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Space Images Forewarn of Indian Groundwater Crisis (Update2)

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By Jason Gale



Aug. 13 (Bloomberg) -- Orbiting satellites measuring the gravitational pull of water below the earth's surface confirm what authorities in **India** suspected for more than 20 years: groundwater is shrinking in some of the nation's driest areas.

Three northwest Indian states lost a volume of water from underground supplies equal to more than twice the capacity of **Lake Mead**, the biggest U.S. reservoir, between August 2002 and October 2008, scientists said in the journal **Nature** yesterday.

The findings suggest that pumping water from wells for irrigation is damaging India's resources more than the government has estimated. Without measures to curb demand, dwindling groundwater supplies may cause drinking-water shortages and erode crop production in a region inhabited by 114 million people, the authors said.

"That part of northern India is really experiencing rapid groundwater decline that's mostly human-driven," said co-author **Jay Famiglietti**, associate professor of earth system science at the University of California, Irvine, in a telephone interview yesterday. "What they are doing is not sustainable."

About a fifth of water used globally comes from under the ground, the **Stockholm International Water Institute** has said. Withdrawals are predicted to increase **50 percent** by 2025 in developing countries, and 18 percent in developed countries, according to the policy group based in the Swedish capital.

India's area of irrigation almost tripled to 33.1 million hectares (82 million acres) from 1970 to 1999, the authors said, spurred by the so-called **Green Revolution** that began in the 1960s to bolster production of wheat, rice and other staples.

River Contamination

Surface water supplies are also strained. Three-quarters of the country's rivers, lakes and dams are contaminated by human and agricultural waste and industrial effluent, according to a **report** by the Ministry of Urban Development in September.

Groundwater stocks in Rajasthan, Punjab and Haryana states are being lowered at an average rate of about 4 centimeters (1.6 inches) a year, Famiglietti and colleagues said. The depletion is equal to about 17.7 cubic kilometers (4.7 trillion gallons) of water a year, exceeding the estimate of 13.2 cubic kilometers by the **Ministry of Water Resources**, the researchers said.

More than a quarter of the land area in the three states is irrigated accounting for about 95 percent of the groundwater consumed, they said. Levels of subsurface water also appeared to be declining in

western Uttar Pradesh. That state, along with Punjab and Haryana are India's largest wheat-producing states.

Monsoon Forecast

This year's monsoon may be the weakest in five years, the India Meteorological Department said this week. That's exacerbating demand for watering crops and prompted some governments to divert electricity to farms to pump water, said **Sunita Narain**, director of the New Delhi-based Centre for Science and Environment, who was not part of the study.

India's government established a **Central Ground Water Authority** in 1986 to regulate pumping from aquifers. Groundwater hasn't been developed evenly across India, and exploitation has led to a drop in water levels and seawater intrusion in some areas, the Ministry of Water Resources said on its Web site. Of **5,723 sites** assessed, 839 are "over-exploited," 226 are "critical" and 550 are "semi-critical."

"I don't think that the water issues are going to get the attention they deserve until we reach crisis mode," Famiglietti said. "In that part of India, they are certainly reaching crisis mode."

Pumping costs are being ratcheted up by the falling water table and the need to drill deeper wells, said Steven Gorelick, professor of earth sciences at California's Stanford University.

Cost of Pumping

"The problem of declining groundwater levels will become self-limiting at some point," Gorelick said in an e-mail yesterday. "Use will curtail when it is simply too costly to pump the water to the surface from great depths, or when the quality of deeper and deeper groundwater is no longer suitable."

Famiglietti and colleagues used hydrological modeling and data from the **Gravity Recovery and Climate Experiment**, or Grace, to quantify groundwater losses over more than six years. Groundwater depletion over the study period was equivalent to a net loss of 109 cubic kilometers of water, which is enough to fill India's largest surface-water reservoir twice and Lake Mead almost three times, the authors said.

Grace's twin satellites, launched in March 2002, detect subtle changes in the earth's gravity field influenced by the motion of water and air. The satellites detect relative differences in gravitational pull since they occupy different positions in space, according to the mission's Web site.

Across Borders

"What is remarkable about this **study** is that such small declines in groundwater levels can be detected using remote sensing based on Grace satellite data," said Gorelick. "The approach is like trying to track new construction of urban skyscrapers by sequentially measuring the average elevation of an entire city."

The technique will enable scientists to gauge water levels in aquifers that cross international borders, Famiglietti said.

"This is the first time that we have been able to go into the region with essentially no data on the ground and be able to come up with a pretty reasonable number for the rate of groundwater depletion," he said. "We have the power now to be able to get that holistic synoptic of view of what's going on over a large area."

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