

Arizona drought coming back into focus

BY GREGG GARFIN

Arizona Governor Janet Napolitano declared a continued drought emergency for Arizona on May 22, 2007, extending an executive order that has been in place since annual rainfall totals plunged sharply nine years ago.

The order continues emergency drought status to improve access for federal aid to farmers and livestock producers. The dry 2006–2007 winter diminished soil moisture, and years of drought have eroded the overall health of Arizona rangelands, reducing healthy soil to dust and withering the root systems of perennial grasses which hold the soil together.

But Napolitano's recent drought declaration is more than a relief measure. It is a continued call to arms designed to mobilize a network of scientists and citizens who monitor the drought as part of the Arizona Drought Preparedness Plan (ADPP). Meshing scientific data with observations of livestock, rangelands, forests, vegetation, and agriculture, drought monitoring can help citizens and management agencies better anticipate drought and take steps to reduce rangeland erosion, human-caused wildfire, depletion of vulnerable—and vital—water resources.

Some bad news

It is undeniable that drought has dominated the state's climatic conditions for at least a decade. For evidence, one need only look at the steadily declining levels of lakes Powell and Mead or the drought-decimated forests of northern Arizona.

Conditions could be worse. Recent research by University of Arizona (UA) scientists suggests the region could be in for megadroughts, covering areas as large as western North America, as the region warms. A reconstruction of Colorado River Basin streamflow at Lees Ferry, the dividing point between the upper and lower Colorado River

basins, indicates periods of drought lasting as long as 62 years (1118–1179), including 13 consecutive years of below-normal flow on the Colorado. This hair-raising result, from UA investigators David Meko and Connie Woodhouse, confirms other megadrought studies that show that droughts in western North America during the Medieval Climate Anomaly (around 900–1300 A.D.) were more severe, lasted longer, and covered more area than more recent droughts. Given the combination of rapid population growth and acknowledged over-allocation of Colorado River water supplies, these results imply that sustaining Arizona's economy through continued growth may require substantial innovations, such as large-scale ocean water desalination; trade-offs among agricultural, riparian, municipal, and industrial water uses; and greater water conservation.

CLIMAS paleoclimate reconstructions of winter precipitation for Arizona and New Mexico climate divisions for 1000–1988 A.D., developed by Fenbiao Ni, Malcolm Hughes, and their UA colleagues, show that the 1200s saw the driest conditions statewide—that is, that century had the greatest proportion of years in the lower third of winter precipitation estimates, but the 1500s had the lowest proportion of wet years (years in the upper third of all values).

Across all of Arizona, except Mohave County, the 1662–1671 drought consistently had the most consecutive years below 85 percent of average winter precipitation and the greatest cumulative winter precipitation deficits. The 1100s drought mentioned by Meko and Woodhouse also figures prominently in the winter precipitation record, especially in central Arizona. Persistent droughts, like the 1100s drought, tend to extend over large areas. The fact that the long 1100s megadrought apparently stretched across the entire Colorado River Basin implies that the surface wa-

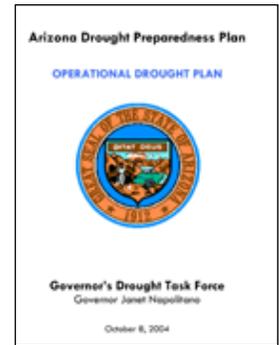
ters that supply Arizona may be at greater risk than previously thought.

Good News!

With the drought strengthening its grip on the state, Governor Napolitano approved a drought task force to develop Arizona's first drought plan in 2003. The task force, a group of state, federal, private sector, and university researchers, experts, and consultants, developed the ADPP in October 2004. Now Arizona boasts the largest state-funded drought program in the country. Its three-fold mission is to provide:

- Timely and reliable monitoring of drought and water supply conditions in the state and an assessment of potential impacts;
- An assessment of the vulnerability of key sectors, regions, and population groups in the state and potential actions to mitigate those impacts;
- Assistance to stakeholders in preparing for and responding to drought impacts, including development of a statewide water conservation strategy and public awareness program.

Critics note that the plan has no teeth because it merely advises Arizonans on drought and water conservation. However, the plan established a foundation for legislative action and spurred municipal and regional preparedness planning. For example, in 2005 the Arizona Legislature approved a bill that requires all community water systems to develop plans for water supply, drought preparedness, and water conservation. The bill requires water providers to submit



continued on page 4



Drought, continued

an annual water use report; such monitoring is a step toward ensuring adequate water supplies throughout the state.

Drought plan implementation is making headway through the efforts of the Arizona Department of Water Resources (ADWR) and other agencies, such as County Emergency Management, University of Arizona Cooperative Extension (UACE), and other state, federal, private sector, and university partners.

Monitoring Drought in Arizona

Drought monitoring is the front line of drought mitigation and response. Monitoring drought and clearly conveying drought status are conceptually simple; in practice, however, they are surprisingly difficult. In Arizona, monitoring is complicated by several factors, including the state's highly diverse terrain, measurement systems that were designed to track short-term phenomena like weather and floods, a lack of soil moisture monitoring throughout the West, a groundwater monitoring system that was not designed to distinguish between drought and other depletions, such as over-pumping by residents and businesses, and a lack of resources to deploy gauges in mountainous areas. Records that have the potential to fill these gaps, such as spatially continuous records from satellites, date back fewer than thirty years or currently lack the detailed spatial resolution required by managers. The Arizona Drought Monitoring Technical Committee (MTC), in coordination with partners, is in the process of resolving some monitoring issues through funding requests for equipment, coordination with federal efforts to deploy new sensors, improvements to ADWR's groundwater monitoring system, and input from Arizona citizens through volunteer drought impact and precipitation reporting efforts.

Established by the drought plan, the MTC monitors precipitation,

temperature, snow-pack, vegetation health, and drought impacts, but it calculates drought status using only long continuous records of precipitation, stream-flow, and reservoir levels. Drought status maps and assessments of other indicators monitored by the MTC are reported at the watershed scale on a monthly basis. These reports inform agency officials and the Governor about drought status and impacts to Arizona's water resources and ecosystems.

Drought indicator levels are linked to recommended steps for drought mitigation and response through a set of drought triggers, or levels of drought severity (Table 1), which were developed in consultation with the National Drought Mitigation Center. Arizona drought triggers differ from the U.S. Drought Monitor (see page 8) due to concerns about over-complexity from drought task force members. MTC partners, including the National Weather Service, USDA-Natural Resources Conservation Service, the U.S. Geological Survey, and the State Climate Office, have developed substantial online drought monitoring data and information resources that add geographic detail to the broad overview of state drought status provided in official monthly MTC reports.

Better Monitoring and Preparedness

One aspect of Arizona's drought plan and monitoring that is unique in the nation and viewed as a potential model for other states is the use of Local Drought Impact Groups (LDIGs). LDIGs are voluntary, county-level citizens groups that communicate drought impact information to the MTC and develop and

Table 1. Arizona drought trigger levels.

Status	Description	Preparedness and Mitigation in a Nutshell	Indicator Percentiles
0	No Drought	Reduce vulnerabilities before the situation escalates to crisis	40.1–100.0%
1	Abnormally Dry	Raise awareness about impending drought	25.1–40.0%
2	Moderate Drought	Voluntary actions to reduce water use	15.1–25.0%
3	Severe Drought	Curtailments in water deliveries	5.1–15.0%
4	Extreme Drought	Eliminate all non-essential water uses	0.0–5.0%

coordinate local drought preparedness, mitigation, and response efforts.

The ADWR Statewide Drought Program began convening LDIGs in 2005, with a pilot project in southeastern Arizona's Cochise County. Cochise County was selected because it did not emerge from moderate to severe drought status during the 2004–2005 winter, which was relatively wet throughout most of the state.

The drought plan recommends that LDIGs collect drought impact information for the MTC, particularly on the economic and societal impacts of drought. This information, coming straight from the front lines, is critical for calibrating calculated drought status with the ways that drought affects people and their activities.

Organized drought impact monitoring is in its initial phases in the United States, and Arizona is one of the few states engaged in systematic collection of drought impact information. Based on input from the Cochise County LDIG, a UA team, led by UACE Climate Extension Specialist Mike Crimmins, has started an online drought impacts reporting system (DIRS), and several counties now report monthly to the MTC. An improved DIRS, using a Google Earth© interface developed by the NSF Science and Technology Center for Sustainability of semi-Arid

continued on page 5



Drought, continued

Hydrology and Riparian Areas at UA (SAHRA), is scheduled for release later this year. Through DIRS, volunteers can report qualitative assessments of range, agriculture, ecosystem, and water impacts. The new system will allow them to map drought impacts to help improve preparedness and emergency response efforts.

A separate effort by Crimmins and SAHRA's Gary Woodard has helped spur interest in citizen drought monitoring. These partners developed a citizen weather monitoring project called RainLog to capture precipitation and drought observations. Such observations can assist the MTC in interpreting geographic variations in precipitation by filling in critical gaps in the official network of rain gauge stations.

Crimmins also leads an Arizona Water Institute project to develop a drought trigger and indicator tool to help water providers submit their drought plans to ADWR. The trigger points are an essential part of drought planning, and solid planning and monitoring at the water provider level will help insure that all Arizona communities do not suffer the extensive shortages that some rural communities experienced in 2002. Crimmins's tool, developed in conjunction with ADWR and in consultation with CLIMAS, the state climatologist (Arizona State University), and stakeholders, will aid water providers in determining a combination of water supply and climatological trigger points for drought actions, such as water conservation, and augmenting water supplies.

Plans for the Future

Since the ADPP's inception, drought monitoring and monthly drought status reporting is proceeding apace. The statewide water conservation program has established a variety of programs for water use efficiency, technological innovation, outreach, and assistance. Moreover, the

statewide drought program is in the process of implementing the innovative LDIGs and guidance to water providers on drought planning. So what lies ahead for Arizona drought monitoring and preparedness?

The Arizona Water Institute (AWI), a consortium of Arizona's three universities, is developing the Arizona Hydrologic Information System (AHIS) to improve the flow of data and information to agencies, planners, communities, and citizens. The AHIS will combine hydrologic information from state and federal sources, such as the Arizona Flood Warning and Drought Monitoring initiative, with the monthly drought status report, DIRS, RainLog, and other statewide drought program tools. This kind of data and information clearinghouse was the highest priority listed by stakeholders responding to an AWI survey. AHIS software developers and others, including CLIMAS, are working to link AHIS to the federally funded National Integrated Drought Information System.

Other ongoing projects to improve Arizona drought monitoring include an effort by ADWR to develop and equip a network of groundwater monitoring wells. This drought monitoring data will supplement the MTC's current drought indicators for determining drought status. This effort is significant because many Arizona communities are dependent on groundwater for drinking water supplies.

The efforts mentioned here, as well as others by ADWR's Statewide Drought Program, MTC member organizations, and Arizona's three state universities are on track to improve drought monitoring and preparedness. Research and outreach are underway to examine the economic impacts of drought, improved drought status indices, enhancements to monitoring networks, and more effective connections to Arizona

communities. Most important of all are the continued interactions between citizens, scientists, and agency officials to improve drought preparedness, monitoring and planning. These interactions will insure that the drought plan is responsive to citizen needs and advances in science and policy designed to protect the state's water supplies.

This article, the first in a series on drought monitoring and planning in the Southwest, looks at what Arizona is doing to improve drought monitoring and preparedness. Gregg Garfin is co-chair of Arizona's drought monitoring technical committee.

Related links

Arizona Drought Preparedness Plan

<http://www.azwater.gov/dwr/drought/DroughtHome.html>

Arizona Drought Monitoring Technical Committee

<http://www.azwater.gov/dwr/drought/MTC.html>

Paleoclimate Reconstructions

<http://www.ispe.arizona.edu/climas/research/paleoclimate/product.html>

NWS Phoenix Drought Monitoring

<http://www.wrh.noaa.gov/psr/DroughtPage.php?wfo=psr&data=ALLDATA>

NWS Tucson Drought Monitoring

<http://www.wrh.noaa.gov/twc/climate/seazDM.php>

USGS Drought Monitoring

<http://az.water.usgs.gov/droughtmaps/droughtmaps.htm>

USDA-NRCS Drought Monitoring

<http://www.az.nrcs.usda.gov/snow/watersupply/outlookreports/index.html>

Arizona Flood Warning and Drought Monitoring initiative

<http://data.afws.org/sui/frontPage.aspx>

