

San Joaquin Valley sinking as groundwater stores are depleted

Tom Knudson, Sacramento Bee, 4-6-14

LOS BANOS -- Flat as a tabletop, the furrowed, brown farm fields east of this San Joaquin Valley town are some of the most productive on Earth.

Every spring, they are planted with a smorgasbord of crops that in one form or another are trucked to grocery stores across America, from fresh juicy tomatoes to freeze-dried onion flakes, honeydew melons to tortilla chips.

Now that bounty is threatened by a crisis of geological proportions: The land is sinking – crippling the region’s irrigation and flood control infrastructure and damaging aquifers that are buffers against climate change.

Nature, though, is not to blame. This problem is self-inflicted, driven by the frontier-style exploitation of the last unregulated resource in California: groundwater.

“We are looking at a material impact of a magnitude that is potentially catastrophic,” said Cannon Michael, a sixth-generation farmer who grows tomatoes, onions and other crops near Los Banos.

“I’m pro-California agriculture in every way,” Michael added. “But there are times when you realize that maybe there are some modes of operation that aren’t working. Your ground falling away at your feet is telling you something is not going correctly.”

Today’s drama is only the latest chapter in a long-running saga of sinking. Three generations ago, so much groundwater was pumped from aquifers that half the valley sank like a giant pie crust, sagging 28 feet near Mendota and inflicting damage to irrigation canals, pipelines, bridges, roads and other infrastructure.

What stopped it were two massive government-funded irrigation efforts – the federal Central Valley Project and California State Water Project – that flooded the region with water from distant California mountains, relieving pressure on the area’s natural underground water supply. But the fix was temporary. Today, drought, climate change and other forces have unleashed a new era of groundwater pumping, triggering some of the worst land subsidence ever seen in California. Near Michael’s farm, the valley is predicted to drop 17 feet by 2060.

“Subsidence is really Mother Nature telling us we can’t continue to do what we are doing,” said Peter Gleick, a water policy expert and president of the Pacific Institute, an Oakland-based think tank. “It is a physical manifestation of the irrationality of our groundwater system.”

While dramatic, valley subsidence is only part of a larger catalog of trouble tied to unrestrained groundwater pumping across California, from water shortages near Paso Robles to dried-up springs and meadows in the Owens Valley.

“You have too many straws in the glass, using too much water – mining the water,” said Jeffrey Mount, senior fellow at the Public Policy Institute of California, a nonpartisan think tank in San Francisco. “This cannot be sustained indefinitely.”

Water policy in California has long been dominated by what we can see: snowmelt streams, cobalt-blue reservoirs, the swamplike sloughs of the Sacramento-San Joaquin Delta. But beneath all of that – invisible, mysterious and vital – is groundwater.

About 30 percent of California's water supply comes from underground supplies, more during droughts. Eighty percent of state residents rely to some degree on groundwater. Some towns, cities and farming operations depend entirely on it.

But unlike other Western states, California has no state standards for groundwater management. Instead, responsibility rests with a patchwork of local and regional entities where oversight varies from careful monitoring and allocation in some places to little or no control elsewhere. Amid one of the worst droughts in California history, state officials now are scrambling to establish a more comprehensive approach.

One of the least regulated regions is the state's agricultural heartland, the 450-mile-long Central Valley, where rain and snowmelt have percolated into the earth over many centuries, forming a vast labyrinth of aquifers that hold more water than all of the state's reservoirs combined.

Over the past century, agriculture and human development have taken a heavy toll on that treasure, pumping far more water out of the ground than nature has replenished, even in the wettest years.

"The cumulative overdraft – our deficit spending of groundwater – is over 122 million acre-feet. That's Lake Tahoe," said Lester Snow, executive director of the California Water Foundation, a Sacramento nonprofit that supports groundwater reform. "That's water we have taken out of our groundwater resources in the Central Valley – and not replaced.

"Groundwater can be renewable if you manage it sustainably, but we are mining it," said Snow, a former director of the California Department of Water Resources. "We are using water that may have been deposited thousands of years ago."

Most of the overdraft occurs in the Central Valley's more arid southern half, the 220-mile long San Joaquin Valley, according to a 2011 study published in the scientific journal *Geophysical Research Letters* that monitored groundwater overdraft by satellite from 2003 to 2010.

"It's a terrible situation," said Jay Famiglietti, a professor of earth system science at UC Irvine and author of the study. And the future, he added, does not look better.

"The snowpack is disappearing. Population is growing. There are competing demands for a decreasing supply of water," Famiglietti said. "The agricultural community will have no choice but to mine the groundwater. And just like any other natural resource, it is not infinite."

"Without doing anything, it's over," he added. "In my opinion, we will see the demise of agriculture in California without groundwater management."

'Let the train wreck unfold'

Trouble does not seem imminent to a traveler driving through the San Joaquin Valley. Even in this drought year, tractors still work the fields. Water muscles through canals and ditches, sparkling like tinsel in the morning sun. Mallards dabble in marshes along quiet country roads.

But the bucolic scenery gives a false impression.

After three years of drought, water tables are dropping fast, from Tulare Basin in the south to Stanislaus County up north. Well-drilling costs are soaring. Conflicts over groundwater are on the rise. No problem, though, is more enormous than the gradual, irreversible compaction of the earth that occurs when aquifers are pumped to historic lows.

The first siege of sinking in the middle 20th century was so widespread a U.S. Geological Survey report called it “the single largest human alteration of the Earth’s surface.” In all, the land sank 1 foot or more across more than 5,200 square miles from south of Bakersfield to north of Mendota – an area nearly as large as Connecticut.

A photo in a 1999 USGS report on subsidence captures the drama vividly. It shows scientist Joseph Poland standing next to a utility pole outside Mendota. On the ground is a placard marked 1977. Twenty-eight feet overhead, another sign is nailed to the pole showing where crops once grew: It reads 1925.

As the land subsided, bridges slumped, levees sank and well casings failed. Canals sagged, too, inviting water to loiter in low spots and spill over banks. From 1955 to 1970, damages topped \$1.3 billion (in 2013 dollars), according to a new report by the California Water Foundation. All kinds of water conveyance infrastructure was harmed, from pumping plants and canal berms in the Tulare-Wasco area to bridges, pipelines and drain inlets on the Delta-Mendota Canal west of Firebaugh. And then, thanks to massive volumes of surface water that arrived via state and federal aqueducts and canals, pumping slowed and subsidence largely stopped.

“By the mid-1980s, we thought subsidence had been conquered,” said Chris White, general manager of the Central California Irrigation District in Los Banos.

So, too, did the government agencies that monitored it. “Over time, funding for coordinated subsidence investigations ended ... and water-level monitoring wells were decommissioned or fell into disrepair,” says the water foundation report.

The valley, though, was poised to slump again. It just needed a chance, something to rekindle the region’s thirst for groundwater.

That moment has arrived with a near perfect storm of drought, climate change, population growth, declining allocations of surface water stemming from environmental restrictions in the Sacramento-San Joaquin Delta, and the changing face of farming in the valley.

In the driest of times, farmers are planting thirsty crops: high-value almonds and grapes that unlike traditional row crops can’t be fallowed in drought years. Federal figures show California’s almond acreage reached an all-time high of 870,000 acres in 2012, most of it in the San Joaquin Valley.

“This rapid shift to perennial crops is driving a well-drilling arms race,” said Mount, the water policy expert. “Whoever’s got the money is able to get the water without consideration of what the end game looks like.

“We have no plan for a soft landing in the San Joaquin Valley,” Mount said. “At present it’s just let the train wreck unfold and see what happens.”

‘Elephant in the valley’

One problem is a paucity of data. No agency monitors who is pumping how much groundwater and where. The state does collect information from drillers about well location, capacity and depth, but by law that information is not available to the public.

“If you pump a million acre-feet out of a single well, you don’t have to report that to anyone in most places in the valley,” said Snow, the water foundation director. “We can’t manage it if you can’t measure it.”

The USGS, which studies groundwater nationwide, gets around the impasse by estimating valley groundwater use. “We essentially figure out what they’ve planted, then how much they would have had to pump to get the yields, which is difficult,” said Michelle Sneed, a hydrologist who specializes in subsidence.

“It’s this huge number we sort of have to back into,” she added. “It’s all numerical games. ... We could be so much better at our job if we had those measurements.”

Asked if such data should be made available, Sneed said: “That’s not my call.”

Others are less reticent. “You have to require that these big pumpers measure and report to the local agencies,” said Tim Parker, director of the Groundwater Resources Association of California, which represents geologists, engineers and other professionals in the field. “We can’t do the science without having good data.”

Basic information about subsidence is missing, too.

“There is no state or federal agency in California that has the responsibility or a program in place specifically to monitor land subsidence,” the water foundation’s report says.

“Alarming rates of subsidence continue to occur throughout California, causing impacts and costs that can have lasting effects to property and the environment. This information is only being collected after the impacts of subsidence have occurred,” the report added.

In California, the USGS relies on outside sources of funding, such as irrigation and water districts, to investigate subsidence. “We are on a lot of what’s called ‘soft money,’ ” Sneed said. “We don’t get this chunk of money from Congress where they say, ‘Do the most important work that you think needs to be done.’”

“When you are dealing with large, regional problems like this, one small irrigation district can’t afford to do that,” Sneed said. “It’s frustrating. I know there is a lot of work we should be doing that we’re not doing.”

Sneed is the author of a 2013 study that documented small amounts of subsidence along the Delta-Mendota Canal south of Los Banos. But the big discovery came about by happenstance.

After hearing about some unusual elevation readings near the San Joaquin River from the California Department of Water Resources, Sneed took a closer look with satellite technology that can detect minute changes in topography across large swaths of land. What she found startled her: Another area of the valley was sinking rapidly, north of the previous hot spot outside Mendota.

“This was just a little extra ‘back of the envelope, let’s see what we can see’ – and oh no!” she said. “This is kind of the elephant in the valley.”

In all, she found 1,200 square miles were subsiding, much of it about half an inch a year. But near the small town of El Nido, not far from the river, the valley had dropped nearly a foot a year between 2008 and 2010 – one of the highest rates ever measured.

“It’s huge,” Sneed said. “A foot a year is not sustainable. You can’t really mitigate against a foot a year.”

Messing with gravity

In a place as flat as the valley, even an inch a year is a lot. The reason is gravity. Gravity is the engine that moves water across the landscape. Subsidence disrupts that engine, altering the gradients of canals, making water run too fast here, too slow there, and reducing canal capacity over time, shorting farmers of water.

Flood safety is another concern. Parts of the Eastside Bypass, a major flood-control channel flanked by earthen levees, have dropped more than 4 feet in recent years due to subsidence. That has changed the pitch of the channel, causing erosion and sedimentation and shrinking its ability to convey water during a flood.

“If we ever get a wet year, that channel is not going to handle the water; it’ll go over the banks,” said David Pruitt, who farms on the west side of the river.

More trouble occurs deep underground inside aquifers. To visualize what happens, imagine millions of dinner plates tipped and tilted at crazy angles. Those plates are tiny grains of clay in the aquifers. The spaces between them are filled with water.

When the water is pumped out, the plates collapse. They rearrange themselves into “stacks of pancakes,” explained Sneed. “There’s a lot less space between the stacks of pancakes so you can’t store as much water.”

The loss typically ranges from 5 percent to 15 percent, but is sometimes higher, and even a major deluge won’t replace it. “It’s forever. It can’t be undone,” Sneed said. “It doesn’t make the aquifer unusable. It just reduces the amount of water that can be stored in it.”

Another looming issue involves a section of the state’s multibillion-dollar high-speed rail line slated to run through the area that is subsiding. “They say they have ideas of how to deal with it,” Sneed said. “I think 11 inches a year is a lot. I’m interested to see what their proposed solutions are.”

But the most immediate problem is playing out on a quiet section of the San Joaquin River where kingfishers dart through cottonwoods and carp splash in the shallows. Here, river water runs headlong into a small concrete dam where it backs up and is shunted into a concrete canal that for generations has provided surface water to farmers across 45,000 acres on the west side of the river.

And now, there’s trouble: The small dam is slowly disappearing into the murk and muck of the San Joaquin.

For years, the structure – known as Sack Dam – has stood 12 inches above river level during the summer. By 2010, 5 of those inches were underwater. Last year, the river was lapping at the top of the dam.

“It scares me to death,” said Chase Hurley, general manager of the San Luis Canal Company, which manages the dam and delivers water to about 80 westside growers. “If I lose this outlet, not a stitch of my land gets irrigated.”

The subsidence has forced federal officials to halt construction of a \$35 million fish-passage facility at Sack Dam, delaying the long-awaited return of salmon to the region. “It was supposed to be a 5-foot-high dam,” said Sneed. “In five years, it’s overtopped.”

What worries west-side growers in Merced County are farmers on the east side of the river, in Madera County, who are drilling wells deep into subsidence-prone aquifers to grow nuts and grapes in a region with no access to surface water.

One of the new agriculturalists is the corporate farming arm of insurance giant John Hancock Financial Services, which bought the 12,000-acre Triangle T Ranch in 2010 and converted its cotton and alfalfa fields to almond and pistachio orchards.

“Engineers have indicated (we) can tap 0.5 acre-foot per acre from the deep aquifer without negative effect,” said Brian Carmichael, John Hancock’s director of corporate communications. “We are and will stay below that level.”

He said the company has installed “state of the art moisture monitoring and irrigation systems” and uses 50 percent less water than when the ranch grew cotton and alfalfa.

“Water is a business expense,” Carmichael said. “We run as efficient an operation as possible and try to use only the water we need. It must be a long-term sustainable resource.”

Hurley has been working with John Hancock and other growers on the east side to try to find a way to slow the pumping and save Sack Dam.

“We’re not telling the farmers you can’t farm,” he said. “We’re saying, ‘Work with us and let’s try to find other avenues to get you the water so you don’t have to rely on the deep groundwater, because that’s causing subsidence.’ ”

But progress has been slow. “It’s a real tough issue,” said Pruitt, the westside farmer. “How do you go tell a guy next door you’re causing me trouble, you’ve got to stop pumping? They’ve got big investments, too.”

The ‘Wild West’ below

Historically, valley farmers have been wary of groundwater regulation. But the sinking San Joaquin dam has persuaded some to rethink that position, including Michael, the Los Banos grower whose great-great-grandfather Henry Miller pioneered ranching in the valley in the 19th century.

“Obviously, nobody wants to be regulated any more than we are,” Michael said. “But I think maybe we have to have somebody step in. People are probably going to be upset that I would say something like that. We have to find ways to protect the resource that we have.

“There are all kinds of surface regulations (for water) and you’ve got this Wild West underneath the ground. The chickens are coming home to roost, unfortunately,” Michael said.

“It’s probably going to come down to a water war,” said Pruitt. “Probably the federal government or the State Water Resources Control Board are going to have to step in and make sure wells aren’t causing problems with subsidence.”

Michael also expressed frustration with Madera County, which does not limit how much groundwater can be pumped. “I see a real lack of leadership,” Michael said.

Madera County has issued more than 1,300 well construction permits over the past four years, and has no step in that process for assessing how much groundwater is actually available. “You tell me: how do we look and see how much groundwater is available?” said Jill Yaeger, director of the county department of environmental health.

Asked if any permit applications had been rejected, Yaeger said, “None that come to mind readily.”

But as water tables drop and conflicts grow, even farm-friendly Madera County is taking a closer look at its groundwater issues and discussing the possible creation of a groundwater authority with nearby cities and water and irrigation districts to better manage the resource, said county engineer Kheng Vang.

“We all are concerned,” said Yaeger. “This is a valley issue. It’s a statewide issue.”

Pressure for some sort of state oversight is growing in Sacramento, as well. A proposal in the California Water Action Plan, a drought-inspired blueprint prepared this January for the governor, calls for better local and regional groundwater management – and state action if necessary.

“You have some regions that regulate it in a very extensive way,” said Felicia Marcus, chairwoman of the State Water Resources Control Board, which regulates surface water and is drawing up a proposal to better manage groundwater. “In other areas, for whatever reason, they haven’t had the political will.”

For his part, Hurley, the westside irrigation manager, hopes to hammer out a solution with eastside growers. But time is short. “Another couple of years and I won’t be able to divert water the way I am today,” he said. “We can’t afford to sit around and wait much longer.

“At the end of the day, maybe it’s going to take something out of Sacramento,” he said. “Whether it’s some legislation, whether it’s legal activity, we don’t know.”

Even if he does stop the sinking and save the dam, the victory will be limited. “Subsidence is happening in a lot bigger area than this,” Hurley said. “There are going to have to be similar things done in this whole valley.”