WATER

Depleted Groundwater Could Be Refilled by Borrowing a Trick from Solar Power

In many places around the world, groundwater is being pumped out faster than nature replenishes it. A new model points to a possible solution

By Erica Gies on October 25, 2023

A desilting pond helps slow down water, allowing sediment to settle out before water is directed towards the infiltration basins in the San Gabriel Spreading Grounds in Los Angeles County. Credit: Citizen of the Planet/Universal Images Group via Getty Images

Pajaro Valley on the coast of central California has little surface water, so its farmers depend on extracting groundwater to grow leafy greens and berries for the global market. But as in many places around the world, these farmers have been pumping the water out faster than nature can replenish it. In different places, groundwater decline can cause various impacts: it can make land sink, streams, wetlands, and wells dry up and seawater creep inland under the ground. And because most pumped groundwater irrigates crops, major declines in availability could lead to a global food crisis.

In some places, water managers actively refill groundwater to ameliorate this tragedy of the commons. One method of doing so is to divert stormwater runoff into scooped basins that have been built over porous ground into which the water quickly sinks. But such efforts have been relatively small-scale and centralized, making them fall short of the current challenge. Depleted aquifers in California's Central Valley alone have lots of empty space: three times the full capacity of the state's more than 1,400 aboveground reservoirs. Yet California squandered much of the bounty from its recent unusually wet winter, as levees, channelized rivers and paved cities funneled much of the runoff into the ocean rather than capturing it. What's needed is a distributed solution, says Graham Fogg, a University of California, Davis, professor emeritus of hydrogeology: many small projects scattered across the landscape that slow water, allowing it to infiltrate underground for storage. This would re-create nature's method for refilling groundwater, which human development has largely eradicated.

An initiative in Pajaro Valley has been working to show how to make this vision a reality for more than a decade. Called recharge net metering (ReNeM), the idea is similar in some ways to rooftop solar net metering, which compensates homeowners for any excess energy they generate and feed into the grid. Using ReNeM, the Pajaro Valley Water Management Agency compensates landowners for a percentage of the amount of water they infiltrate underground. Once underground, the water could remain available locally or move into the wider groundwater system.

Dennis Lebow, a land manager at agricultural conglomerate Reiter Affiliated Companies, oversees one farm involved in the initiative. For ine years, the farm has been infiltrating runoff from a 170-acre slope into a four-acre recharge basin. Researchers measure the water that flows off the hillside and into the basin. To calculate how much water seeps underground, they use stream and pressure gauges, as well as thermal probes inserted into the shallow soil at the bottom of the basin. "The infiltrating water carries heat," says Andrew Fisher, a hydrogeologist at the University of California, Santa Cruz, and co-founder of the project. "By measuring the amount of heat carried downward, we can determine the flow rate."

California landowners had long held rights to pump water from under their property. That calculus started to change in 2014 with a state law that now requires communities to bring groundwater use into balance, under threat of state intervention. Still, as people across California begin to consider large-scale groundwater recharge, a big question has remained: What could motivate individual landowners to help refill a shared aquifer?

A paper published on October 18 in *Nature Water* details how scientists chose recharge sites on willing landowners' properties in Pajaro Valley, calculated the net infiltration and compensated the landowners for this community service. The paper explains how ReNeM could be easily tweaked to work in a range of landscapes and communities around the world and how it could use various financial incentives, such as rebates against pumping fees, direct payments or property tax discounts.

And recharge basins such as the one on Lebow's land aren't the only way to sink water. Infiltration wells cover a much smaller area but go deeper, which allows water to seep through their walls. Restoring native plants and wetlands helps slow water's movement across the land, giving it time to sink underground. Additionally, moving levees farther away from riverbanks allows water to spread and flow over floodplains as they would naturally, slowing it and recharging groundwater.

"ReNeM is a mechanism to build collective responsibility for a common resource," says Molly Bruce, a research fellow at Wheeler Water Institute at the University of California, Berkeley, and lead author of the new paper. (Fisher is a co-author.) The concept of ReNeM represents a cultural shift away from thinking of water as a commodity and toward treating it as a collective benefit because infiltrated water, not only raises groundwater levels, but can also support the wider system, feeding surface flows and keeping saltwater at bay. "Recharge net metering doesn't give independent landowners a right to the water they infiltrate," Bruce says. "The rebate payment is a symbolic severance of that right."

Fogg, who wasn't involved with the paper, says he sees getting paid for recharge as "a major transition in civilization. It's the only thing I've seen that looks like it could incentivize enough people to divert water for recharge." But he does sound one note of caution about this idea: "There could be unintended consequences of diverting too much water," he says, such as reducing the flow in nearby waterways. Fogg recommends monitoring impacts and adapting projects if necessary.

Also, the economics may not yet be compelling. Lebow says that for him, the recharge basin "is not a business decision." The money he spends on dredging sediment that the water picks up as it flows over disturbed ground is roughly equal to his average rebate of $12,000 a year. But he says his company is motivated to keep agriculture viable here, with the added benefit of retaining local control of water. The annual recharge from Lebow's basin roughly balances the water needed to irrigate his land. "We're almost sustainable," he says.

With climate change and overuse making access to water increasingly insecure in many of the world's food baskets, "we have to move toward living within our means," Fisher says. "Pajaro Valley is the future of California. The rest of the state just doesn't know it yet."

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