Our Oversized Groundwater Footprint

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Figure: A dry well in India. Credit: Bhaskaranaidu/Creative Commons

We don't see it, smell it or hear it, but the tragedy unfolding underground is nonetheless real – and it spells big trouble. I'm talking about the depletion of groundwater, the stores of H2O contained in geologic formations called aquifers, which billions of people depend upon to supply their drinking water and grow their food.

For a long time, we had only a vague sense of the scale of this depletion, mostly through anecdotal evidence and selected country studies. While researching my 1999 book *Pillar of Sand*, I gathered the best data I could find at the time, and with all the necessary caveats, estimated that about 8-10 percent of the world's food supply depended upon the draining of underground aquifers.

About a decade later, modeling work by Marc Bierkens of Utrecht University in the Netherlands and his colleagues arrived at a global depletion estimate that produced a similar figure: their estimated 283 billion cubic meters of groundwater depleted in 2000 is sufficient to produce 188.6 million tons of grain, equal to 10 percent of that year's global grain production. While not all groundwater pumped from the earth is used to produce grain, the vast majority of it is.

In recent years a number of other studies, along with NASA's GRACE (Gravity Recovery and Climate Experiment) mission, have corroborated the dangerous trend. From the Arabian deserts to the North China Plain, and from the breadbasket of India to the fruit and vegetable bowl of the United States, we are increasingly dependent on the unsustainable use of groundwater.In effect, we're robbing the Peters of the future to feed the Pauls of today.

Now a new study, led by Tom Gleeson of McGill University in Montreal and published last week in the journal *Nature*, provides perhaps the most compelling and informative assessment to date of what's happening with groundwater globally.

Gleeson and his team build upon the concept of our "ecological footprint," which expresses humanity's consumption as the area of biomass needed to support that consumption sustainably. Today, according to the Global Footprint Network, humanity uses the equivalent of 1.5 planet Earths. In other words, we've overshot sustainable levels by half an Earth.

In a creative adaptation, Gleeson's team applied a similar approach to assessing humanity's groundwater footprint. They estimate that the size of the global groundwater footprint – defined as the area required to sustain groundwater use and groundwater-dependent ecosystem services — is about 3.5 times the actual area of aquifers tapped for water supplies.

Not only does a significant share of the world's food depend on this groundwater, but an estimated 1.7 billion people – nearly one quarter of humanity – live in areas where groundwater or its dependent ecosystems are under threat.

Of the 783 aquifers analyzed, pumping from those in the Upper Ganges basin of India and Pakistan produce the largest footprint by far, with the footprint spanning 54 times the area of the aquifer itself. Next come the aquifers of Saudi Arabia, Iran, western Mexico, and the U.S. High Plains, which includes the Ogallala, the source of water for 27 percent of U.S. irrigated land. The researchers estimated that pumping from the High Plains aquifer results in a footprint 9

times greater than the aquifer's area. (Any ratio greater than 1 signals depletion of the aquifer; the higher the ratio, the more severe the depletion.)

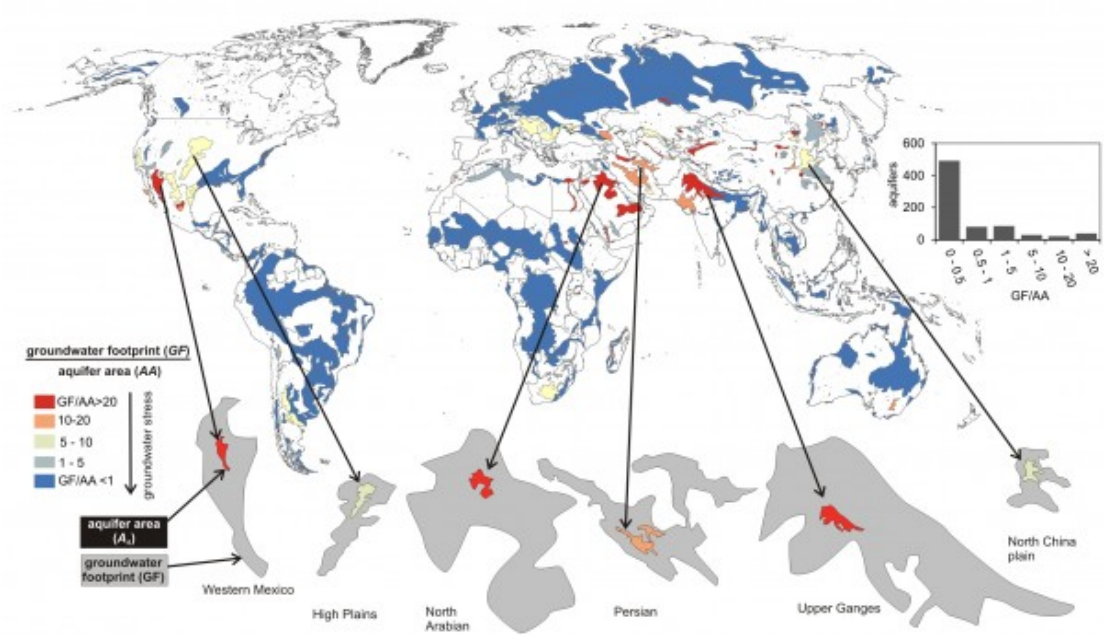

Figure: Groundwater footprints of aquifers important for food production. At the bottom of the figure, the groundwater footprints (in gray) of six aquifers (in red, orange or yellow) are shown. The bigger the relative footprint size, the more severe the depletion. Courtesy of Tom Gleeson and the journal Nature.

The good news is that groundwater depletion is not ubiquitous: at current rates of use, 80 percent of aquifers around the world are not being depleted and therefore could sustain additional pumping to grow food or support expanding cities.

That said, the handful of countries that dominate the global groundwater footprint – those that are depleting the most groundwater – are among the world's top food producers, including the United States, China, and India. Saudi Arabia has substantially depleted its own aquifers, and Saudi companies are now buying up land in Ethiopia and elsewhere to help ensure Saudi food security.

The ramifications of groundwater depletion for this and future generations are serious and mounting. The Gleeson team's visual depiction of the depletion drives home the urgency of taking action now to reverse the trend.

Capping groundwater pumping to match rates of aquifer replenishment would halt the depletion. At a minimum, pumping limits could be set to slow the draining of aquifers, as has been done in parts of the Texas High Plains and elsewhere. Such measures would drive up irrigation efficiency and water productivity, and preserve more water for the next generation.

Unless we take action soon, we'll bequeath to our children and grandchildren a whopping groundwater debt that makes food crises – and the social and political turmoil that springs from them – all but inevitable.

Sandra Postel is director of the Global Water Policy Project and lead water expert for National Geographic's Freshwater Initiative. She is the author of several acclaimed books, including the award-winning Last Oasis, a Pew Scholar in Conservation and the Environment, and one of the "Scientific American 50."