

EARTH

Who pulled the plug on Lake Powell in southern Utah? A chalk-white "bathtub ring" marks the level that the water once reached, 30 meters (100 feet) above the current surface.

And why are so many Las Vegas residents ripping up their lawns? The grass removed in the last several years would cover almost 1,500 football fields.

The disappearing water and grass are just a few signs of the severe drought that has parched much of the southwestern United States since 1999. The question now is: When will the drought end, or—as some experts believe—will it become permanent?

DRY SUBJECT

A *drought* is a long period of abnormally low precipitation. "It can occur anywhere, any year, even in a rain forest," says Mark Svoboda, a climatologist with the National Drought Mitigation Center.

A drought usually is caused by a shift in ocean temperature thousands of miles away. Most climatologists believe that cooler-than-average

Pacific Ocean temperatures near the equator cause droughts in the U.S. Southwest. That cooling of Pacific Ocean water, called *La Niña*, occurs every three to five years. It changes the direction that moisture-carrying storms travel, diverting them from the Southwest. "La Niña starves the U.S. Southwest of winter moisture,"



Rocky Anderson, the mayor of Salt Lake City, Utah, shows off his home's drought-resistant front yard.

says Gregg Garfin, a University of Arizona climatologist.

The Atlantic Ocean seems to be contributing to the current dry spell too, adds Garfin. The northern Atlantic has been warmer than normal, further diverting storms away from the Southwest.

THIN RINGS

How bad is this drought? Bad! says Malcolm Hughes, an expert in *tree rings* and climate at the University of Arizona. A tree adds a layer of new tissue to its trunk every year. Because trees grow more slowly during drought years, their new growth rings are thinner than

Measuring tree rings, Hughes has traced the Southwest's climate back more than 1,000 years. So far, he says, the worst drought occurred in the 1580s. "But this one may be going beyond that," he told *Current Science*. For example, between May 2005 and May 2007, most of Arizona received from 25 to 80 percent below the normal precipitation.

Droughts are nothing new to the Southwest. But cities as big as Phoenix and Las Vegas are. Even before the drought set in, residents acted as if there was enough water to go around, though there wasn't. "The average Las Vegas home was putting 73 gallons of water on each square foot of lawn every year," says Doug Bennett, conservation manager for the Southern Nevada Water Authority.

Bennett's agency has helped Las Vegans kick some of their wasteful habits. It pays home owners to tear out water-sucking grass and replace it with desert plants. The program has saved 64 billion liters (17 billion gallons) of water—enough

Dry Run

Will the drought gripping the U.S. Southwest ever end?

By Beth Geiger

to fill more than 190,000 Olympic-sized swimming pools—since 2000.

Measures like that have enabled Las Vegas and other southwestern cities to cope so far with the drought. But what if it never ends? What if a drier climate becomes the norm?

THE NEW NORMAL

A recent study says that's just what will happen. The study, led by Richard Seager of the Lamont-Doherty Earth Observatory in New York, was published in April.

Seager compared 19 computer models that forecast how global warming will affect the Southwest's climate. A computer model is a computer program that analyzes how various factors—for example, wind patterns, air temperature, and rainfall—influence one another. Eighteen of the 19 computer models said the same thing: "On average, by the end of the century, people in the Southwest will see a 10 to 20 percent reduction in rainfall compared with the present," explains Yochanan Kushnir, one of Seager's coauthors. "There is remarkable agreement between the different models."

Global warming, says Seager, will change a wind pattern called the *Hadley Cell*. The Hadley Cell is a conveyor belt for air that connects the tropics with subtropical regions. Air within the Hadley Cell rises in the tropics, dropping moisture as it gains altitude. The dried-out air moves north (and south) of the equator, then descends in subtropical regions such as the American Southwest.



Las Vegas property owners are importing water to run fountains and nourish plants.

Global warming will cause the Hadley Cell to widen and move farther north, making the Southwest even drier.

Global warming will have a second effect. Warm air holds more water than cool air, so global warming will pull moisture from the soil. Dry soil heats up quickly, further warming the air above it. The Southwest is particularly susceptible to that effect because it has much less vegetation than other regions; vegetation shades the soil and holds moisture in the ground.

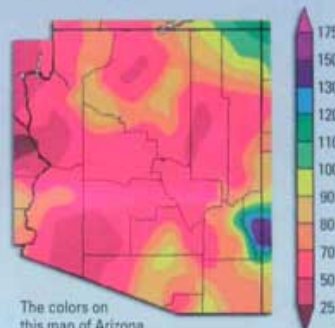
SUMMER SHOWERS

Some scientists say the computer models may not account for summer thunderstorms that bring rain to the Southwest and could help make climate change there more bearable. "I think we have to be cautious with modeling studies," says Svoboda.

But, says Garfin, though Seager's findings may not account for every

detail, his conclusion is basically right: Far worse conditions lie ahead. A warmer, drier climate in the Southwest in the future will be tougher on ecosystems and water supplies than ever.

"The drought of the future," he says, "isn't going to be your father's drought." **CS**



The colors on this map of Arizona indicate the percentage of precipitation each region received during the last two years compared to the yearly average.



The long drought in the American Southwest has lowered the level of Lake Powell by 30 meters (100 feet).