using ground water in a manner that can be maintained for an indefinite time without causing unacceptable environmental, economical, or social consequences. Management of ground-water resources for sustainability is often accomplished using ground-water flow models that numerically represent changes in ground-water levels and streamflow discharges through time, given recharge and ground-water development information. Simulations of ground-water flow models have shown that the response of ground-water levels to climate variability is a significant issue for sustainability. The U.S. Geological Survey (USGS) Southwest Ground-Water Resources Project has been investigating how climate variability can affect natural recharge rates and water levels. Results from this study are summarized in the following discussion and are fully documented in the journal articles listed in the section entitled "For more information."

Use of models to study ground-water resources

Computer models are useful tools for understanding complex ground-water systems because the amount of ground water stored in aquifers and the rates and directions of flow are difficult and cost prohibitive to measure at adequate spatial scales. Ground-water models simulating Southwestern alluvial aquifers typically use a steady-state, or average, recharge rate though time. Recharge processes in aquifers, however, are influenced by both seasonal, interannual, and interdecadal climatic forcings. Additionally, the variability of the recharge caused by these climatic forcings is largely unknown. In situations where recharge variations are significant, the use of steady-state boundaries is likely to lead to erroneous model simulations that do not represent aquifer responses. Recharge rates that vary with time owing to climate variability are needed to improve simulation results and, therefore, improve the quality of ground-water management decisions aimed to achieve sustainability.

Reconstructing climate variability

Prior studies have revealed cyclical climate patterns during the previous century using long-term data on streamflow, precipitation, ground-water levels, and tree-ring indices (see, for example, Hanson and others, 2004). These patterns contain multiple frequencies that are partially coincident to climate cycles. Water-level cycles of 2- to 6-year periods could be related to the El Niño-Southern Oscillation (ENSO), which is a system of interactions between the tropical oceans and the overlying atmosphere. Other water-level cycles of 10- to 25-year periods could be related to sea-surface temperature variations in the North Pacific Ocean described by the Pacific Decadal Oscillation (PDO).

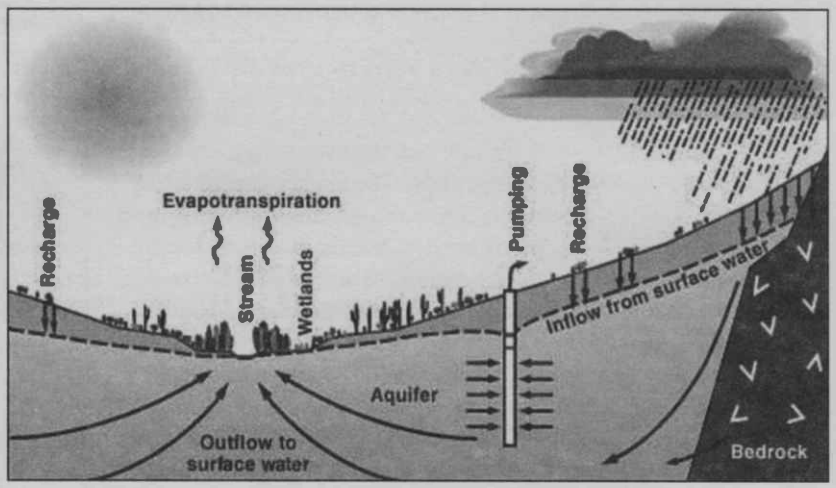

Figure 1. *Cross-section of an idealized aquifer in the Southwestern United States. Ground water flows from recharge areas near mountain fronts to discharge areas near streams and wetlands.*

Effects of climate variability on water levels

In order to gain a general understanding of the response of aquifers to climate variability, a series of ground-water flow models of idealized aquifers (Figure 1, for example) were used to simulate water-level fluctuations through time. The models include a range of possible configurations of basin size and shape, aquifer thickness, and aquifer hydraulic properties. Recharge patterns were varied similar to ENSO- and PDO-type cycles identified in previous analyses of hydrologic data (Figure 2). Ground-water flow was simulated from areas of focused recharge at a mountain front along the basin boundary to a stream at the basin center. The total recharge rate per aquifer varied between 0 and 26,000 acre-feet per year in cyclical

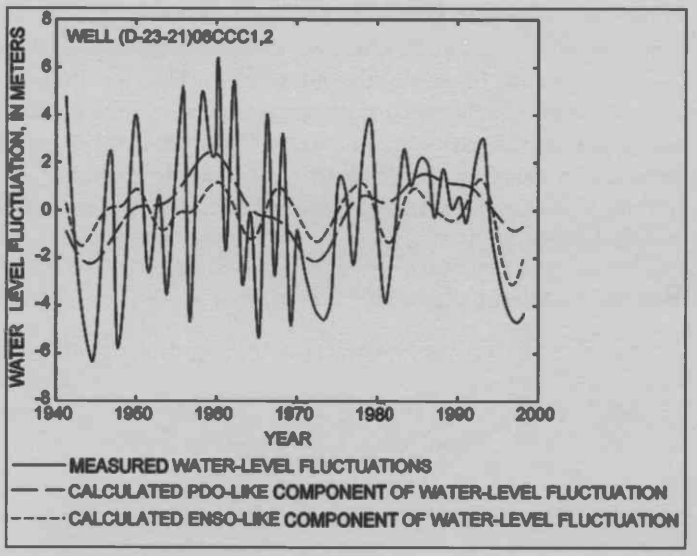

Figure 2. *Water-level fluctuations from a well in the Upper San Pedro Basin in southeastern Arizona and two calculated patterns of periodic behavior used in the inverse process.*

patterns of 4-, 8-, and 16-year periods. The aquifer transmissivity averaged 5,000 feet-squared per day in the basin center, and ranged from 5,000 to 200 feet-squared per day near the mountain margin. The storage coefficient ranged between 0.1 and 0.001.

The preliminary analyses (1) identified which basin geometries, aquifer properties, and recharge patterns most affected water-level fluctuations and (2) determined the aquifer responses to climatic stresses for selected modeled configurations. The water-level fluctuations were most sensitive to transmissivity, storage coefficient, and length of the recharge cycle. For recharge cycles of longer periods, water-level fluctuations were observed at greater distances from recharge areas in basins having large transmissivity and small storage coefficient. In contrast, water-level fluctuations of short periods were not observed outside of recharge areas in thin aquifers having low hydraulic conductivity and large storage coefficient. For example, applying a recharge cycle of a 4-year period to a simulated aquifer having a transmissivity value of 5,000 feet-squared per day near the mountain front resulted in water-level fluctuations of 29.6 feet in that area, whereas applying the same recharge cycle to a simulated aquifer having a transmissivity value of 200 feet-squared per day near the mountain front resulted in water-level fluctuations of 13.4 feet in that area (Figure 3).

Effects of climate variability on recharge rates

A method was developed to estimate variations in the rates of recharge that are attributed to climate variability. The method uses an inverse application of a one-dimensional analytical model for periodic flow to estimate periodic recharge on the basis of (1) fluctuations in long-term water-level records and (2) estimated transmissivity and storage coefficient values. In our study, the amplitudes and periods of the water-level cycles were obtained by spectral analysis of water-level time series data (Figure 3). These cycles are partially correlated to PDO and ENSO indices. At least two time series of water levels at two different wells are required for model inversion. An application of the method to the Upper San Pedro Basin in southeastern Arizona in the Carr Canyon area produced an estimate of recharge rate variation of a 20.3-year cycle that varied in time between 0 and 0.75 feet per day in that area. Recharge cycles of periods between 6.7 and 1.8 years varied in time between 0 and 13.1 feet per day. The long-term average of these estimated recharge rates were nearly equal to previous average recharge estimates at the same location of 9.0 feet per day that was used in a regional ground-water flow model.

The estimated recharge variations can be applied systematically to a transient model of regional ground-water flow to produce flow variations and water-level changes that consist of patterns and frequencies similar to natural climate variability. This allows for a more realistic and accurate representation of the year-to-year fluctuations in water levels caused by climate variations. It also translates into greater confidence in the predicted effects of future recharge and ground-water management scenarios, assuming that these recharge cycles continue into the future.

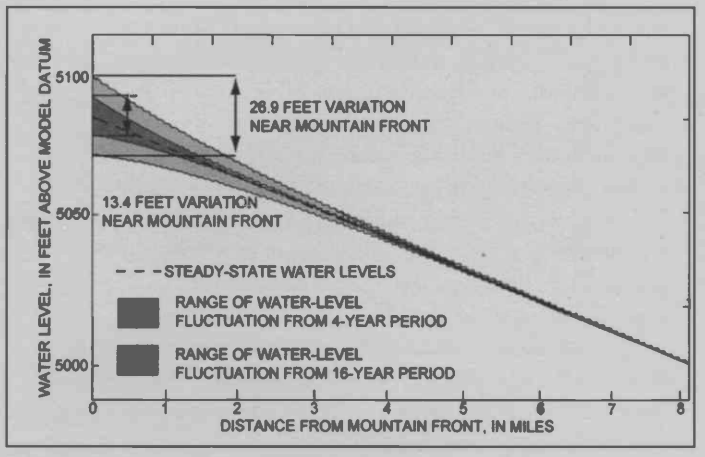

Figure 3. *Range of water-level fluctuations of the idealized model for cyclical recharge rates of 4- and 16-year periods.*

For More Information:

Dickinson, J. E., Hanson, R. T., Ferré, T. P. A., and Leake, S. A. 2004, Inferring time-varying recharge from inverse analysis of long-term water levels, in Water Resources Research, 40, W07403, doi:10.1029/2003WR002650.

Hanson, R. T., Newhouse, M. W., and Dettinger, M. D. 2004, A methodology to assess relations between climate variability and variations in hydrologic time series in the Southwestern United States, in Journal of Hydrology, v. 287 (1-4), p. 253–270.

U.S. Geological Survey
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Legislation and Law

Arizona – New Mexico Agreement Clears Way for Action on Arizona Water Settlement Act

Arizona Water Settlement Act, S. 437, is expected soon to get congressional action now that Arizona has worked out an agreement with New Mexico over New Mexico's claims to 18,000 acre feet of Central Arizona Project water. An Arizona legislative priority, S. 437 is to resolve various outstanding CAP issues. The legislation was stalled awaiting a settlement between Arizona and New Mexico over the development of New Mexico's hitherto unused CAP allocation.

The 1968 Colorado River Basin Project Act, P.L. 90-537, which authorized the building of the CAP, included an allocation of 18,000 acre-feet of water to New Mexico. New Mexico's 1968 allocation was not intended to be mainstem Colorado River water. Instead the allocation was a strategy to enable New Mexico to exchange 18,000 acre feet of Colorado River water for an equal amount of Gila River water. The Gila River is a tributary of the Colorado River that flows through New Mexico.

New Mexico's main objective in the negotiations was to work out details that would enable the state to develop its CAP allocation. In effect, New Mexico wanted funding.

Arizona's priority in the negotiations was to protect the water rights of Arizona farmers irrigating about 30,000 acres along the Gila River in the Duncan-Virden and Safford valleys, if New Mexico were to tap upriver into the Gila River. In the event of such pumping, Arizona wanted bypass parameters to be established to ensure that New Mexico's actions would not result in cost or economic injury to state water right holders.

Also in the negotiations, Arizona wanted to protect its Lower Basin Development Fund. As defined by S 437, CAP repayments, instead of going to the U.S. Treasury, would be used to establish the fund and spent to support Indian water projects in the state. New Mexico officials proposed that up to $150 million be set aside from the fund to assist the state in developing its CAP allocation.

New Mexico achieved some terms favorable to its cause but did not get all it wanted. Instead of $150 million, New Mexico, beginning in 2010, is to have access to a total of $66 million, to be paid in ten equal installments. The money is to be used for various water development projects in southwestern New Mexico. Such projects could include hydrologic studies or mitigation, restoration and/or environmental measures, and the work does not have to relate to the state's CAP allocation. New Mexico officials announced they will seek local input to identify types of projects.

Further, if New Mexico eventually decides to build a project to divert Gila basin water in exchange for CAP water, the state will have access to up to $100 million — and possibly up to $128 million depending on interest earned by the Lower Colorado River Basin Development Fund. Access to these funds would depend upon specific project feasibility requirements being met.

New Mexico officials stress that no decision has yet been made whether to divert water from the Gila River. Instead they say the agreement opens the door to making a decision in the future. According to the settlement, New Mexico has until 2014 to notify the Secretary of the Interior about plans to divert water from the Gila River. Further, the NEPA process must be completed with a record of decision by 2019.

The settlement also addressed Arizona's concern about protecting the rights of Arizona water users along the Gila River. New Mexico agreed not to divert more than 14,000 acre feet in any ten year period, even though the 1968 legislation allocated the state 18,000 acre feet. New Mexico's concession to reduce its allocation by 4,000 acre feet ensures that by-pass parameters can be set to accommodate the rights of Arizona water users along the Gila River. Specific by-pass parameters are being worked out. Further, New Mexico agreed not to divert water if the San Carlos Reservoir storage is less than 30,000 acre feet.

Environmentalists have kept a wary eye on the negotiations, concerned about possible environmental costs if New Mexico were to develop its entitlement to the Gila River, the last mainstem river in New Mexico without a major water development project. They argued that whatever diversion technique is adopted will reduce water available for wildlife, vegetation, nutrient cycling and other vital river functions.

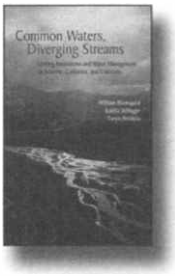
They were concerned that the terms of agreement did not include wording to protect the Gila River. A statement issued by the Gila Conservation Coalition urges that the amendment to S.437 include language that would "allow for the adequate protection of the present ecological functions and processes, riverine habitat and associated riparian corridors of the Gila and San Francisco rivers."

Some environmentalists, however, were somewhat heartened by the progress of the settlement. On the plus side, state officials seemed aware that damming the Gila River would be a very unpopular decision and therefore not an option likely to be pursued. Even further, the settlement showed that state officials, despite their position early in the negotiations, are not now totally committed to a diversion project and are willing to examine alternatives.

The New Mexico Interstate Stream Commission has endorsed the agreement between the states and public hearings have been conducted. Arizona is proceeding more cautiously. Gregg Houtz, an attorney with the Arizona Department of Water Resources, says, "We made a lot of progress and have a general agreement of principles, and we are working out the details." Working out details involves executing contracts among parties affected by the New Mexico agreement.

Arizona officials are anxious to finalize the settlement so that congressional markup on S 437 can occur. A July 14 targeted markup date was missed; officials now look forward to the work being done on Sept.15, with final legislative action occurring this session, although they concur this may be an overly optimistic goal.

Publications & On-Line Resources



Common Waters, Diverging Streams: Linking Institutions and Water Management in Arizona, California, and Colorado
William Blomquist, Edella Schlager and Tanya Heikkila, Resources for the Future, 210 pp., $30.95 paperback. (For purchasing information check http://www.rffpress.org)
Conjunctive water management, a strategy recognizing the interconnection between groundwater and surface water, has broad management and hydrological implications. This book discusses the situation of three western states that conjunctively manage, in at least parts of their areas, groundwater and surface water. The states are Arizona, California and Colorado. By comparing these three states with similar water resource problems but with different laws and organizational structures, the authors discuss the importance of institutions — laws, policies and organizational organizations — in improving resource management.

The authors focus on Arizona, California and Colorado because they share common characteristics. Each is experiencing rapid population growth and rising water demands, and each has water supplies often geographically remote from areas of water demand. Also, the states, each located in the arid Southwest, periodically experience severe and prolonged drought

Despite such common characteristics, the authors say conjunctive management has taken different paths in each state, with varying historical courses and adopted practices. The result has been different outcomes as each state works to solve similar problems with the same policy reform. In attempting to account for the different outcomes, the authors describe the origins of the conjunctive management policy, its practices, its potential and the influence of institutional arrangements on its application.

Promoted as the first book on conjunctive water management, the book is said to be making an important contribution to policy literature and policymaking. In other words, the authors are attempting to link theory with practice, often a challenging task. The authors take on the task by discussing how state laws and regulations, legal doctrines, the organizations that govern and manage water supplies, and the division of authority between state and local government can explain the diverging courses taken by each state in its adoption of conjunctive water management.

Water Resources Data for Arizona, Water Year 2003
The U.S. Geological Survey Arizona District's surface-water program operates 196 continuous-recording streamflow-gaging stations and 30 crest-stage gages throughout the state. The continuous-recording gaging stations transmit real-time data available on the Web at az.water.usgs.gov. Each year the data are reviewed, basic statistical analyses performed, and the data published in an annual data report, "Water Resources Data – Arizona." The publication contains daily streamflow data, locations of gaging stations, drainage areas, periods of record, annual and historic peak flows, annual and historic low flows, discharge statistics and gage descriptions. Groundwater level, aquifer-compaction, water-quality, and sediment data are also published in the report. The report is available online at az.water.usgs.gov/publications.html. Local, state, tribal and federal agencies support USGS data collection and publication.

Drought...continued from page 2

in Yuma into the Cienga de Santa Clara also relieved the pressure to use the plant.

Those urging the start-up of the plant say that the 100,000 acre-feet of water now being released from Lake Mead to help fulfill treaty obligations to Mexico could remain in the reservoir. Water desalinated at the Yuma plant could then replace the reservoir water and be delivered to Mexico. Mexico is guaranteed by treaty 1.5 million acre feet of low-salinity water.

The 100,000 acre feet remaining in Lake Mead would help defer a declaration of water shortage on the Colorado River. Arizona is especially anxious to avoid a shortage situation since the CAP has low-priority water.

Cost to restart the plant is figured at about $30 million, with an annual operating cost of $30 million. Also, however, there is an environmental cost to be considered. Operating the plant would harm the Cienega de Santa Clara, a Mexican wetland in the Colorado River Delta which relies on the bypassed saline water. The wetlands' supply of water would be cut off.

Mexico
The basin states have agreed to request that the Secretary approach Mexico to discuss the possibility that the country share the Colorado River shortage, despite being ensured by treaty 1.5 million acre feet annually. Basin state officials believe the severity of the drought in the United States justifies requesting Mexico to accept a reduced allocation.

Water Bank
A proposed water-sharing strategy is to create an interstate water bank in Lake Mead to benefit Arizona, California and Nevada. Agricultural water has been mentioned as a source for such a bank, more specifically Imperial Irrigation District water. By using less water the district would enable water to be banked in Lake Mead, to be used by the three lower basin states. In return, the district would receive credit for the banked water, to be recovered at a later date when river flow returns to normal. Another option would be for the district to expand its current fallowing program and then sell its resulting unused apportionment to the bank. Arranging such a plan without running afoul of the Law of the River would be an issue.

Interstate Water Transfers
The water bank is one example of interstate water sharing, with

Continued on page 12

Special Projects

Monsoon Study..continued from page 1

affected area. The area extends from southern Mexico, along the country's west coast into the U.S. desert Southwest. The Arizona rim country intercepts moisture coming north and is generally regarded as the northern edge of the regular monsoon pattern. Some monsoon moisture pushes into Utah and even into the Northwest, but it is very transitory.)

The first three years of the NAME were devoted to planning and to identifying hypotheses for testing. This year marks the data collecting phase of the program, to be followed by research and analysis to test hypotheses formed the previous four years.

Erik Pytlak, meteorologist with the Tucson National Weather Service, says, "After data is collected the real hard work begins. We then take a look at the data to figure out what it is we sampled and how we use the data to improve our ability to forecast. ... What will happen after 2004 is basically trying to prove hypotheses formed during the previous four years."

In taking on such a complex issue, NAME will be examining many and varied situations that likely effect the monsoon. Pytlak says, "One of the key things we are looking at is gulf surges or moisture that pool up over the Gulf of California. This is transported either into Mexico or into Arizona by the wind patterns. We are investigating when these moisture surges occur and what they do to the weather regimes in Arizona and surrounding areas.

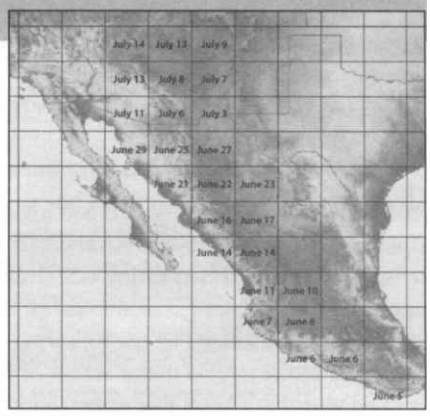
"We are also looking at upper-level disturbances and how they impact the monsoon. These upper-level disturbances can either bring a lot of thunderstorms or can shut the monsoon down. We are investigating what conditions cause either an upswing or downswing in monsoon activity to occur."

NAME's major field campaign is occurring this year, July through September, with information about the monsoon being collected over a wide area. Scientists from more than 30 universities, laboratories and agencies in the United States, Mexico and Central America are participating in this phase of the program. U.S. institutions include the Sonora Research Institute, University of Arizona, Princeton University and Harvard University. The purpose of the field campaign is to conduct atmospheric, oceanic and land-surface observations in the core region of North American monsoons. This includes northwest Mexico, southwest U.S. and adjacent oceanic areas

The National Weather Service office in Tucson has a key role in this phase of the program, with the Phoenix and Flagstaff offices also participating. Ten other NWS offices in the desert Southwest and southern Plains also are involved. Designated as the Forecast Operations Center, the Tucson office will be gathering information from wind profilers, balloons, radar, research airplanes, research ships in the Gulf of California and surface weather stations at more than 100 locations in Mexico and the United States. This bi-national effort is breaking new ground, providing U.S. meteorologists their first opportunity to combine satellite data above Mexico with weather observations reported from 84 Mexican surface stations.

Pytlak says information provided to Tucson's Forecast Operations Center will be used to compile a daily weather forecast to be issued to NAME science and operation directors. The information will enable them to make data-gathering decisions such as determining when to release weather balloons more frequently or send aircraft to investigate conditions over the Gulf of California.

Pytlak says, "That has been our piece of this much larger puzzle."



Shown above is the mean calendar date of monsoon onset, based on the time frame 1963–1988. Differences in rainfall regimes cause varying regional onset definitions. Using different time frames may cause average onset dates to change slightly, but the relative timing of the northward progression of the monsoon should remain constant. (Data from Higgins, et al., Journal of Climate, *March 1999)*

Also, Arizona figures into the project this summer because a suitable research site is located within the state for studying a critical monsoon issue: the effect of surface conditions on the monsoon. Researchers are examining the premise that land surface conditions, especially the amount of soil moisture, are critical in determining when monsoons begin and their intensity. This is because soil moisture affects evapotranspiration, the quantity of water transferred from the surface to the atmosphere. This in turn is a likely significant factor in the development of storm systems.

Pytlak says, "One of the hypotheses is that soil moisture has an impact on what is called moisture recycling. ... Moisture in the soil evaporates into the atmosphere, and you get the thunderstorms over and over again. Wet monsoon and dry monsoon seasons seem to feed on themselves."

NAME researchers are focusing on Tombstone, specifically the Walnut Gulch area, for the soil moisture study site. University of Arizona researchers have worked the area for the past 30 years, with the result that soil types in the area are extensively known. Pytlak says, "It is a very well documented plot of land."

A comparable research site for studying soil moisture is being developed in the Sonoran region of Mexico near Hemosillo.

NAME also includes an educational component, to encourage monsoon understanding among people ranging from adults to school age children. The strategy is to start with children. Pytlak says, "What we have seen in the Midwest and tornado alley is if we get children involved, from K through 12, they would educate the parents." Monsoon safety will be stressed although information about the workings of the monsoon also will be presented.

Two teachers, a U.S. and a Mexican teacher, have been selected to participate in NAME field activities and to provide leadership in the educational component of the program. NOAA selected an Arizona teacher, Rhonda Feher, who teachers at the Kayenta Intermediate School, as the U.S. teacher participant.

Announcements

Nominations Sought for 2005 Endangered Rivers List

The American Rivers organization invites nominations to its America's Most Endangered Rivers 2005 list. The organization releases an annual report listing U.S. rivers identified as facing an uncertain future due to activities within the coming year. Successful nominations are judged by the following criteria: the magnitude of the threat to the river; a major action or decision being made in the coming year that affects that threat; and the regional and national significance of the river. (The Upper San Pedro River was awarded the dubious distinction in 1999 and the Colorado River in 2004) Nominations must be submitted by Oct. 1. For more information about the awards and to access nomination forms check the American Rivers website: http://www.americanrivers.org

ADEQ Issues RFP for Water Quality Improvement Program

The Arizona Department of Environmental Quality is requesting applications for the Water Quality Improvement Grant Program. The program funds on-the-ground water quality improvement projects to control nonpoint source pollution, with about $1.5 million available during the 2004 grant cycle. Tasks a proposed project must address include: improve, protect or maintain water quality in an Arizona water body by addressing a nonpoint source of pollution; demonstrate acceptable water quality management principles, sound design and appropriate procedures; yield benefits at a level commensurate with project costs, have an on-the-ground implementation component within Arizona; and provide for at least 40 percent of the project costs as non-federal match. The deadline for applications is 3 p.m., October 20, 2004, with awards announced February 2005. A 2004-2007 Water Quality Improvement Grant Manual describing the program is available from Danese Cameron at 602-771-4569 or, toll free, 800-234-5677, Ext. 771-4569. The grant manual also can be downloaded from the ADEQ web site, http://azdeq.gov/environ/water/watershed/fin.html. The program is funded by EPA under the provisions of the 319(h) section of the Clean Water Act.

Urban runoff adds to nonpoint source pollution.

Plant Society Includes Water Issues at Conference

The Arizona Native Plant Society will hold its annual conference October 13 at the Lake Pleasant Desert Outdoor Center in Peoria, AZ. Participating in the event will professionals with expertise in desert and riparian habitats, climate change, drought, ethnobotany, native plant landscaping, water management, flora data collection, exotic weeds, rare and endangered plants, and restoration, revegetation and plant salvage. The conference addresses the concern that the impact of water and related population issues on native plants requires urgent attention as well as prudent planning to ensure the survival of our unique heritage for future generations. For additional conference information check the ANPS website (www.aznps.org) or contact Doug Green, 480-998-5638 or email: conference@aznps.org

Water for the West Issues RFP

Water for the West announces the availability of grant monies up to $25,000 for projects promoting the goals of the organization: accurate and timely information to those who shape public policy and opinion; educated and informed media on western water issues; educated and informed business community about the vital role water plays in the economic sustainability of the West; educated and informed customers about the source, costs, history and benefits of water supplies; and informed youth on the role of western water developments and conservation. Approximately $200,000 in grant funds will be available this fiscal year. Applications must be submitted by October 15. For addition information contact: Glenn D. Johnson, glenn@lpsnrd.org or Lawrence M. Libeu, info@sbvwcd.dst.ca.us

ADWR Seeks Water Resource Specialist IV

The Arizona Department of Water Resources seeks a Water Resource Specialist IV for the Phoenix Active Management Area. This is a senior-level position responsible for the redevelopment of the Third Management Plan municipal conservation program in the Phoenix AMA and will assist the other AMAs with their municipal conservation programs. This position will be involved in all facets of the operation and management of the Phoenix AMA municipal program. It is anticipated this individual will eventually lead the development of the Fourth Management Plan municipal conservation program. Applicants can contact Mark Frank, Phoenix AMA director or John Schneeman, assistant director, at 602-417-2465 or check the ADWR web site for additional information: http://www.water.az.gov/adwr/

Public Policy Review

by Sharon Megdal

WRRC Strives to be Productive Member of the AZ Water Community

This is my first column as director of the University of Arizona's Water Resources Research Center, and I begin my position during exciting times in the water world. We are facing challenges related to providing water to our increased and growing population and to supporting our varied local and regional economies at a time of severe drought. There is much work to be done and, indeed, the level of effort is high throughout the state.

A recent Battelle Report recognized that Arizona's challenges are similar to those faced by people the world over and recommended making Arizona the "Water Management Capital" of the world. One of the recommended strategies is creating a water sustainability consortium involving all three Arizona state universities. The report also recommended involving all stakeholders in development of a "water policy framework" to be a model for arid lands sustainability throughout the world. It is expected that the private sector and various levels of government will be involved.

The AWR newsletter has previously included information about the UA Technology and Research Initiative Fund, known as the Water Sustainability Program. WSF funded research, education and outreach activities relevant to resolving Arizona-specific water quantity and quality issues. WRRC expects to continue its participation in these and other efforts. Through our programs, we will continue to inform and educate, to facilitate the connections between university and non-university participants, and to provide independent analyses of water policy and management. As director, I intend not only to continue but to expand our activities.

Based on internal assessment and stakeholder input, I have established some WRRC priorities. I will briefly describe them and indicate opportunities for you to participate in our efforts to promote sound water management and policy in Arizona and the region.

WRRC will serve as an effective focal point for the exchange of water resources information and analysis, both on and off campus. I am pleased to have received very positive feedback regarding this newsletter. In addition to the distribution of it via mail, which we intend to continue, we post the newsletter on our web site. We hope to include, as often as possible, special inserts like the U.S. Geological Survey supplement within this issue. The inserts enable us to provide more in-depth coverage on a topical area and to provide a service to those offering financial support for the newsletter.

We will continue sponsoring our annual statewide water conference. The 2005 conference, to be held April 6, 2005 in Tucson, will be on the important topic, "Water and the Environment." On an as needed basis, we will continue to offer "brown bag" seminars on water-related topics, with speakers and attendees both internal and external to the university. We publicize these seminars via email. If you want to be on our email list for the brown bag seminars or if you have suggestions for a program, please contact us at wrrc@ag.arizona.edu. We intend to continue our high-level presence in conferences, programs and other forums. Recent papers and presentations also can be found on the WRRC web site.

WRRC will continue to collaborate with others on and off campus to address Arizona water resource issues. Interdisciplinary efforts, so important to addressing complex water quantity and quality questions, have flourished under the Water Sustainability Program's competitive grants program, instituted in 2003.

The WSP Education and Outreach component supports a number of activities on campus and throughout the state. Included among its varied activities was a briefing for Legislators. The Safford County Cooperative Extension Water Wagon, funded by a WSP grant, is an attractive, mobile educational trailer. Planning is just getting underway for a Water Day at the Capitol Mall, which is tentatively scheduled for January 25, 2005. It is hoped that many entities, public and private, and all three universities, will participate in this effort. If interested in participating, please contact Dana Flowers (602-470-8086, ext 335 or dflowers@ag.arizona.edu). As discussed above, our annual conference also involves significant opportunities for collaboration through sponsorship and participation.

WRRC will continue to increase its policy analysis activities. During the past few years, Kathy Jacobs and I have joined WRRC. We've brought to campus our knowledge of policies and policy making, gained from lengthy, and in my case, somewhat varied work experiences. To increase our capacity in this area, I have created a new position to focus on applied research. This person will investigate and write about real-world policy and water management matters in a manner understandable to the interested public as well as the water professional. We intend to work with water stakeholders on identifying topics for analysis.

WRRC will continue to increase its involvement with federal and state agencies, Arizona State University and Northern Arizona University and private entities, to identify mutually beneficial, collaborative projects. In addition to administering the 104b grant program in partnership with USGS, WRRC personnel are involved in several projects, including studies for the Army Corps of Engineers and the Bureau of Reclamation to enhance the environment in Arizona as well as a multi-disciplinary project involving Reclamation related to modeling Colorado River flows.

WRRC will continue its strong Water Education for Teachers program. Project WET Director Kerry Schwartz has overseen rapid growth of this program, which means more K-12 teachers are integrating water resource education into Arizona classrooms. Project WET includes the very popular Arizona Make a Splash, Project Wet Water Festival. We are developing a business plan to increase the reach of this special one-day educational program for students.

Space constraints prevent me from providing more details. As I said at the outset, these are exciting times to be working in water resources. The WRRC staff and I look forward to continuing to work with you.

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unused water leased or sold across state lines. Officials are exploring other arrangements for interstate water sharing. Whatever might be arranged, however, would have to be worked out among states within a single basin, whether lower or upper basin, since the law of the river prohibits interbasin transfers.

Nevada wants to buy Colorado River water from willing California and Arizona farmers, a plan that would likely meet with formidable legal obstacles. End users such as Arizona and California farmers are not able to sell or exchange river water allocated to them. Reallocating such water requires the approval of all seven Colorado River states; agreement is not a foregone conclusion since there is much opposition to the concept.

With the continuing drought, the interstate marketing of water and water rights is likely to get increased attention. A June 8 editorial in the Las Vegas Review-Journal titled, "A Free Market in Water," stated: "Market sales of water and water rights are the wave of the future. They are a better, proven system that will and eventually must be allowed to work. The more quickly an indolent bureaucracy is prodded to allow the re-introduction of market pricing to allow the free movement of this vital resource to those who need it and are therefore willing to pay for it, the better."

Some creative thought has gone into ways to arrange interstate water transfers. For example, a plan that has attracted some attention is for Southern California to obtain a water supply from the relatively water-rich northern part of the state. What is obtained from the north could replace Colorado River water now being used, with the water left in the reservoir. Obtaining water from the distant north, however, would incur an increased cost for pumping and treatment. Another state paying that extra cost could access California's unused Colorado River apportionment.

The Arizona Water Banking Authority has set a precedent for interstate water transfers. AWBA has the authority to bank Colorado River water for California and Nevada. This would entitle the two states to take extra water from the river during times of excess flow. With this strategy water does not actually cross state boundaries. California and Nevada pay Arizona for water that is used.

Reservoir Management

Reservoirs might be managed differently to better save water. One proposal is store lower-basin water in upper-basin reservoirs to reduce evaporation. Temperatures at Lake Mead can reach as high as 120 degrees resulting in a huge evaporation loss. If that water were retained in Lake Powell or other upstream reservoirs where lower temperatures prevail, evaporation would be less.

Another proposal seeks to reduce Lake Powell releases to Lake Mead, this time for power generating purposes, although the idea also would serve a water resource aim. Instead of releasing 8.23 million acre feet from Lake Powell, 7.8 million acre feet would be released, thereby maintaining Lake Powell's generating capacity. A drawback would be a more rapid drop of Lake Mead's water level. This would likely be to the disadvantage of Nevada since Lake Mead is Las Vegas' primary water supply, and the state already is concerned that the water level may drop below its intake.

The upper-basin states support this proposal since it is to their distinct advantage to maintain Lake Powell water levels. Depletion of Lake Powell could result in a "compact call" requiring that the upper-basin states dip into their own water reserves to supply water to the lower basin.

The Metropolitan Water District of Southern California is involved in a project to reduce evaporation from the reservoirs. One idea is to cover the reservoir surface with a nontoxic substance to prevent evaporation. Another idea, one that would pay dividends during a future drought, is to raise the height of Hoover Dam.

What is basically at stake in Colorado River negotiations is the self-interest of the each of the seven basin states. That may not be as self-serving as it sounds since a state's self-interest might best be served by cooperating with other basin states when confronting drought.

Arizona Water Resource

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