

# Water, energy, and climate linked in complex ways

## Arizona water summit brings water and electrical connections to light

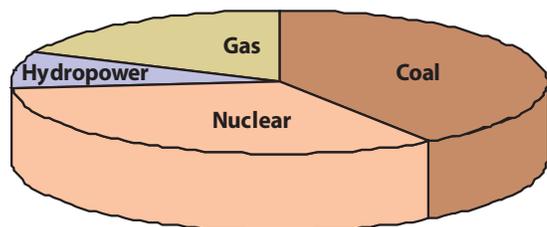
BY MELANIE LENART

Rain and snow yield water, flowing on the surface or replenishing groundwater aquifers. Water supports energy production—it's tapped for hydroelectric power or cycled to cool electrical plants. Most electrical plants, in turn, emit greenhouse gases, which warm the planet and disrupt water cycles.

These and other interconnections between water, energy, and climate fueled discussions at an Arizona Water Summit in Flagstaff earlier this month that attracted educators, tribal members, commercial interests, and policy makers, including the governor of Arizona.

Governor Janet Napolitano last year requested that the state's three universities address the links between water and electricity, summit organizer Gary Deason of Northern Arizona University (NAU) reminded as he introduced a session on the topic. Along with summit planning, researchers from NAU, the University of Arizona (UA) and Arizona State University (ASU) have been working together to launch a "virtual water university," also at the governor's behest. (See story to the right).

Concern about climate variability and global warming translates into worries about water and energy. The recent drought drained many reservoirs serving Arizona to half empty by mid-2004, including Lake Mead and Lake Powell,



**Figure 1.** The share of electrical power generated by fuel types is shown above, based on 2002 data from the Energy Information Administration.

which store Colorado River water. Dams associated with these and other reservoirs together provide about 8 percent of Arizona's electrical power (Figure 1).

Although the smaller Arizona reservoirs are refilling at an encouraging rate, especially those serving Phoenix, it could take years to decades to refill the major reservoirs that store Colorado River water, noted Gregg Garfin, program manager for the UA Climate Assessment for the Southwest (CLIMAS).

Governor Napolitano said she suspects the drought will "reassert itself" despite the relatively wet water year that began last October, a position that many climatologists also hold. During a summit talk, Garfin illustrated the potential for more drought ahead by pointing out droughts of 10 to 20 years in long-term precipitation records for the Southwest derived from tree rings.

Tree rings and other climate proxies also have been used to reconstruct northern hemisphere temperature patterns for the past millennium. John Brock of ASU showed summit participants the famous "hockey stick" reconstruction of global temperatures (Figure 2). The record shows an ongoing trend toward increasing temperatures, which scientists agree relates mainly to the input of additional greenhouse gases from fossil fuel and forest burning.

Water vapor is the most prevalent of the atmospheric greenhouse gases that warm the planet to about 60 degrees Fahrenheit overall. Without the greenhouse effect provided by water vapor and other atmospheric gases, the Earth's average temperature would be a freezing 15 degrees Fahrenheit, analyses indicate.

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## Virtual water university



BY MELANIE LENART

A "pet project" of Arizona Governor Janet Napolitano's—a virtual water university that pulls together on-line expertise from Arizona's three universities—took a step forward this month with a newly launched interactive website.

Gary Woodard of The University of Arizona (UA) unveiled a website called "Arizona Water," the first product of the virtual university's collaborative efforts. The website offers a searchable database on experts, projects, facilities, and publications by about 420 water researchers working at the UA, Northern Arizona University (NAU) and Arizona State University (ASU). It is posted at [www.arizonawater.org](http://www.arizonawater.org).

The virtual university "breaks down walls" between the universities, providing a science-based pool of resources to assist state decision-makers at a variety of levels, Governor Napolitano told summit participants during the August 4 dinner. One of the tasks of the university will be to improve predictions of future climate conditions in order to reduce vulnerability of water supplies.

"My view is that we can't do good planning without good data. That has to be the foundation for the public policy choices that need to be made," Napolitano said.

During a breakfast meeting about the virtual university the next morning, the UA's Kathy Jacobs stressed that

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## Complex links, continued

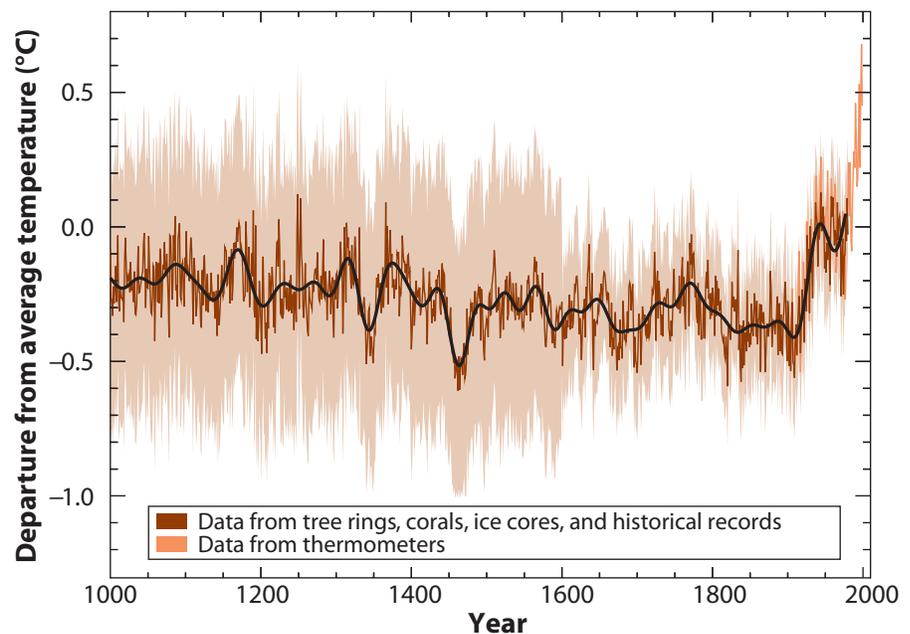
Given the additional input of greenhouse gases from human activities, scientists project the planet will warm by another 3 to 10 degrees Fahrenheit by the end of the century. The variable influence of water vapor helps confound precise projections (as does the possibility that society may change its patterns of energy use). Water vapor tends to moderate climate, working to dampen daytime temperatures through evaporative cooling while warming nighttime temperatures by trapping heat near the Earth's surface.

In the West, the warming is ramping up even faster than projected, although the heat island effect from growing cities also contributes to rising temperatures. Both greenhouse warming and urbanization have the greatest effect on nighttime temperatures.

The ongoing warming threatens to wreak havoc on the delicate balance of southwestern water supplies, in part because of a trend toward earlier snowmelt that could strain Colorado River allocations. (see *Southwest Climate Outlook [SWCO]*, December 2004). To top it off, some fear that drought could become even more commonplace as evaporation rates climb with temperatures and precipitation becomes more variable. Many people advocate taking steps to reduce this risk (see *SWCO*, December 2003).

"We can mitigate climate change by decreasing our dependence on fossil fuels," Garfin suggested at the summit. This "no-regrets" strategy would address public health issues related to air quality. Society can also adapt to climate change, he added, by improving water conservation, water banking and irrigation practices.

A recent survey of Arizona irrigators suggests that nearly half a million acre-feet—roughly 160 billion gallons—of Colorado River allocations are likely to be freed up in the near future by farm



**Figure 2.** The instrumental record of northern hemisphere temperature (pink) is superimposed on a 1,000-year temperature record for northern hemisphere reconstructed from annual tree rings, coral growth, and ice core layers (brown, with range of potential error shown in tan and "smoothed" average shown in black). Its shape, with an abrupt rise in modern times, has led some to dub the record a "hockey stick." Source: Intergovernmental Panel on Climate Change Third Annual Assessment, 2001.

sales, noted the UA's George Frisvold. However, expanding development in Arizona will continue to drink up any savings from the decline in agricultural use for irrigation, he warned.

"The plain fact of the matter is that with population growth in Arizona, Nevada and California, the Colorado River is being strained to the utmost," Governor Napolitano said at a summit dinner.

In addition, pending legal decisions are expected to require that Arizona's allocation of the Colorado be more fairly shared with the Native Americans living on tribal lands. "There are [water] rights that are going to be given to the Navajo and Hopi, appropriately, and people are going to have to live with that," as Arizona Legislature Representative Tom O'Halleran reminded the group.

Many Diné people living on the Navajo Reservation stretch a 55-gallon-drum's worth of water through an entire week, Justin Willie of the Navajo Waters Information Network told the group. The Hopi adopt a similar approach.

"Many of our people have to drive over 100 miles to haul water for their consumption, for their livestock, for their farms," said Wahleah Johns, a Hopi with the Black Mesa Water Coalition. "It's appalling."

Johns, Willie, and dozens of other Native Americans reminded summit participants that "water is life," and urged people to see water as sacred—not as something that can be bought and sold like any other commodity.

"One of the big themes was that we have a spiritual connection to water," Enei Begaye of the Indigenous Environmental Network said, reporting on a tribal water caucus held in Flagstaff the previous day. About 50 people from tribes throughout Arizona and New Mexico attended the caucus, and many stayed for the summit.

But prayer must be balanced with activism, Begaye counseled. "The issue of who controls the water is a huge issue," she said during a discussion session she

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## Complex links, continued

moderated on the commodification of water. In Arizona and many parts of the country, groundwater pumping remains mostly unregulated, and it remains legal for companies to profit privately from water extracted from a shared aquifer.

Tribal members at the summit also expressed concern about the use of pristine groundwater below Navajo and Hopi lands to transport coal slurry from mining operations in northern Arizona's Black Mesa to an electrical plant in Nevada.

Mining operations account for about 2.6 percent of groundwater withdrawals for the state, but about 64 percent of groundwater withdrawals from the aquifer below Hopi and Navajo lands, based on U.S. Geological Survey documents for 2000 and 2003 respectively (available at <http://water.usgs.gov/pubs/circ/2004/circ1268/index.html> and <http://water.usgs.gov/pubs/of/2005/1080/>).

The cooling of coal, gas, and nuclear energy plants, accounts for about 2.2 percent of the state's groundwater withdrawals, or 10.9 percent of non-irrigation withdrawals. Counting surface water, it requires about 100 million gallons of water a day. Meanwhile, electricity consumption is growing at about 4 percent a year, Arizona Corporation Commission member Kristin Mayes told the group.

"It used to be that every megawatt powered 1,000 homes. Now it's powering 250 homes," Mayes explained. The average Arizona house is larger and less efficient, she said. Also, rising temperatures in recent decades, especially in paved cities like Phoenix, have boosted peak summer electrical demand for cooling.

The increased use of renewable energy was touted as a means of water conservation by Mayes and others during the summit and the sustainability exposition that followed on its heels. While

nuclear energy uses the most water to produce electricity, wind and solar energy require virtually no water, except for the occasional cleaning of windmills and solar cells, speakers indicated.

Northern Arizona is well-suited for both wind and solar energy, Lane Garrett of ETA Engineering in Tempe explained during a workshop. The systems work well in tandem, in part because winds tend to blow the hardest on cloudy days and during the monsoon, Garrett indicated. (For a summary of Arizona's renewable energy potential and background on the Hopi solar enterprise NativeSUN, see: [http://www.energyatlas.org/PDFs/LowRes/atlas\\_state\\_AZ.pdf](http://www.energyatlas.org/PDFs/LowRes/atlas_state_AZ.pdf)).

Renewable energy fits well with tribal culture, and suits remote locations far from the grid, summit participants noted. The renewable model also interests Arizona residents concerned about sustainability. Napolitano appears to be among the latter: She chose "Creating Sustainability in the West" as this year's theme of the Western Governors Association, which she chairs.

Garrett's futuristic vision of sustainability features people using the wind and the sun—two elements as revered as rain by many cultures—to produce energy, along with hydrogen to store the energy generated by windmills and solar cells. Renewable energy sources have a neutral influence on global climate, he reminded, and lead to saving water instead of evaporating it in fossil fuel and nuclear power plants. In a desert region, where the sun is omnipresent and water is scarce, he has hope that this vision will continue to move beyond a mirage.

*Melanie Lenart is a postdoctoral research associate with the Climate Assessment for the Southwest (CLIMAS). The SWCO feature article archive can be accessed at the following link: <http://www.ispe.arizona.edu/climas/forecasts/swarticles.html>.*

## University, continued

the virtual university's success will depend on it having a "cyber backbone" to make data available and accessible to a variety of users. She urged researchers in attendance to begin preparing datasets, along with the information required for their appropriate interpretation, for web distribution.

Plans for the web-based decision-support system include a variety of accessible databases, interactive maps, information on trend analyses, and easy-to-use models involving forecasts and scenarios.

During a question and answer session, the governor said she agreed with a summit participant's comment that the university should tap into tribal experts as well as university experts on water issues, particularly water conservation.

Input from the tribes will be solicited through the universities for at least the initial stages, the governor's chief of staff for operations, Alan Stephens, specified during the follow-up breakfast session. For instance, NAU's Institute for Tribal Environmental Professionals will be among the core groups involved, NAU's Rand Decker noted.

Though the Arizona Legislature has not provided any funding for the virtual university, the Board of Regents has pledged \$150,000 to cover salary and expenses for an executive director of the virtual university. State officials indicated they envision the university becoming self-sustaining through federal and private foundation grants as well as contributions from industry.

The website, which was created by the University of Arizona's Water Sustainability Program, is housed at SAHRA, the NSF Center for Sustainability of Semi-Arid Hydrology and Riparian Areas.

