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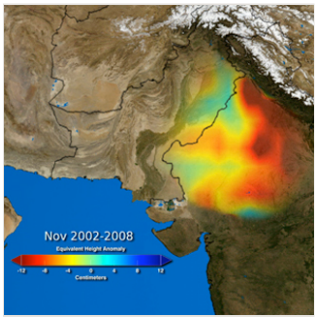
Is Northwestern India's Breadbasket Running Out of Water?

A new study using satellite data suggests the region is using more groundwater than is being replenished by rainfall

By David Biello



WATER CRISIS?: Satellite measurements show that northwestern India is losing a foot of groundwater from its aquifer yearly.
NASA/TRENT SCHINDLER AND MATT RODELL

The fields of barley, rice and wheat that feed much of India are running out of water, according to a new study based on satellite data and published online in *Nature* today. The heartland of last century's Green Revolution lost 109 cubic kilometers of water from its Indus River plain aquifer between August 2002 and October 2008. (*Scientific American* is part of the Nature Publishing Group.)

"By our estimates, the water table is declining at a rate of one foot per year averaged over the Indian states of Rajasthan, Punjab and Haryana, including the national capital territory of Delhi," an area in northwestern India that covers more than 438,000 square kilometers, says NASA hydrologist Matthew Rodell, lead author of the paper. "We are not able to estimate the total amount of groundwater in storage [in the aquifer], so we can't say when it will be gone, but residents are already feeling the effects and it will only become worse."

The consequences include wells that run dry, water shortages in India's capital and, potentially, a decline in yields from agriculture. India's Ministry of Water Resources has long suggested that tapping the aquifer for irrigation was exceeding the limited regional rainfall that replenishes its water, and the World Bank has warned that the country faces a water crisis. On a yearly basis, nearly 63 cubic kilometers of water are drawn from the aquifer, whereas the Indian government estimates that roughly 45 cubic kilometers of water recharge the aquifer annually.

The scientists relied on data from the pair of GRACE satellites—NASA's Gravity Recovery and Climate Experiment orbiters launched in 2002—that measure subtle changes in Earth's gravitational field, which are often the result of shifting water, whether on the surface or deep beneath it. In addition to large-scale water losses detected in Greenland and other polar regions by the GRACE satellites, northwestern India stands out as another area of rapid water loss. "Basically, it is like we weigh Earth every month and we look at the changes," explains geophysicist Isabella Velicogna of the University of California, Irvine, part of the research team.

The primary reason for such groundwater depletion is irrigation, which has fed the Green Revolution that transformed cereal production in the region and helped sustain a growing population that has reached 114 million people. Between 1970 and 1999 irrigated fields in India tripled in overall extent to cover more than 33 million hectares.

That irrigation now looks unsustainable: "The problem is that groundwater consumption was not capped at a sustainable level and now it will be difficult to curb demand," Rodell notes.

It is also clear that global warming's accelerated melting of the nearby Himalayan glaciers is not the primary culprit in the region's water deficit. These meltwaters feed the rivers of northwestern India and beyond, but that water soon flows out of the area and is lost to it. Even with a generous assumption that all Himalayan glacial melting since 1962 (roughly 13.4 cubic kilometers per year) was concentrated in the 150-kilometer stretch of land closest to the study zone rather than spread across the entirety of the Himalayas, the scientists could explain, at most, 15 percent of the water loss in northwestern India. And the arid region's rainfall levels were above the average of 50 centimeters per year from 2002 to 2008.

The water contained in the Indus River plain aquifer, once pumped, is lost to the region via evaporation from irrigation or transpiration from irrigated plants. And GRACE has detected similar depletion in the U.S., as well, including the Ogallala Aquifer under the western plains and the groundwater in the California's Central Valley. "Groundwater resources are being rapidly depleted in many regions of the world," says U.C. Irvine hydrologist James Famiglietti, another team member. "These signals of groundwater loss, in particular in the Central Valley, are very strong."

The solution may be to impose limits on pumping aquifer water— particularly in the case of northwestern India, which uses it to fill seasonal rice paddies covering some 38,000 square kilometers. "If farmers would shift away from water-intensive crops, such as rice, and implement more efficient irrigation methods, that would help," Rodell says.

As population growth continues and food production increases, however, demand for groundwater will only increase, Famiglietti warns. Nevertheless, this research, he says, "suggests that we can keep track of rates at which groundwater reserves are dwindling the world over."