Environmental Updates

July 2015

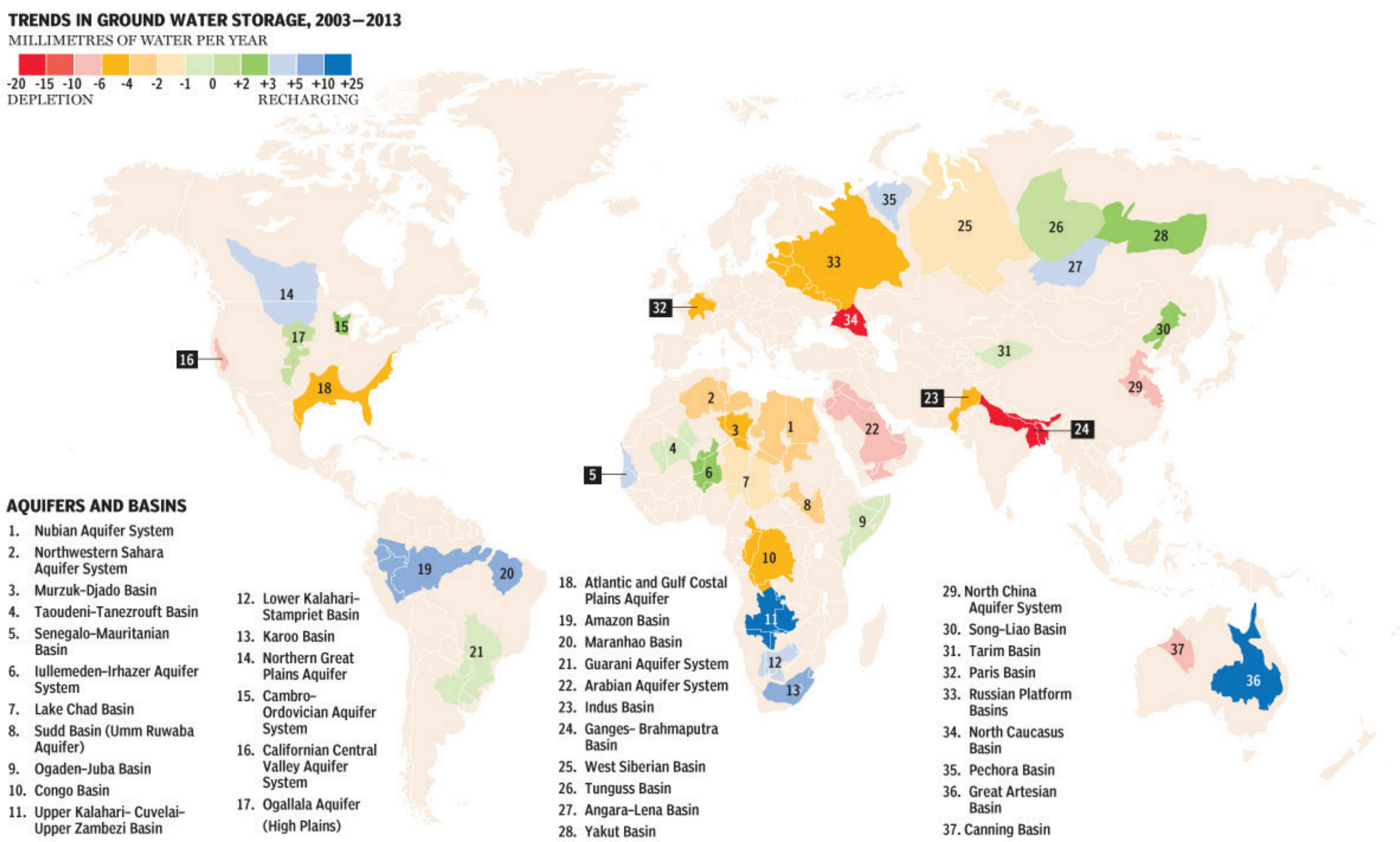
Designed for use with the Global Development And Environment Institute's *Environmental and Natural Resource Economics* textbook

Status of the World's Groundwater Supplies

As discussed in Chapter 15 of the text, in many areas of the world groundwater aquifers are being managed unsustainably, with withdraws exceeding recharge rates. Two 2015 companion papers provide perhaps the most comprehensive data yet on the status of the world's groundwater supplies. Using new satellite data from NASA, one paper focuses on measuring the degree of stress placed on each of the world's 37 largest aquifers, assessing both withdrawals and recharge. The results find that withdrawals exceed recharge in 21aquifers – those shaded yellow, orange, or red in Figure 1 below. The other 16 aquifers gained water during that time period – those shaded blue and dark green in the figure.

Of the aquifers with net losses, eight were classified as "over-stressed," with virtually no natural recharge and significant

Figure 1. Status of the World's Major Aquifers (Recharge rate minus withdrawal rate)



Credit: Andrew Barr/ National Post

withdrawals. The Arabian aquifer system under Saudi Arabia and Yemen was determined to be the most overstressed in the world. The aquifer, which is a source of water for 60 million people, is being severely depleted due to agricultural irrigation. The other aquifers being used the most unsustainably are the Indus Basin under India and Pakistan and the Murzuq-Djado Basin in northern Africa.

The Central Valley aquifer system under California was classified as "highly" or "extremely" stressed based on different approaches. During the prolonged drought in California, farmers have increasingly relied upon pumping groundwater to meet irrigation needs. Surprisingly, the results show that recharge exceeds withdrawals in the Ogallala aquifer in the central U.S., likely due to a large portion of withdrawals running back into the aquifer after irrigation applications.

In the companion paper the researchers tried to estimate the quantity of water available in each aquifer, in order to determine how long it may take to deplete supplies based on various assumptions about withdrawals. While estimates were previously available for the total water storage of major aquifers, the availability of recent satellite data allows for revised estimates.

In most cases the results find that previous estimates of water storage were overly optimistic. In several cases total water storage was estimated to be potentially only half of what was previously thought. Also, despite the availability of the satellite data, the uncertainty regarding the amount of available water actually increased relative to previous estimates. Lead author Alexandra Richey noted, "We don't actually know how much is stored in each of these aquifers. Estimates of remaining storage might vary from decades to millennia. In a water-scarce society, we can no longer tolerate this level of uncertainty, especially since groundwater is disappearing so rapidly." For example, estimates of the time to depletion for the overstressed Northwest Sahara Aquifer System range from 10 years to 21,000 years!

The paper calls for a "significant investment in regional monitoring and measuring systems" to reduce the level of uncertainty in storage estimates. Further,

> until improved storage estimates exist to determine a system's full capacity to buffer against renewable groundwater stress, continued pressure on aquifer systems could lead to irreversible depletion that seriously threaten the sustainability of groundwater dependent regions.

The threat of irreversible depletion is more severe in regions prone to drought. The authors particularly note the potential for this problem with the Central Valley aquifer. The first regulations to control the extent of groundwater pumping were only recently passed in 2014, and do not require sustainable management until 2040. Even more stringent regulations may be needed as "the lifespan of usable groundwater … is highly threatened and may be expended in a matter of decades given current rates of groundwater depletion."

Sources:

Richey, Alexandra S., Brian F. Thomas, Min-Hui Lo, John T. Reager, James S. Famiglietti, Katalyn Voss, Sean Swenson, and Matthew Rodell. 2015. "Quantifying Renewable Groundwater Stress with GRACE," Water Resources Research, online accepted article

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NASA. 2015. "Study: Third of Big Groundwater Basins in Distress," Jet Propulsion Laboratory News, June 16, 2015, http://www.jpl.nasa.gov/news/news.php?feature=4626