Unquenchable Thirst: Pajaro Valley's Pursuit of Groundwater
by Arianna Hall-Reinhard

Some children learn at an early age that water flows both above the ground and below. A young Andy Fisher wove that simple fact into a full-fledged fantasy. "I pictured frothing white cataracts, like a big whitewater rafting river, flowing through huge tunnels under the ground," says Fisher. "In my five-year-old mind, there were fins of giant sharks cutting through the water."

Fisher's vibrant childhood vision bloomed into a lifelong passion to understand and preserve groundwater. As leader of the Hydrogeology Group at UC Santa Cruz, he studies the nearby Pajaro Valley Groundwater Basin. The Pajaro Valley, one of the nation's most fertile agricultural regions, sits at the heart of Monterey Bay's curving coastline. From New York City to China, people eat strawberries, lettuce, and artichokes grown there. But the valley is isolated from California's vast water redistribution network, so farmers depend on local groundwater for 85% of their fresh water supply.

"Groundwater is cryptic and hidden. It's very hard for people to get a sense of it," says Fisher. Perhaps the inability to see this precious resource encourages its dramatic overuse in the Pajaro Valley. Groundwater here is pumped out faster than it returns by natural processes, like rain and stream flow. Salt water from the nearby bay also threatens the valley's supply. Fisher's latest work centers on finding creative ways to reverse these trends. His weapon of choice is Managed Aquifer Recharge.

Recharge systems can enrich the valley's aquifer by replacing water gradually through a network of surface basins. It's a simple and cost-effective method to protect the groundwater supply, but it takes time—and it relies on excess surface water, so recharge doesn't work during droughts. Not everyone in the valley agrees, but Fisher thinks managed recharge is a vital tool to keep fresh groundwater flowing.

Farming operations densely ribbon the Pajaro Valley from the Pacific Ocean to the Santa Cruz Mountains. With its well-drained soils and mild winters, the valley nurtures valuable berries, nuts, and table crops year-round. This booming agricultural industry consumes groundwater at an unsustainable rate. Excessive groundwater extraction, called "overdraft," is causing water levels in the region to drop. Like our burgeoning national debt, overdraft has steadily increased in the valley over the last 30 years.

Managers estimate that at least 20% of groundwater pumped in the Pajaro Valley is overdraft. That's enough to supply about 24,000 families of four with fresh water for a year. California's recent persistent drought has only intensified the problem. Although agriculture draws most of the overdraft, Fisher thinks everyone in the valley should play a role in fixing the problem. “If we’re all putting straws into the milkshake, who’s responsible for the level going down? Everybody is,” he says.

In 2001, the Pajaro Valley Water Management Agency (PVWMA) installed its first Managed Aquifer Recharge project to combat overdraft. Just west of the city of Watsonville, the Harkins Slough project site nestles between wetlands and active farms near the Pacific Ocean. Here, the agency built a system of pumps, pipes, and culverts that lead to a 7.5-acre infiltration basin. In the rainy season, workers run the system to divert water from the nearby Harkins Slough wetland into the basin, quickly turning it into a pond. During peak stormy months, the basin can fill with water nearly 20 feet deep. The weight of this trapped water forces it to flow downward into tiny spaces between the grains of soil. The water wends its way through 50 feet of earth to recharge the aquifer below.

“I’d like to see more recharge systems,” says Fisher. “One of the big challenges is to figure out where the water [for recharge] will come from, and storm water is one option.”

Sarah Beganskas, Fisher’s graduate student, is exploring storm water recharge at a second Pajaro Valley site. Local growers and land owners concerned about the aquifer’s future granted Beganskas and colleagues access to their land for the team’s research. This farmland unfurls at the base of the Santa Cruz Mountains, nearly 10 miles from the Pacific and far from major roads. Only the hum of bees and the occasional metallic scrape of a nearby windmill punctuate her work at the site.

During the rainy season, excess storm water runs off from 120 acres of the farm. The water snakes through a series of plastic-lined ditches toward a settling pond, where a culvert feeds it into a 2-acre infiltration basin. This heavily instrumented basin is where Beganskas collects data on the volume, rate, and timing of storm water flow and how quickly the water penetrates into the soil. Beganskas has studied the basin for the last two years, a period with very little rainfall. She is eagerly awaiting the end of the current drought to test the system’s response to significant storm water flows. “You’ll see me doing happy dances every day next year if it’s rainy,” says Beganskas.

Recharge systems, like Harkins Slough and the site monitored by Beganskas, can provide a much-needed influx of water to the groundwater basin, according to Fisher. They can help to keep irrigation water flowing for farmers, and they may help tackle another critical challenge in the valley: salt water encroaching from the sea.

Pumping groundwater to the surface leaves behind a void in the aquifer. In coastal aquifers, if the void created by pumping is not replenished by fresh water, salty water seeps inland from the coast. The extra salt can make groundwater unusable for irrigation or drinking.

In coastal areas, the boundary separating fresh groundwater from an underlying wedge of salt water can be fuzzy, with a zone of mixing between the two. When the groundwater system is in balance and the water table sits well above sea level, flows from the aquifer to the ocean help to hold salty water at bay. But when groundwater is overdrawn and the water table falls, the ocean's pressure pushes the salty end of the wedge inland. This salt-contaminated water trickles through minuscule spaces in the rock, percolating ever farther from the sea.

In the Pajaro Valley, the salty intrusion advances an average of 200 feet per year, leaving a trail of poisoned coastal wells in its wake. It only takes a gallon of seawater in 100 gallons of fresh water to ruin a well, according to Fisher. Even this small dose of salt water can wither plants and render the water undrinkable.

Fisher thinks Managed Aquifer Recharge projects can help win the fight in the valley's underground battle with the sea. The question plaguing the water agency is where to place these projects for maximum benefit. Fisher and his group began exploring this question three years ago.

Fisher and his former student Tess Russo created a detailed map of the valley, in collaboration with staff from the PVWMA. They included data on farmland and paved areas, underlying geology, elevation, and aquifer properties. The research team used Geographic Information Systems (GIS) software to unify the diverse data sets and pinpoint them on the map. They identified about 7% of the valley that appears to have conditions suitable for recharge projects—areas that span 3,800 acres.

Taking it a step further, the researchers integrated the map with a computer model to quantify the interplay of water, topography, and geology in the valley. They used this model to project 30 years into the future, tweaking the placement of hypothetical recharge ponds and watching how the aquifer would respond. Ponds placed near the coast swiftly stifled the incoming seawater. But within a few years, the recharged groundwater at these sites began to flow out to sea. In contrast, ponds at sites scattered across the valley replenished groundwater that stayed in the aquifer. But there is a drawback to this approach: it can take 30 to 40 years to halt the inland march of seawater.

Fisher believes the GIS and modeling approach can be a powerful planning tool for water district managers and researchers alike. "I'd love to see it exported to other parts of the state," he says. "I think it has great potential."

This year, with funding from the Coastal Conservancy and the Resource Conservation District, Fisher and colleagues will expand the GIS and modeling approach to include all of Santa Cruz County, including the City of Santa Cruz. Without the benefit of a groundwater supply, the city depends on rainfall, surface water, and a single reservoir to quench the thirst of its residents. A recent desalination proposal was scrapped when citizens objected to its environmental impacts and cost. Fisher will use the GIS and a computer model to predict storm water runoff and identify the best locations for collection and storage systems throughout the county.

Fisher's many research projects touch upon the concerns of farmers, residents, politicians, and aquifer managers—for whom water has become one of the most delicate topics. "It's easy to demagogue and blow smoke on these issues," says Fisher. But he works hard not to alienate anyone from the dialogue with a misplaced word or misrepresented opinion. He is as persistent as the flow of groundwater itself, determined to evaluate recharge projects over time with high-quality data. "It is a challenge" in the Pajaro Valley, he says. "But it's important not to give up."

Arianna Hall-Reinhard, an undergraduate majoring in Earth sciences at UC Santa Cruz, wrote this story in spring 2014 for SCIC 160: Introduction to Science Writing.