From *The Atlantic* **CityLab**

Why Storing Water for the Future Means Looking Underground

Conventional dams and reservoirs work against nature. It's time to work with it.

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A resident walks with a dog across the drying bottom of the Paraibuna dam, part of the Cantareira water system that provides greater Sao Paulo with most of its water. (REUTERS/Roosevelt Cassio)

Whatever the conclusion of COP21, adapting to climate change will only become more urgent, as its impacts become harsher. These impacts are, and will be, felt primarily through water: rising sea-levels, dwindling snowpack, droughts, and floods.

As countries all over the world grapple with these challenges, there's been a lot of talk about innovative water-saving approaches, such as desalination, recycling, novel irrigation systems for farmers, and conservation tools for homes. But there's another variable in the equation when its comes to adapting water use to climate change, and that's storage—how we hold onto water when it's available, so that supplies meet demand in unsteady times.

More big dams?

Building more dams and reservoirs is probably the first solution that comes to mind. Especially in the last century, they've been the primary way that the U.S.—and many other countries like China, India, and South Africa—have collected water. By providing a steady stream of water and electricity to cities and farmers, dams and reservoirs have buttressed economic and population growth all over the world.

But that's once they're already built. Penning up rivers for human gain comes at tremendous costs. Dams interfere with the natural direction of waterbodies and often devastate the wildlife dependent on those flow. And especially when compared to their enormous financial burden, the capacity of dams to supply humans with water is often pretty limited.

The drought has caused a bridge over a Firebaugh, California, irrigation canal to subside until there's almost no space between bottom of bridge decking and canal water surface. (Florence Low/ California Department of Water Resources via AP)

For example, in California, home to 1,400 regulated reservoirs, some $2.7 billion in drought emergency bond money has been earmarked for water storage development. Should the state build even more dams, as some elected officials insist? Besides the fact that all the best spots for damming are taken, the math just doesn't add up, according to a recent report by the Public Policy Institute of California (PPIC), a non-partisan think tank:

> Five proposed projects — costing roughly $9 billion — would expand statewide reservoir capacity by about four million acre-feet. However, these projects would raise annual average supplies by 410,000 acre-feet, or just one percent of annual farm and city use.

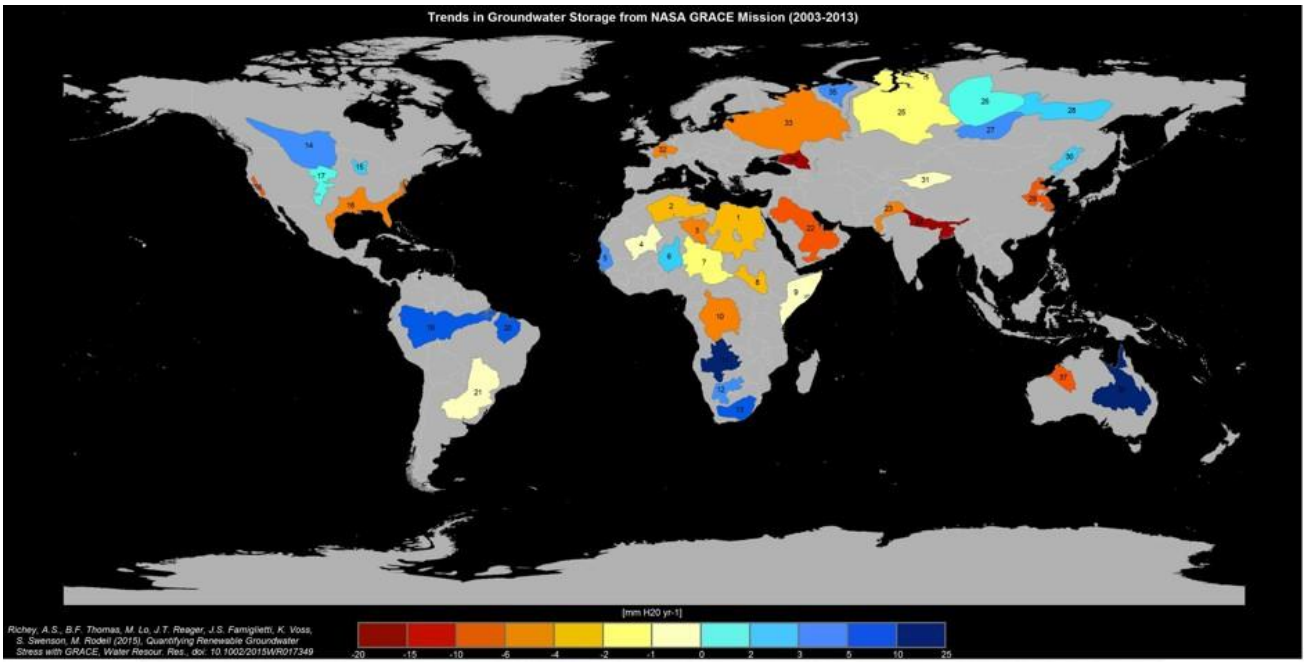
There are lots of reasons dams are inefficient at getting humans water. Reservoirs have to leave lots of room empty in case of floods. Large portions of banked water have to be dedicated to environmental purposes (at least in the U.S.). And still more water has to be guarded for use during droughts, during which times those stores can be quickly depleted. On top of all that, a recent study in *Science* shows that humans have been underestimating global water consumption by about 20 percent, largely due to the rate of evapotranspiration—evaporation and water taken up by plants—in dams and irrigation structures.

Not all dams are necessarily bad ideas, though. "Small dams can slow down rivers that are swollen from a heavy rain, hold back the water, and allow it to soak into the soil," writes Brett Walton at water news site *Circle of Blue*. Existing dams can also be enlarged or renovated to boost supply. Overall, though, there are lot a good reasons that the U.S. has been increasingly shy about building big dams in the past few decades.

Looking to the ground

When it comes to storage options, then, the smart money is on groundwater.

To use California as an example again, its groundwater basins store at least three times as much usable water as manmade reservoirs, according to the PPIC. During the state's historic drought, those groundwater supplies have dwindled to dangerously low levels, even causing parts of the state to physically subside. Sadly, California's not unique; a 2015 study by UC Irvine researchers revealed that supplies in 21 of the world's 37 largest aquifers have fallen off since 2003. And the severe depletion of about a third of them is threatening regional water availability.



Trends in global groundwater storage, quantified by depletion in millimeters per year. (Water Resources Research)

Fortunately, these threats are forcing people to dream up ways to recharge groundwater supplies. The concept of groundwater banking—directing stormwater and excess dam flow towards earthen complexes, designed to percolate water back to the aquifer—is gathering steam across the U.S. and beyond. To go back to California, that $2.7 billion water storage bond could get six times the water storage capacity if the state used it for groundwater projects rather than for new dams and reservoirs.

Restocking groundwater supplies has its drawbacks. Letting water percolate to the ground, and drawing it back up when needed, is simply a slower process than a reservoir's speedy fill and release cycle. It's also harder to regulate. "You got to be damn sure somebody else hasn't dropped a straw" into below-ground reserves, Jeffrey Mount, a senior fellow at the PPIC, told the *L.A. Times.*

Still, the low costs and high gains of groundwater recharge make it one of the most promising answers to the question of global water storage. Some scientists are even calling on leaders at COP21 to include groundwater in their universal agreement. "Local managers do not necessarily have the tools for managing groundwater," Jason Gurdak, a hydrologist at San Francisco State University, told *Circle of Blue*. "They lack financing to build projects and they lack programs to develop technical knowledge. There has to be leadership at the global level."

Perhaps best of all, recharging existing aquifers means working with nature's infrastructure, not building on top of it. "The mighty waters of the Colorado were running unused to the sea," said President Franklin Delano Roosevelt in his dedication

speech at Hoover Dam in 1935. “Today we translate them into a great national possession.” Eighty years later, the world is on the brink of climate change catastrophe. Policymakers had better learn not to try and “possess” natural resources as essential as water—but work with them instead.

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