EDITORIAL

# The drought you can't see

The Western Hemisphere is experiencing a drought of crisis proportions. In Central America, crops are failing, millions are in danger of starvation, and if the drought doesn't break soon, even vessels transiting the Panama Canal will need to lighten their loads, which will increase prices for goods transported globally. In the western United States, the drought-stricken region spans a vast area responsible for much of the nation's fruits, vegetables, and beef. As the drought's grip has tightened, water users have turned to tapping groundwater aquifers to make up the deficit for people, crops, livestock, and industry. But even when the rain does return, regreening the landscape and filling again the streams, lakes, and reservoirs, those aquifers will remain severely depleted. It is this underground drought we can't see that is enduring, worrisome, and in need of attention.

The Gravity Recovery And Climate Experiment (GRACE) satellites have provided a global look at groundwater depletion by monitoring small temporal changes in Earth's gravity field. GRACE confirmed massive losses of groundwater from the aquifer underlying California's agriculturally important Central Valley since the 1980s.* In the decade between 2003 and 2012, the drawdown was equivalent to the entire water storage volume of Lake Mead, the nation's largest surface reservoir.† The extraction of groundwater has caused wells to run dry and produced detectable regional uplift or rebound of the land due to water displacement (see Borsa *et al.*, p. 1587).

Underground reservoirs are a natural long-term water storage solution. Taking advantage of aquifers avoids the expense and environmental issues of dam construction. Unlike surface reservoirs, aquifers are not subject to evaporative loss, but under natural conditions they are only recharged slowly as excess precipitation percolates into the aquifer. In some cases, the average age of groundwater can be many thousands of years old, dating back to a time when the climate was wetter. But when water is withdrawn through pumping at prodigious rates, hydrologic processes are not sufficient to fully recharge the reservoirs, especially when land development has created impervious surfaces.

Forty years ago, the state of Arizona reached a critical juncture that called for action, with rapidly falling water tables, dry wells, subsiding land surface, and deteriorating water quality. Now, in the Tucson area for example, water from the Colorado River is used to artificially recharge the aquifers with excess water in wet years that can later be tapped during dry years. The statewide 1980 Groundwater Management Act guarantees that over a 10-year period, the aquifer cannot be overdrawn. The current crisis has prompted the legislature of California—the last state in the west without groundwater regulation—to pass a series of bills that establish state-level oversight of pumping from aquifers.

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Surface- and groundwater are all part of one coupled system, responding on different time scales to changes in precipitation. Five years ago when I was director of the U.S. Geological Survey (USGS), an Arizona congressman had some concerns about a USGS report on the impact of overpumping of groundwater on surface stream flows. The congressman declared, "You all should be aware that according to Arizona state law, surface water and groundwater flows are decoupled." Jim Leenhouts, the USGS associate director for the Arizona Water Science Center responded, without hesitation, "Thank you, congressman. Here at the USGS we follow the laws of nature, not the laws of man." It is high time we started managing our precious water supplies in harmony with the laws of nature.

**– Marcia McNutt**

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*http://pubs.er.usgs.gov/publication/fs20093057. †J. S. Famiglietti, M. Rodell, *Science* **340**, 1300 (2013).

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PHOTOS: (INSET) JUSTIN SULLIVAN/GETTY IMAGES; (RIGHT) STACEY PENTLAND PHOTOGRAPHY