

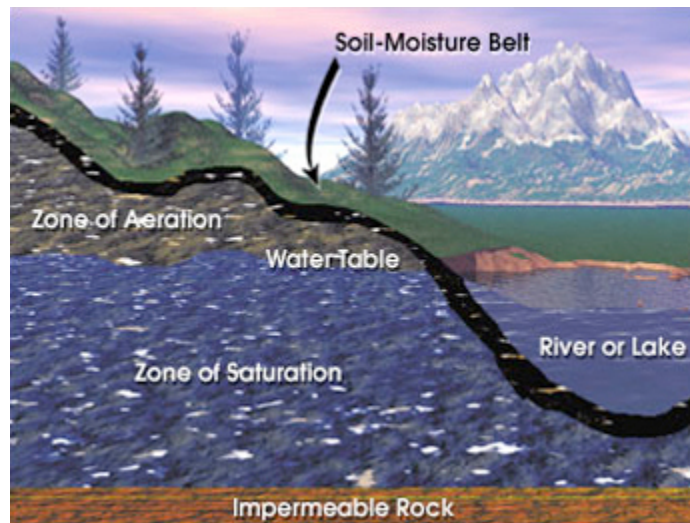
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Satnews Daily

Amazing GRACE Discovers Disappearing Water in India

Using NASA satellite data, scientists have found that groundwater levels in northern India have been declining by as much as one foot per year over the past decade. Researchers concluded the loss is almost entirely due to human activity.

Groundwater resides beneath the soil surface in permeable rock, clay and sand as illustrated in this conceptual image. Many aquifers extend hundreds of feet underground and in some instances have filled with water over the course of thousands of years. Credit: NASA More than 26 cubic miles of groundwater disappeared from aquifers in areas of Haryana, Punjab, Rajasthan and the nation's capitol territory of Delhi, between 2002 and 2008. This is enough water to fill Lake Mead, the largest manmade reservoir in the United States, three times.



A team of hydrologists led by Matt Rodell of NASA's Goddard Space Flight Center in Greenbelt, Md., found that northern India's underground water supply is being pumped and consumed by human activities, such as irrigating cropland, and is draining aquifers faster than natural processes can replenish them. The results of this research were published today in *Nature*.

The finding is based on data from NASA's Gravity Recovery and Climate Experiment (GRACE), a pair of satellites that sense changes in Earth's gravity field and associated mass distribution, including water masses stored above or below Earth's surface. As the twin satellites orbit 300 miles above Earth's surface, their positions change relative to each other in response to variations in the pull of gravity.

Changes in underground water masses affect gravity enough to provide a signal that can be measured by the GRACE spacecraft. After accounting for other mass variations, such changes in gravity are translated into an equivalent change in water. Groundwater comes from the natural percolation of precipitation and other surface waters down through Earth's soil and rock, accumulating in cavities and layers of porous rock, gravel, sand or clay. Groundwater levels respond slowly to changes in weather and can take months or years to replenish once pumped for irrigation or other uses.

Data provided by India's Ministry of Water Resources to the NASA-funded researchers suggested groundwater use across India was exceeding natural replenishment, but the regional rate of depletion

was unknown. Rodell and colleagues analyzed six years of monthly GRACE data for northern India to produce a time series of water storage changes beneath the land surface.

Researchers examined data and models of soil moisture, lake and reservoir storage, vegetation and glaciers in the nearby Himalayas in order to confirm that the apparent groundwater trend was real. The loss is particularly alarming because it occurred when there were no unusual trends in rainfall. In fact, rainfall was slightly above normal for the period. The only influence they couldn't rule out was human.

GRACE is a partnership between NASA and the German Aerospace Center, DLR. The University of Texas Center for Space Research in Austin has overall GRACE mission responsibility. GRACE was launched in 2002.