Environmental Science & Technology LETTERS

Editorial

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Rising and Falling Waters (and Land)

I spend most of my time thinking about water quality: what pollutants are in water, how they got there, what the transformation products are, and how to remove them. The other side of water issues is that of water quantity, and I find it necessary to break out of my routine and think about where water is, how much we use, and whether there is enough to satisfy human, industrial, agricultural, and ecosystem needs. What I see worries me.

Water storage in our existing reservoirs may be insufficient to cope with greater variations in runoff and increased demand, especially in arid regions like western and southwestern states in the United States and many cities in Australia. Visual evidence of our need to better manage surface water is obvious from the falling water levels in Lake Mead caused by the combination of drought and unsustainable water use. Groundwater, however, is hidden from view, and thus, overuse of this resource is less obvious. Groundwater has certain advantages—it is locally available and often of high quality—that lend it to use (and overuse) by society. The overuse of groundwater is not confined to areas of water stress. In Minnesota, where we have more than 10000 lakes, groundwater depletion is an important issue. Because of overpumping of groundwater, one lake in the Twin Cities area had falling water levels for a decade, leaving docks far from the shoreline and leading to a call for development of a sustainable water management plan. The challenge in developing such a plan is that while surface water and water table levels are easily measured, the total groundwater storage is less well-defined, especially given that connections between surface and groundwater may be unknown or unexpected and the time lags in the system for movement of water from one unit to another must be considered.

There are clear indications that we have been using and continue to use groundwater unsustainably. The classic U.S. Geological Survey picture from the San Joaquin Valley in 1977 showing the nearly 30 foot change in surface elevation over a 50 year period marked on a telephone pole is well-known. This effect clearly indicated that groundwater withdrawals were greater than inputs. The current drought in California is causing increased reliance on groundwater, and the subsequent water restrictions routinely receive attention from the media. The balance between various water consumers and their responsibilities in conservation of these stressed resources continues to be discussed. These are issues that are faced worldwide. Recently highlighted is the Mekong Delta, where pumping groundwater for drinking water and agriculture is leading to subsidence of 1−5 cm/year, which will have a dramatic impact on a region only 2 m above sea level. Additionally, on a global scale, water removed from aquifers eventually makes its way to the oceans, and thus, the use of groundwater at a rate greater that the recharge rate is leading to sea level rise. Coupled with rising sea levels due to climate change, the overuse of groundwater presents a daunting challenge to this low-lying populated and agriculturally productive area. The potential intertwined problems of subsidence and water overuse/climate-driven sea level rise on coastal communities are only beginning to be understood.

There is a need to evaluate both engineered (high-tech and low-tech) and policy-driven solutions to establish means for sustainable groundwater use. As populations continue to grow and demands for clean water sources rise, sustainable groundwater use will become more difficult, especially because increases in water usage rates often outpace population growth. These challenges are emphasized by recent studies demonstrating that more than half of the world's major groundwater basins have been losing water over the past 10 years, with >20% receiving essentially no recharge. In places where there is more reliance on groundwater (i.e., regions subject to drought), the problem of overuse is most dire. In the United States, there are the resources to attempt to develop sustainable water plans and tackle the major challenges of understanding where all of the water is, how much is accessible, how much is (or can be) replenished, where the interconnections between water resources are, and what current demands are. When there are limited or unsafe water resources in regions where high-technology measurements and solutions are cost prohibitive, the path forward is not clear.

There is also the potential to solve water quality problems to assist with water quantity solutions, using engineered, although potentially high-energy footprint, solutions to turn saline waters, contaminated groundwater, or wastewaters into high-quality water sources. Processes such as managed aquifer recharge replenish groundwater supplies but require biological and chemical pollutants to be (largely) removed. Thirty-five years after the passage of the "Superfund" legislation, there are also areas where groundwater resources cannot be used or managed to their full potential because of historical contamination.

At *ES&T Letters*, we are seeking contributions on the cutting edge of environmental solutions. Those that link water quality and availability and the interconnections among water, population, and climate are of interest to our readership, and studies on these topics will help drive the conversation about the development of sustainable groundwater use in a changing world.

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Notes

Views expressed in this editorial are those of the author and not necessarily the views of the ACS.

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