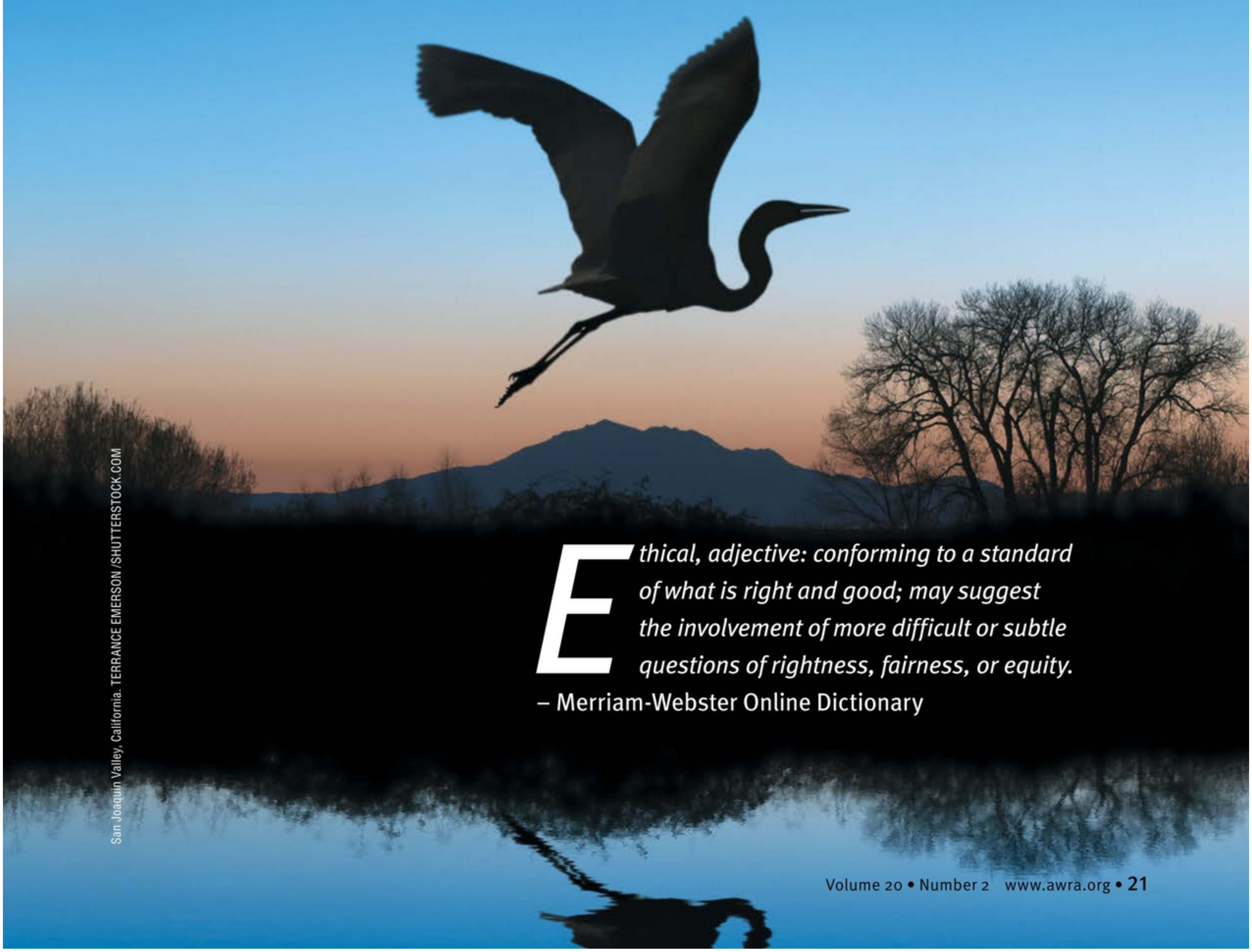
FEATURE

MAD About an Ethical Approach to Unsustainable Groundwater Extraction

Michael E. Campana

"Nothing is impossible for the man who doesn't have to do it himself."
– A.H. Weiler (Weiler's Law)



San Joaquin Valley, California. TERRANCE EMERSON /SHUTTERSTOCK.COM

Ethical, adjective: conforming to a standard of what is right and good; may suggest the involvement of more difficult or subtle questions of rightness, fairness, or equity.
– Merriam-Webster Online Dictionary

> One of the tenets of ethical groundwater management is sustainability, that is, pumping groundwater no more than the amount that assures the aquifer will not be depleted.

A long time ago in a university far, far away

I recall the day with uncharacteristic clarity. It was 47 years ago this month. I sat at the University of Arizona office of my advisor, Eugene S. Simpson. At the time I was a graduate student in his groundwater hydraulics class. Two of my classmates and I listened as Gene waxed eloquent about groundwater management in California. He was unimpressed with it. So what else is new, you're saying.

Gene pointed out that we had known about land subsidence in the San Joaquin Valley as early as the 1930s, yet here we stood in 1971 (try 2018) and subsidence was still occurring. He did note that to lessen groundwater pumping and mitigate subsidence, surface water was now being transported from northern California to the valley and points farther south.

"So what's the safe yield of the San Joaquin Valley groundwater system?" he inquired. Safe yield was a vague concept in vogue at that time. It purported to indicate how much groundwater we could take from an aquifer without producing an undesirable effect(s). Clearly, safe yield hinges upon what one considers 'undesirable effects' and their evaluation. Gene asked us what some relevant undesirable effects were.

We named the usual suspects: land subsidence; streamflow depletion; economics (pumping costs increase as well water levels drop); conflict (causing someone else's well water levels to drop); water quality degradation; impairing another's water rights, etc. The perceptive reader will note that nowhere is something like 'degrading ecosystems' mentioned. Remember, this was 1971. We three were happy with what we had produced.

Gene took a long draw on his corncob pipe. His next question, asked with an impish smile, threw us for a loop: "Does this have anything to do with the ethical management of groundwater?"

Almost 50 years would pass before I addressed that question. That day has arrived.

Of groundwater, checkbooks, streams, stocks and flows

[For an excellent introduction to groundwater, visit the U.S. Geological Survey (USGS) website: https://on.doi.gov/2kYoEmV]

One of the tenets of ethical groundwater management is sustainability, that is, pumping groundwater no more than the amount that assures the aquifer will not be depleted. This is analogous to a checking account in which the deposits and withdrawals (inflow and outflow - the *flows* of the checking account) are equal in a given time period, such that the checking account balance (the *stock*) remains constant. As long as inflow and outflow are balanced, the checking account *balance* is irrelevant (remember this quirk—I'll come back to it later). But if the inflow and outflow are not balanced and the latter exceeds the former, trouble could result—like an overdraft notice from the bank.

One can analyze groundwater in a similar stocks-and-flows checkbook fashion. The physics of groundwater are more complex than those of a checking account, but the general concept holds: we seek balance—or at least inflows (deposits) greater than outflows (withdrawals)—so that the balance (stock) remains constant or increases.

For a given aquifer system, the *stock* means the volume of water stored and *flow* means the flow rate of water. The flows of specific interest are inflows or *recharge* to the aquifer and outflows or *discharge* (via pumping, springs, evaporation, transpiration, etc.) from the aquifer. Just like oil, all the water in an aquifer is not totally recoverable via pumping; some always remains behind. When I say *stock,* I am referring to the amount of *recoverable* water.

Unlike most streams, aquifers have stocks that are much greater than their flows; they are *stock-dominated.* Streams are typically *flow-dominated.* That's one reason why streams are often dammed—to create more storage so that water will be available during dry years (low flows). The large stocks of many aquifer systems (as well as the inability to see them) serve to mask groundwater depletion and lull users into imagining that the groundwater will last forever.

Pumpers' (ethical?) dilemma: the High Plains Aquifer of Texas

In many regions such as the San Joaquin Valley of California; the North China Plain; northwestern India and the High Plains Aquifer System (aka Ogallala Aquifer) of the United States Great Plains, we are pumping groundwater unsustainably. The balance of our checking account is declining to an alarming degree—with the risk that soon the recoverable groundwater will be exhausted.

The main culprit causing the imbalance of groundwater flows, or *overdrafts*, is food production via irrigated agriculture—a crucial human use of water. Even when practiced efficiently, irrigated agriculture consumes large amounts of water—the single highest human use of freshwater on Earth. That's just the nature of the beast.

Commentators often vilify those who pump groundwater unsustainably and those who allow such behavior, because unsustainable groundwater use depletes a critical resource without any perceived concern for ecosystem needs, their neighbors or the future. On the other hand, such pumping provides not only food but also livelihoods for those who depend upon agriculture. Should we just tell these folks to quit pumping so much water?

My Texas trip

This dilemma was brought home to me when I visited Lubbock, TX, in February 2016 to discuss the depletion of the High Plains (Ogallala) Aquifer by irrigators. In Texas, a landowner can pump as much groundwater as she wants from beneath her land without any 'reasonable use' restriction. The only stipulation is that no 'malicious pumping' is allowed. Local groundwater districts may place some restrictions on pumping.

The Texas approach provides little or no incentive for conservation and actually encourages overconsumption. If you conserve, your neighbor may not and start pumping some of *your* water. It's the classic 'race to the bottom' or the 'tragedy of the commons.' Communities over the Ogallala Aquifer are not certain whether or when the water is going to run out, but in the meantime, they enjoy the fruits of over-pumping. That's the dilemma facing the communities in the area I visited. [Note: the film *Written On Water* by Merri Lisa Trigilio documents this plight. http://bit.ly/2CTrpiF]

Is such water use profligate and unethical? What should we do to address this situation?

Managed Aquifer Depletion (MAD)

We need to acknowledge that unsustainable groundwater use is a fact of life and is not going away soon. Too many rely on it and see no alternatives. For situations like the Ogallala Aquifer in Texas, we should implement *managed aquifer depletion,* which yields the appropriate (?) acronym MAD. This management approach requires that we determine groundwater stocks using a combination of fieldwork and modeling. To be clear, stakeholders must buy into this approach and considerations must be given to ecosystems, unintended consequences, and yes, the future.

Sustainability advocates do not often see the necessity for evaluating stocks because their approach demands equality of inflows and outflows, so who needs to know stocks? Recall the checkbook example.

I consider MAD an ethical approach because it accounts for the communities' wishes, provides certainty, and does not simply demand (perhaps unrealistically) that pumpers 'cease and desist.' Managed aquifer depletion can also provide water for future generations—perhaps for hundreds of years. This depends upon those doing the planning. Will they attempt to provide some groundwater for the future, or will they decide to use it all themselves? This latter viewpoint is exemplified by an irrigator who said he didn't care how much groundwater was left in 2040. Why? Well, he needed it now to grow more food so he could send his children to college. They'd already told him they weren't coming back to be farmers; the 'big city' was their destination. So who needs the groundwater in 2040? Not his family!

Interestingly enough, the Texas Water Development Board encourages an approach based on community-determined *desired future conditions* (DFC), which is its version of the managed aquifer depletion approach. (see http://bit.ly/2lAyc74)

The end

Eleven years ago, I heard a talk by Robert Hirsch, who was then the U.S. Geological Survey's Chief Hydrologist. Bob is of my generation, so his comments about hydrologic education rang true. In his 1970s engineering hydrology class, the question was, "How much water can we take out of the river for human use?" Now, it's "How much water should we leave in the river?" I would amend that to ask, "How much water is in the aquifer and should we use it all or save some for the future?"

As the South Africans would say: "Some for all, forever." ■

Michael E. Campana is professor of hydrogeology and water resources management at Oregon State University and technical director of AWRA. He is also founder and president of the Ann Campana Judge Foundation and a member of the Steering Committee of the Global Water Partnership. Campana enjoys many things (especially 1950s-1960s rock 'n' roll) but mostly he enjoys his status as an inveterate WaterWonk-hydrogeologist-hydrophilanthropist who blogs at www.waterwired.org and tweets @ WaterWired. Contact: aquadoc@oregonstate.edu.