

Arizona's Water @ Work

An e-magazine about the professional activities of ADWR

Volume 1, No. 1

ARIZONA
DEPARTMENT
OF WATER
RESOURCES

Where do all the data come from?

The Arizona Department of Water Resources is in the information business as much as the water business.

ADWR provides information about the water supply to Arizona's citizens, and to a host of interested parties in government, education and business. We are a data-driven, technical bunch.

So what is this "data" that drives ADWR? Where does it come from? Sometimes we get it from holes in the earth and other times we get it through the earth from sensitive instruments.

The data consist primarily of:

- Global Positioning System (GPS) positions and water elevations at discrete points.
- Absolute and relative gravity values at discrete points for determining depth to bedrock, and
- Aquifer storage modeling and broad swaths of Synthetic Aperture Radar (SAR) data (pg. 3) that cover the majority of Central and Southern Arizona.

The data are recorded by hydrologists using finely calibrated electronic instruments as well as plain old handheld measuring tapes. We do our best to see that the accuracy of our data builds as time passes.

Hydrologists visit the same locations repeatedly to measure and to log changes to the precise depth to water and bedrock. They do this with gravity meters. These highly accurate instruments can detect 1 part in 100,000,000 of the normal gravity of the earth. Under good conditions, they can detect depth changes of as small as 1 inch.

Our ongoing water level monitoring includes collecting groundwater elevation data from 1,700 statewide index wells and, recently, through 113 automated

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No, not R2D2. It's a Gravimeter



The cowboy and his horse were the reason for measuring a well 100 years ago. The cowboy probably used a stick, or dropped a rock down the hole. Today, ADWR measures many wells with electronic transducers. They help to gather and transmit water levels 22,500 miles into space and back down to earth, where they are recorded by our hydrologists. ADWR currently has over 100 'satellite' wells in the field. It is the future.

What Makes a Good Well for Monitoring?

It's simple. We install a small pressure transducer with a data collection device and battery in the well casing at the top of the well.

1. Unused well with no pump
2. Well that is not affected by large nearby pumping wells.
3. Well with a potential for use over the long term.

Would you like to volunteer a well for automated monitoring?

Southeastern Arizona and the San Pedro River

The gathering of water-level data by sounding, by transducer, and by gravimeter returns oceans of numbers that mean little unless placed in context. The analysis of the data tells us where the water table is in decline, where it is rising, and helps regulators to formulate policy.

So it is in southeastern Arizona, a region like other parts of the state in that it contains mountains, valleys, deserts, grasslands, rivers, and streams. The southeast has one feature of great interest to scientists, bird watchers, environmentalists and ordinary Arizonans who like the veil of a cool green place on a white-hot summer's day.

It is the San Pedro River, and it has become an international symbol of something beautiful but fragile that needs protection and nurturing.

It is a major flyway for tens of thousands of birds on their annual migration routes to and from the warmer regions.

The San Pedro River is one of the few remaining free-flowing perennial streams in the arid Southwestern United States, and the riparian forest along the river supports several endangered species.

That the San Pedro is a largely ephemeral stream is a jarring reality for those charged with studying and protecting it. It may be free-flowing and perennial, but not everywhere. Hydrologists sift the record of measurements and conditions looking for answers.

They know, for example, decreases in streamflow of the San Pedro River at Charleston, AZ have been substantial: from the first 20 years of streamflow record (1913–36) to the last 20 years of record (1983–2002) showed:

- A drop of 54 percent for annual flows,
- A 70-percent decrease in summer flows, with
- A decline of 20 percent in winter flows.

The challenge is in knowing why. Is it because of declining precipitation? Or temperature change? A change in the composition of the watershed? How about human activity? (pg 3)



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groundwater monitoring sites. These water levels allow us to track changes in the aquifer and to better relate the changes to groundwater pumpage and recharge.

These data "tie" together other equally important hydrologic monitoring information such as precipitation, snowfall, stream flow and water use. We use this information to interpret water level fluctuations observed by monitoring wells. This provides us the ability to construct timely and accurate water budgets and monitor hydrologic behavior throughout the state.

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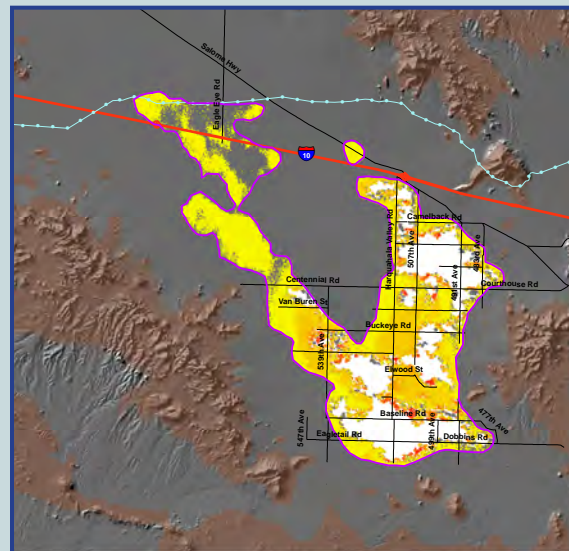
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Land Subsidence

ADWR has been monitoring land subsidence around the State of Arizona, using synthetic aperture radar (SAR) since 2002. Synthetic aperture radar is a side-looking, active (produces its own illumination) radar imaging system that transmits a pulsed microwave signal toward the earth and records both the amplitude and phase of the back-scattered signal that returns to the antenna. SAR that is processed using interferometry (InSAR) is a technique that compares the amplitude and phase signals received during one pass of the SAR platform over a specific geographic area with the amplitude and phase signals received during a second pass of the platform over the same area but at a different time. InSAR techniques, using satellite-based SAR data, produce highly accurate images of land subsidence over areas as large as 100 km. sq. Learn more about this highly complicated technology at: www.azwater.gov/AzDWR/Hydrology/Geophysics/InSAR.htm



Is Nature the culprit for loss of San Pedro River streamflow?

Could nature itself be guilty? Maybe... partially.

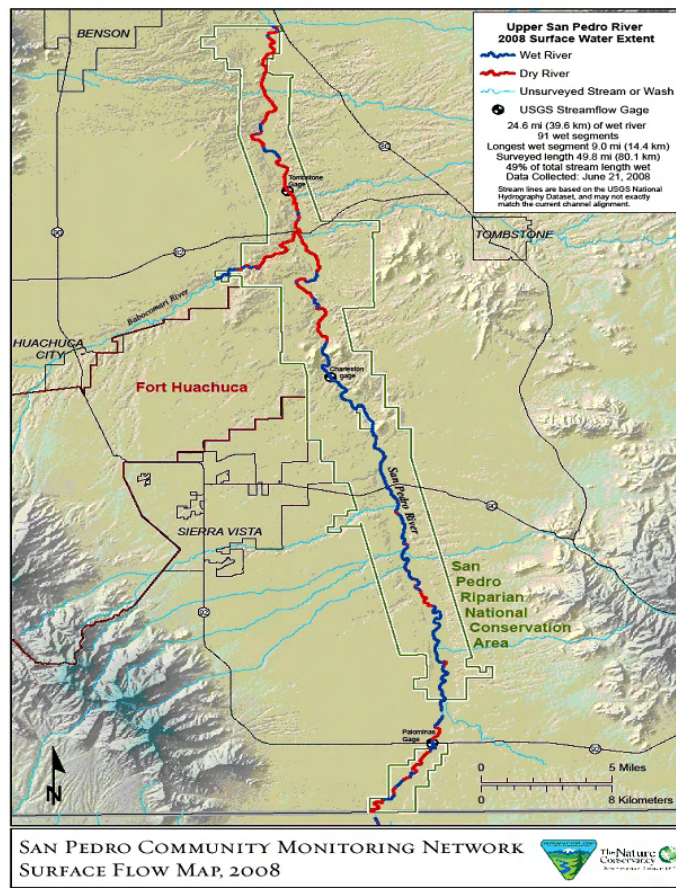
A 2006 USGS report on streamflow in the San Pedro cited "changes in upland and riparian vegetation" as possibly contributing to decreased streamflow.

Another potential cause of low flow is that rainfall decreased 13% from 1913 to 2002. Annual streamflow, however, declined 66%.

The most likely causes for lower flow are the usual suspects: less rainfall, man's impact on the area, and increased groundwater pumping, the report concluded. But things that change over time – plant growth along the river, vegetation in surrounding hills and changes to the streambed itself, also are potential contributors.

The density of the surrounding plant life increased in the 20th Century, researchers said, and this resulted in more water loss from plants' "transpiration," or expelling water vapor.

Human activity, especially groundwater pumping, certainly played a major role in the lowering flow. Pumping in the area grew from 2,500 af/yr before 1940 to 53,000 af/yr by 2002. The effects, however, are mixed throughout the study area.

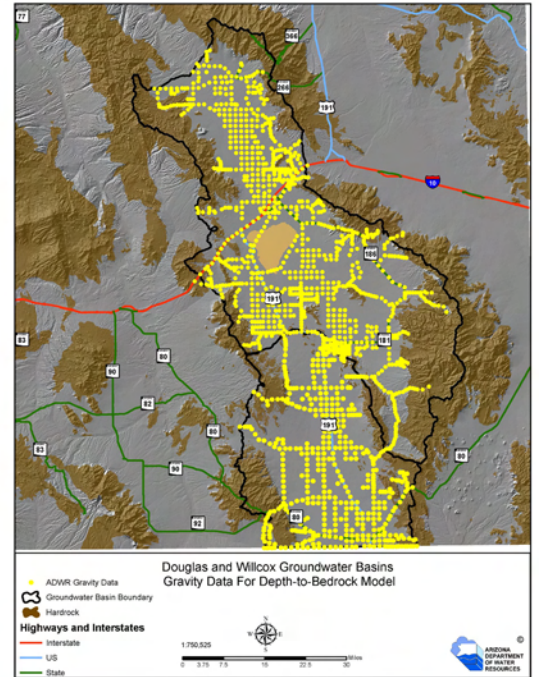


Gravity Metering in Southeastern Arizona

How gravity metering works: As you get higher up, away from sea level, gravity decreases. When taking a measurement with a gravimeter, a change in altitude renders a slight difference in measurement.

How to use a gravimeter to determine a change in an aquifer storage level:

1. The ADWR Geophysics Surveying Unit (GSU) visits gravity points spread out over an area, taking a measurement at each point - at the exact same spot, every year or every other year. A difference in the measurement means an increase or decrease in the water levels.
2. In combination with water-level data gathered by the Basic Data Unit. That information is used to create a water-level surface. That is combined with the bedrock surface developed from gravity metering. The result is an idea how thick the aquifer is and how much groundwater is in storage.



Depth-to-Bedrock

Readings in the Willcox and Douglas groundwater basins

The GSU collected more than 1,400 gravity and GPS measurements throughout the entire Willcox and Douglas-groundwater basins from September 2008 to March 2009.

The hydrologists took a GPS and gravity measurement at half-mile and one-mile intervals along the roads across the Willcox and Douglas groundwater basins.

Gravimeters measure the earth's gravitational pull. Gravity values change throughout the basins due to the thickness and geological composition of the basin as well as the elevation above sea level of each gravity measurement.

ADWR hydrologists collected these measurements to develop a depth-to-bedrock model for the Willcox and Douglas groundwater basins. The depth-to-bedrock model will help ADWR estimate the amount of groundwater in storage throughout both basins. This helps determine safe limits on future water use.

WHAT DO WE USE THE DATA FOR?

Data is the fuel that drives ADWR.

The agency uses it to create interactive maps to display our GWSI information on our website. (Try it out at: <http://gisweb.azwater.gov/gwsi/waterresourcedata.aspx>)

The data goes into the calculations our Water Management staff performs while processing assured & adequate water supply applications.

Data enables ADWR to monitor the condition of groundwater aquifers all over Arizona. Hydrologists use it to create the groundwater-flow models of the Salt River Valley and other complex systems around the state. They are displayed on the agency website: www.azwater.gov/azdwr

Another part of ADWR uses the data gathered in the field to publish monthly reports on the current drought and will report when conditions improve sufficiently to say we are no longer in a drought.