



Groundwater Resources and Climate Variability

An END InSight participant recently asked an interesting question about a vital issue in the Southwest, which this article will address: "What is the impact of the recent drought on groundwater supplies?"

First, a bit of context: groundwater constitutes more than 25 percent of the nation's water supply, equal to 65 gallons *per day* for every man, woman, and child in the country for domestic purposes alone. Worldwide, 1.5 billion people, or one-quarter of the world's population, depend on groundwater for drinking water (1). Groundwater is by far the most important water source in the Southwest, providing drinking water for 90 percent of New Mexico's population and 60 percent of Arizona's (2). Over-pumping of this limited resource not only threatens human water supplies, but can also lead to land subsidence, the loss of springs, streams, and wetlands, and decreases in water quality (3).

Groundwater Monitoring Challenges

Linking groundwater levels to climatic variability is a complex task for several reasons. Some aquifers are shallower and more sensitive to climatic fluctuations, while others are deeper and slower to respond. An area's geophysical characteristics, as well as rainfall patterns and seasonality, can determine how much precipitation is absorbed into the aquifer and how much runs off and evaporates before it can replenish groundwater supplies. Human activities can also simultaneously influence aquifer levels, making it difficult to isolate climatic impacts. Thus there is no simple for-

mula for equating the amount of precipitation that falls directly with recharge rates. However, some up-to-date groundwater monitoring tools are available.

Groundwater Monitoring Information

Interestingly, it appears easier to monitor longer-term groundwater changes in New Mexico, while shorter-term fluctuations are easier to track in Arizona. The U.S. Geological Survey (USGS) provides a very useful map of New Mexico at <http://nm.water.usgs.gov/drought/gwbasin.html>. Clicking on any of the 34 monitoring wells pictured will produce a hydrograph of water level changes over several decades. While the hydrographs can be correlated with records of past climatic events, they do not distinguish which fluctuations are actually climatically induced and which are due to human activities and land-use change.

Arizona and several other states (not including New Mexico!) have real-time well monitoring systems that monitor water level changes on time scales of one week to one month (see <http://waterdata.usgs.gov/nwis/current/?type=gw> for a list of stations). Users can click on one of 12 site locations (see accompanying map) and see a hydrograph of well level changes. Again, this information does not reflect human activities, such as drilling new wells or shutting down existing ones, and does not provide information for all areas of the state. However, it does make it easier to see the effects of specific periods of precipitation on localized groundwater supplies.

Groundwater in the Southwest

Depending on the information you examine, it may be easy to see that groundwater declines are a serious problem in many Southwestern cities. For example, groundwater is Albuquerque's sole source of municipal water supplies, and on average less than half of what the city currently pumps is naturally recharged on an annual basis (6). Like many rapidly growing Southwestern cities, Albuquerque is seeking to supplement its dwindling groundwater supplies with greater use of surface water. The city intends to divert surface water from the Rio Grande River and via the San Juan-Chama Diversion Project, but the project is not expected to be completed until 2025 (6). The city faces a more immediate obstacle to using Rio Grande River water to which it holds the rights, but

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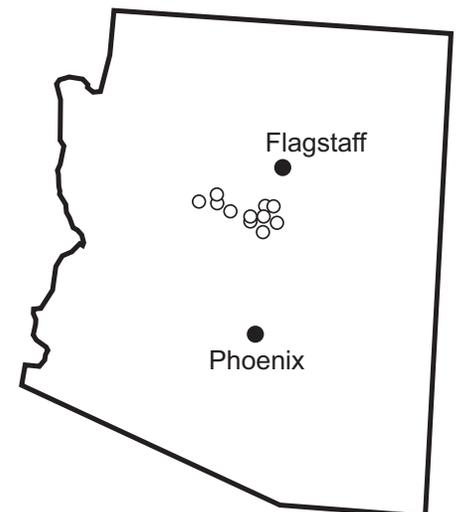


Figure 1. Real-time groundwater measurement locations in Arizona are shown by open circles.



Groundwater, continued

which is also needed to provide habitat downstream for the silvery minnow. Because this species is federally protected under the Endangered Species Act, the city may be prohibited from impeding the river's flow by storing water upstream, behind the Heron Dam in northern New Mexico (7).

Flagstaff, Arizona, on the other hand, utilizes both surface and groundwater, but groundwater supplies are quite limited, and surface water is highly sensitive to climatic variability. The city currently taps Lake Mary to cover increased water demand on hot summer days, but several consecutive years of below-average rainfall have left the lake nearly dry (8). The city is seeking to increase its groundwater pumping, although drilling new wells is expensive and contributes to Flagstaff's comparatively high water rates (9).

Both cities, as well as other locations in the Southwest, were forced to restrict municipal water use during the summer of 2002 to cope with ongoing drought conditions and could face even more severe supply problems if the drought continues through the summer of 2003. While groundwater has been viewed as a hedge against severe drought, mounting human needs are severely testing its ability to compensate for the lack of precipitation in many areas.

—Rebecca Carter, CLIMAS

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About END InSight

END InSight is a year-long project to provide stakeholders in the Southwest with information about current drought and El Niño conditions. As part of the Climate Assessment for the Southwest (CLIMAS) project at the University of Arizona, END InSight is gathering feedback from stakeholders to improve the creation and use of climate information.

The *END InSight Newsletter* is published monthly and includes background and topical climate information. All material in the newsletter may be reproduced, provided CLIMAS is acknowledged as the source. The newsletter is produced with support from the National Oceanic and Atmospheric Administration (NOAA).

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Product of the Month:

Experimental Colorado Forecasts

This month your packet includes an experimental forecast of ENSO-related precipitation conditions, produced by Klaus Wolter of NOAA's Climate Diagnostics Center. The new page features images excerpted from his comprehensive experimental forecast web page (<http://www.cdc.noaa.gov/~kew/SWcasts/>). This monthly resource provides both official and experimental forecasts, including ENSO predictions for the next 6–9 months, typical precipitation impacts during El Niño episodes, and discussion of experimental forecasts.

Page 18 of your packet has details of how this forecast was produced and how it differs from other forecasts. The experimental forecast was mentioned in an article about the use of climate divisions in the November END InSight newsletter. We and Dr. Wolter are very eager for your feedback on this product and encourage you to let us know how you think this product might be improved and whether you'd like to see this forecast included in future packets.