

Pumped beyond limits, many U.S. aquifers in decline

SUBLETTE, Kansas – Just before 3 a.m., Jay Garetson's phone buzzed on the bedside table. He picked it up and read the text: "Low Pressure Alert."

He felt a jolt of stress and his chest tightened. He dreaded what that automated message probably meant: With the water table dropping, another well on his family's farm was starting to suck air.

The Garetson family has been farming in the plains of southwestern Kansas for four generations, since 1902. Now they face a hard reality. The groundwater they depend on is disappearing. Their fields could wither. Their farm might not survive for the next generation.

At dawn, Jay was out among the cornfields at the well, trying to diagnose the problem. The pump was humming as it lifted water from nearly 600 feet underground. He turned a valve and let the cool water run into his cupped hands. Just as he had feared, he saw fine bubbles in the water.

"It's showing signs of weakening," he said sadly, standing in the shoulder-high corn.



Jay Garetson lets water run into his hands from a well on his family's farm near Sublette, Kan. He saw fine bubbles in the water and said that indicates the well is weakening as the Ogallala Aquifer declines. He said he's worried about the future of farming

in the area.

(Photo: Steve Elfers, USA TODAY)

"This'll last another five or 10 years, but not even at the production rate that we're at here today," he said. "It's just a question of how much time is left."

Time is running out for portions of the High Plains Aquifer, which lies beneath eight states from South Dakota to Texas and is the lifeblood of one of the world's most productive farming economies. The aquifer, also known as the [Ogallala](#), makes possible about one-fifth of the country's output of corn, wheat and cattle. But its levels have been rapidly declining, and with each passing year more wells are going dry.

As less water pours from wells, some farmers are adapting by switching to different crops. Others are shutting down their drained wells and trying to scratch out a living as dryland farmers, relying only on the rains.

In parts of western Kansas, the groundwater has already been exhausted and very little can be extracted for irrigation. In other areas, the remaining water could be mostly used up within a decade.

The severe depletion of the Ogallala Aquifer is symptomatic of a larger crisis in the United States and many parts of the world. Much more water is being pumped from the ground than can be naturally replenished, and groundwater levels are plummeting. It's happening not only in the High Plains and drought-ravaged California but also in places from the Gulf Coastal Plain to the farmland of the Mississippi River Valley, and from the dry Southwest to the green Southeast.

In a nationwide examination of the problem, USA TODAY and The Desert Sun analyzed two decades of measurements from more than 32,000 wells and found water levels falling in nearly two-thirds of those wells, with heavy pumping causing major declines in many areas. The analysis of U.S. Geological Survey data revealed that:

- Nationwide, water levels have declined in 64 percent of the wells included in the government database during the past two decades.
- The average decline among decreasing wells has been more than 10 feet, and in some areas the water table has dropped more than 100 feet during that period – more than 5 feet per year.
- For 13 counties in Texas, New Mexico, Mississippi, Kansas and Iowa, average water

levels have decreased more than 40 feet since 1995.

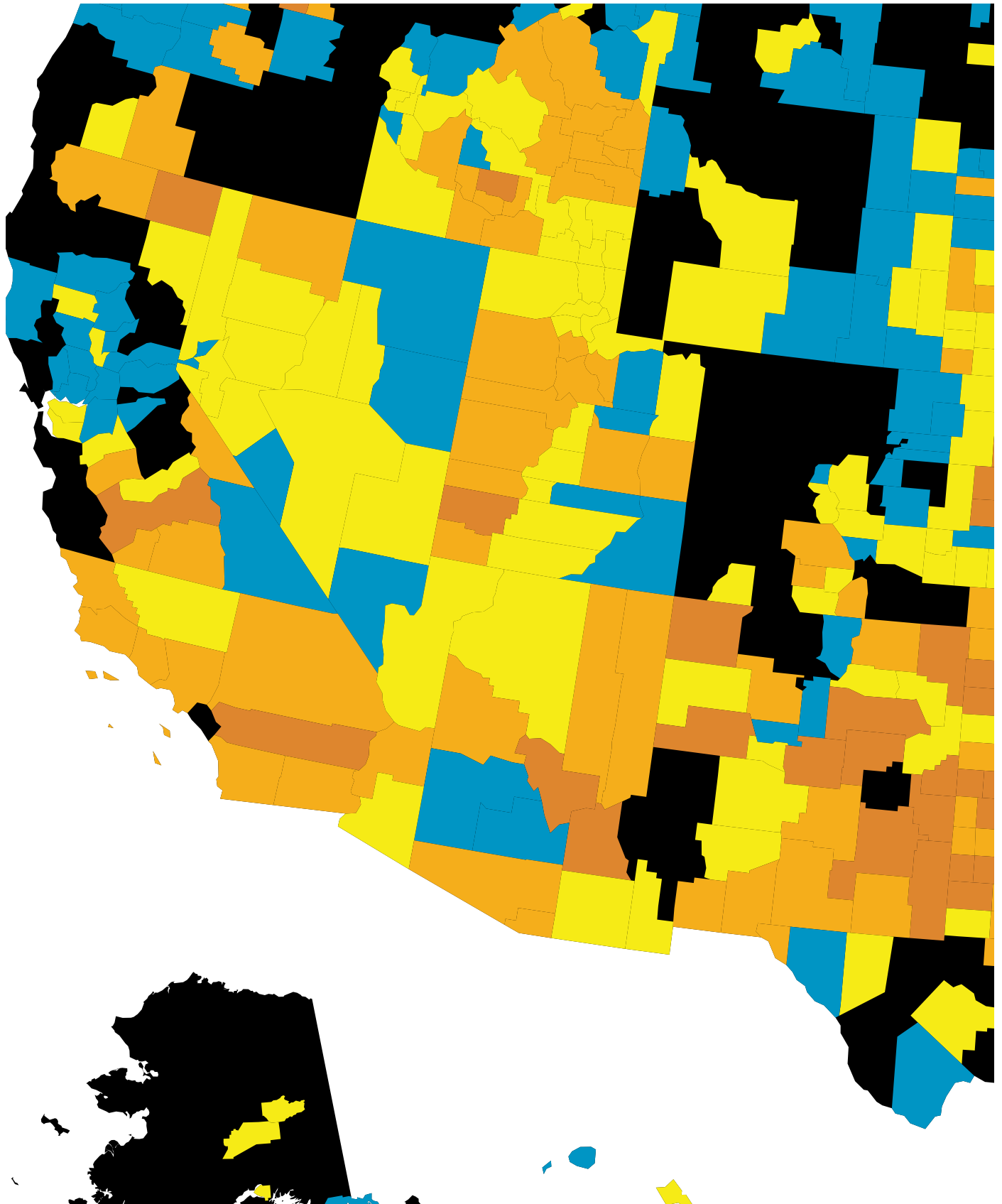
- Nationally, the average declines have been larger from 2011-2014 as drought has intensified in the West. But water tables have been falling consistently over the years through both wet and dry periods, and also in relatively wet states such as Florida and Maryland.
- Across the High Plains, one of the country's largest depletion zones, the average water levels in more than 4,000 wells are 13.2 feet lower today than they were in 1995. In the southern High Plains, water levels have plunged significantly more – in places over 100 feet in just 20 years.

In many counties across the United States, groundwater levels have been dropping.

The problem is especially severe in the region that relies on the Ogallala Aquifer.

Across the southern High Plains, farms have been draining the aquifer.

Haskell County in western Kansas is one of the areas where wells have been going dry and farms are threatened.



Average decrease in water level

15ft.+

5-15ft.

0-4ft.

increase or stable

Source: USA TODAY/Desert Sun analysis of USGS data

Aquifers are being drawn down in many areas by pumping for agriculture, which accounts for nearly two-thirds of the nation's use of fresh groundwater. Water is also being drained for cities, expanding development and industries. Across much of the country, overpumping has become a widespread habit. And while the symptoms have long remained largely invisible to most people, the problem is analogous to gradually squandering the balance of a collective bank account. As the balance drops, there's less of that resource to draw on when it's needed.

At the same time, falling groundwater levels are bringing increasing costs for well owners, water utilities and society as a whole. As water levels drop, more energy is required to lift water from wells, and those pumping bills are rising. In areas where aquifers are being severely depleted, new wells are being drilled hundreds of feet into the earth at enormous cost. That trend of going deeper and deeper can only go on so long. When groundwater levels fall to precarious lows and wells are exhausted, farming businesses can suffer. And in particularly hard-hit communities, such as parts of California, homeowners have been left relying on tanker trucks to deliver their water.

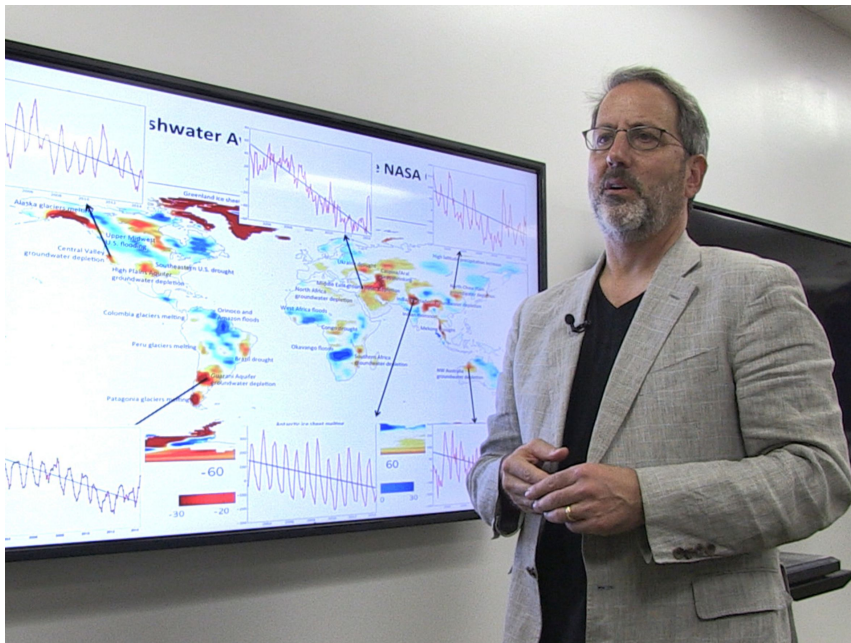
Since the beginning of the 20th century, the United States is estimated to have lost more than 1,000 cubic kilometers of water from the nation's aquifers – about 28 times the amount of water that can be held in Lake Mead, the country's largest reservoir.

That [estimate](#) of water losses from 1900 through 2008, calculated by USGS scientist Leonard Konikow, shows the High Plains has accounted for 35 percent of the country's total depletion. California's Central Valley accounted for more than 14 percent, and other parts of the country have depleted the remainder, about half of the total.

In places, water that seeped underground over tens of thousands of years is being pumped out before many fully appreciate the value of what's lost. The declines in groundwater in the United States mirror similar decreases in many parts of the world.

NASA satellites have allowed scientists to map the changes underground on a global scale for the first time, putting into stark relief a drawdown that has long remained largely out of sight. The latest satellite data, together with measurements of water levels in wells, reveal widespread declines in places from Europe to India, and from the Middle East to China.

"Groundwater depletion is this incredible global phenomenon," said Jay Famiglietti, a professor of earth system science at the University of California, Irvine, and the senior water scientist at NASA's Jet Propulsion Laboratory. "We never really understood it the way we understand it now. It's pervasive and it's happening at a rapid clip."



Jay Famiglietti, a professor of Earth System Science at the University of California, Irvine and the senior water scientist at NASA's Jet Propulsion Laboratory, explains his research on groundwater depletion. Famiglietti and a team of researchers have been using data from NASA's GRACE satellites to study changes since 2002 in the total amounts of water, both aboveground and underground, in regions around the world. (Photo: Marilyn Chung, The Desert Sun)

Famiglietti and his colleagues [have found](#) that more than half of the world's largest aquifers are declining. Those large-scale losses of groundwater are being monitored from space by two satellites as part of the [GRACE](#) mission, which stands for Gravity Recovery and Climate Experiment.

Since 2002, the orbiting satellites have been taking detailed measurements of Earth's

gravity field and recording changes in the total amounts of water, both aboveground and underground. Using that data, the researchers have created a global map showing areas of disappearing water as patches of yellow, orange and red. Those “hotspots” mark regions where there is overpumping of water or where drought has taken a toll.

The map shows that, just as scientists have been predicting due to climate change, some areas in the tropics and the higher latitudes have been growing wetter, Famiglietti said, while many dry and semi-arid regions in the mid-latitudes have been growing drier. In those same dry regions, intensive agriculture is drawing heavily on groundwater. And with little rain to recharge the aquifers, their levels are dropping.

“Many of these resources are finite,” Famiglietti said. “It took tens of thousands of years to accumulate this water, and we’re burning through it in a matter of decades.”

In many regions, government agencies and water districts have studied the problem but haven’t taken sufficient steps to manage aquifers or prevent declines.

Alongside climate change, groundwater depletion has become another human-caused crisis that could bring devastating consequences. As aquifers are pushed far beyond their natural limits, water scarcity is battering farms, undermining economies and intensifying disputes over water.

In parts of the southern High Plains, farmers are feeling the effects. Some counties have seen small decreases in population as people have moved away. Local leaders have been expressing concerns about what sorts of businesses can help sustain their economies as water supplies dwindle.

The Kansas Geological Survey has mapped out how much longer the aquifer can support large-scale pumping. It projects that some places still probably have more than a century of water left, but that large patches of western Kansas will go dry in less than 25 years. Some areas will likely run out faster, within a matter of years.

The Ogallala Aquifer’s decline shows what the world can expect in other areas where groundwater is being quickly depleted, Famiglietti said. “The fact that they’re running out of water means that we will no longer be growing food there, and so where will that food come from?”

The green circles of center-pivot irrigation systems stand out in areas where farms rely on

water from the High Plains Aquifer. Much of the corn grown in Kansas is used as cattle feed. It is also used to produce ethanol.

(Photo: Ian James, The Desert Sun)

In Haskell County, Kansas, windswept fields of sorghum and corn stretch to the flat horizon in a swaying sea. The huge farms, many of them in the thousands of acres, still appear lush and productive. But driving along the arrow-straight country roads, Jay Garetson can point out spots where wells have gone dry – both on his family's land and other farms.

All that's left at one of his decommissioned wells is a round metal cover on a concrete slab, with a rusty Frigidaire lying on its side next to it. His grandfather once used the refrigerator to store oil for the pump.

Opening the well's metal lid, Jay dropped in a rock. It pinged off the steel casing. More than five seconds later, there was faint splash.



Jay Garetson removes the metal cover from a decommissioned well that went dry. He and his brother had the well drilled in the early 2000s when a shallower well failed. It lasted less than a decade. When it went dry in 2012, they were forced to drill again, this time 600 feet deep, down to the bedrock at the bottom of the aquifer.

(Photo: Steve Elfers, USA TODAY)

"Now the only water it finds is a couple three feet at the very bottom of the well that the pumps can't effectively access anymore," Jay said, his voice echoing in the empty well.

He and his brother, Jarvis, drilled this well in the early 2000s when a shallower well failed. It lasted less than a decade, and then it went dry in 2012, forcing them to drill again – this time 600 feet deep, down to the bedrock at the bottom of the aquifer. It's hard to say how long that well might last.

If the water keeps dropping about 5 feet per year, he said, it might be finished in as few as 10 years.

"Very simply, we're running out, and it's happening far faster than anybody anticipated," he said. "And as optimistic as I'd like to be about the future, the window for that optimism is closing very quickly."

He put the cover back on the old well, pointing out a tag that was placed on it by a state regulatory agency.

"We're documenting very well the demise of the aquifer, but we're not making the real-world changes in the way we manage the aquifer to really do the serious things that need to happen," Jay said. "We seem to be unwilling to take the necessary steps to actually reduce water usage."

Jay is an influential farmer and a longstanding member of the Kansas State Board of Agriculture who has been appointed by both Democratic and Republican governors. He has many ideas about how to extend the life of the aquifer, including mandatory water cutbacks that would be shared by farmers. But he has faced resistance from those who oppose mandatory limits.

Over the past five years, the pumping capacity of the Garetsons' wells has decreased by about 30 percent as the water table has fallen. They've been forced to plant less corn and instead more wheat and sorghum, which use less water and bring in smaller earnings.



Jay Garetson stands in front of a farmhouse where he lived as a young boy. No one has been able to live in it since its well went dry two years ago. He said he fears more houses will be abandoned in the area in coming years unless steps are taken to slow the decline of the Ogallala Aquifer.

(Photo: Steve Elfers, USA TODAY)

When Jay's grandparents drilled wells in the mid-20th century, they were told the water supply was inexhaustible. They had clung to their land through the hardships of the Dust Bowl, when blowing drifts of soil and grit decimated crops and sent many others packing. In the decades that followed, they built a successful business on the water they pumped from the ground.

Since then, numerous studies have shown that the status quo is far from sustainable. Starting in 1986, Congress directed the USGS to monitor and report on changes in the levels of the Ogallala Aquifer, recognizing its economic importance. An estimated 30 percent of the groundwater used for irrigation in the country is pumped from the aquifer. Researchers have [projected](#) that without action to slow the losses, the portion of the aquifer in Kansas will be nearly 70 percent depleted within 50 years.

"What frustrates me is with all this knowledge and all this information, we still collectively refuse to act," Jay said. "I don't understand how we can all be so lacking in courage when we all can clearly see this is a train wreck happening in slow motion."

The costs of inaction are visible just down the road, at a farmhouse where Jay lived as a young boy. Today the white house is abandoned. Weeds have grown around the front

steps. Scraps of wood lie in a pile on the porch like logs on a campfire.

When the well went dry two years ago, a farm employee was forced to move out. The Garetsos drilled test holes but found no more water to tap.

In the yard, Jay pointed out the spot beneath a dying elm tree where he used to play on the swings. "It's probably seen its last swing set in the yard," he said wistfully.

"It's something I used to read about and study, you know, the Dust Bowl. And you would see these abandoned farmsteads, and now I'm actually seeing it in my own lifetime," he said. "Now we're kind of at the end of the tracks here, and the only thing left to do is decide whether we should go ahead and push the house in and burn it, or probably the most painful option in my mind is to stand back and watch time just slowly melt it down."

The worst-case scenario, he said, is that within a decade many more homes in the area could look just like this one – dry and deserted.



Jay Garetson checks on a well that is starting to weaken as the Ogallala Aquifer declines. *Steve Elfers, Ian James*

The United States, along with India and China, is one of the largest users of groundwater

in the world.

The federal government has [estimated](#) that in 2010, the country used 76 billion gallons of fresh groundwater per day. That's 117,000 cubic feet per second, roughly comparable to Niagara Falls. Wells across the country are pumping out as much water – even slightly more – than the average flow of approximately 100,000 cubic feet per second that tourists see plunging from the top of Niagara Falls.

When groundwater is pumped from wells, some of it is soaked up by plants, some evaporates, some courses through pipes to cities, and some soaks back into the ground. Part of it ends up flowing into the [oceans](#), adding to the global problem of rising seas as glaciers and ice sheets melt.

Most of the planet's available freshwater lies underground. Aquifers store water like sponges, holding it in the spaces between rocks, sand, gravel and clay. So much water is now being sucked from some aquifers that those underground spaces are collapsing and the surface of the Earth has been permanently altered.

The ground has sunk in parts of California, Texas, Arizona and Nevada, cracking the foundations of houses, leaving fissures in the ground, and damaging roads, canals and bridges. As layers of aquifers gradually subside, their water-storing capacity is irreversibly decreasing.

Groundwater levels have changed relatively little in some of the country's wetter areas, as rainfall and snowmelt have offset the amounts pumped out. But even in pockets of the Northeast and upper Midwest, there have been significant declines. Average water levels in Cumberland County, N.J., for instance, decreased nearly 6 feet over the past two decades. In Outagamie County, Wis., there was a decline of 6.1 feet.

Elsewhere, there has been significant depletion across entire regions, largely driven by agriculture. Average water levels fell by 5.7 feet across the Mississippi River Valley aquifer system, by 12.6 feet in the Columbia Plateau basaltic rock aquifers of the Pacific Northwest, and by 17.8 feet in some of the Snake River Plain's aquifers of southern Idaho.

As the nation's population grows, expanding cities and suburban development are also having an effect. Total U.S. water use has [decreased](#) in recent years due to improvements in efficiency and conservation, but the cumulative strains on groundwater have continued to build.

Big drops in water tables have occurred in many parts the country. The U.S. Geological Survey's data show that individual monitoring wells with water level decreases of more than 100 feet in the past two decades are located in a long list of states: California, Nevada, New Mexico, Texas, Maryland, Washington, Oregon, Kansas, Iowa, Arkansas, Idaho, Arizona, Louisiana, Colorado, Wyoming and Mississippi.

Saltwater has been seeping into declining aquifers along portions of the Atlantic coast in places such as Hilton Head, S.C. and Savannah, Ga., and beneath coastal cities in Florida such as Jacksonville, Miami and Tampa. When [saltwater intrusion](#) taints supplies of drinking water, it can force water districts to use different wells or invest in other costly solutions.

In parts of the desert Southwest and the Great Plains, natural springs that used to gush from the ground have dried up.

There have also been long-term declines in groundwater levels around urban areas including Chicago, Milwaukee, Wis., Long Island, N.Y., Baton Rouge, La., Memphis, Tenn., and Houston.

In each state, the use of groundwater falls under different laws. In many areas, though, the agencies charged with managing water supplies have allowed aquifers to fall into a state of perpetual overdraft, with water levels receding deeper by the year. Even where groundwater regulations exist, pumping often remains largely unchecked.

"Like your bank account, you can't keep depleting it forever. That's a non-sustainable condition," the USGS scientist Konikow said. "Society will have to do something about it. Some areas, they are doing things about it. Other areas, it's going to kind of slap them in the face at some point as a wake-up call."

Fields of grain sorghum, also known as milo, surround grain silos in southwestern Kansas. The crop is used as cattle feed.

(Photo: Ian James, The Desert Sun)

In the farm country of Grant County, Kansas, where grain silos tower over fields that stretch out to a flat horizon, the chamber of commerce hosts an annual dinner that has been a tradition for 53 years. Hundreds of people line up while volunteers dish out local food: barbecued beef, sweet corn, candied squash and prized doughnuts made with milo,

another name for sorghum.

The dinner consistently attracts top state politicians. This September, when Lt. Gov. Jeff Colyer gave a speech to a packed auditorium, he emphasized the importance of water.



Volunteers dish out locally produced food at the annual Grant County Home Products Dinner in September in Ulysses, Kan.
(Photo: Ian James, The Desert Sun)

"We all know here that the lifeblood of our land is that Ogallala Aquifer below us," Colyer said. "We've got to rely on that water."

He said that's why Gov. Sam Brownback recently launched an effort to develop a "50-year water vision" for the state. Colyer said southwestern Kansas is working to preserve its water, and he pointed to the large cattle industry and the fast-growing dairy business as signs of a bright economic future.

Those applauding at the long tables included Jay Garetson, his wife, Jill, and two teenage sons. But while Jay credits the state government with doing more than ever to focus on water, he's concerned the consensus-building approach and the voluntary measures being promoted aren't enough.

In his office, he rolled out a map to explain why. The map is marked with patches of orange and red denoting areas that have relatively little water left. In one of those spots, "right in the bull's eye," he pointed to the family's hometown of Sublette.

The biggest problem, he said, is that no one can slow down the decline alone. And those who try to use less water will have the aquifer pumped out from beneath them by neighbors.

"Everybody's got a straw in the same soda," Jay said. "When you have a common resource, and the individual motivations are to accelerate the use rather than to stretch it out over a period of time, the net result is everybody loses."

The economics of the profit-driven status quo are driving the depletion, he said, and that points to a need for the state and the regional groundwater district to intervene – like a referee in a sporting event that has deteriorated into a free-for-all. He said the referee should "call a timeout."

Then, he said, "we need to sit down and think about changing the rules."

Wells have been drawing out less water and going dry in places from eastern Colorado and the Texas Panhandle. Northern portions of the aquifer in Nebraska still have more water remaining, but parts of the southern High Plains have been left with parched fields.

In areas where little water remains, people have been turning to dryland farming, relying on the rains to grow wheat and other crops. That switch leads to sharply reduced earnings per acre. It requires farmers to use much bigger acreages to turn a profit. It means the land will support far fewer farms, and that could bring hard economic times.



Jarvis Garetson changes a flat tire on a center-pivot irrigation

**system on his family's farm in Haskell County, Kan. Rapid declines in the level of the aquifer threaten the future of farming in this area. He said: "It's tough to think about what's been in my family for well over a hundred years not being here in 20."
(Photo: Ian James, The Desert Sun)**

Jay's brother Jarvis explained how profound those changes could be, pausing from his work after changing a flat tire on a center-pivot irrigation system.

"It's tough to think about what's been in my family for well over a hundred years not being here in 20. It may mean that my kids or my nephews don't come back, may not even have a chance if that's their desire," he said, his voice quavering. "It's just tough to think about it not being there. I mean, it's a way of life."

Trying to make the aquifer last longer, some farmers have been adopting water-saving irrigation systems. A sign on one highway reads: "Make Every Drop of Water Count."

Marieta Hauser, a dryland farmer who is director of the Grant County Chamber of Commerce, said she's concerned about what sorts of businesses could take the place of irrigated farming, which drives the economy.

"Ideally we all want the aquifer to last forever. It's not going to. We realize that. So what's the best way to go forward and maintain the viability of our communities and our businesses?" Hauser said. "Those are the discussions that I hear more than anything, is 'What's going to happen to our communities when irrigation is not viable?'"

Some towns, such as Ulysses and Johnson City, have been buying water rights from farmers to secure enough drinking water supplies to keep the taps flowing.

One experiment aimed at slashing water use on farms is underway in Sheridan County, in northwestern Kansas, where the state's first "Local Enhanced Management Area," or LEMA, was established in 2013. Through that five-year plan, farmers are trying to keep within a "budget" that calls for a 20 percent reduction in water use.

Even as that strategy is showing signs of working, water managers acknowledge it's not coming close to halting declines in the aquifer. It's simply buying a bit more time.



Grain elevators tower over the street in Sublette, Kan., where the farming economy depends on water pumped from the Ogallala Aquifer.

(Photo: Ian James, The Desert Sun)

Mark Rude, executive director of the Southwest Kansas Groundwater Management District No. 3, can put a specific number on the gap between the amounts of water pumped and the quantities of rainfall that recharge the aquifer in an average year: "We're only about 9 percent sustainable."

In other words, the people of southwestern Kansas are pumping out 11 times more than the aquifer's natural recharge. People are barred from adding new wells in the area. If a new well is drilled, it needs to replace another well that is shut down.

In practice, the water rights system doesn't limit pumping at all. In fact, farmers are using much less than they would be permitted under the system of appropriated groundwater rights, which was established decades ago when water seemed plentiful and flood irrigation was the norm.

"Ultimately, I think, budgeting the aquifer is where any area has to start. How much do you have and how much are you willing to see consumed? That's always a difficult step," Rude said. When the water district has held meetings and asked farmers whether they're in favor of developing a water budget, some have been apprehensive about restrictions or mandates.

While some keep pumping, others are leaving. Within the traditional Mennonite community, elders have begun sending away young couples to settle in other areas such as the Snake River Plain in Idaho, where even though aquifer levels are declining, more water remains. They're leaving, Rude said, "because as the water supply leaves, the intensity of agriculture leaves, and the job opportunities also leave."

For every acre that runs out of irrigation water and starts being dry-farmed, the state estimates the economy loses nearly \$4,000 a year.

The difference between irrigated fields and dryland farms appears starkly on a large satellite photo on the wall of the water district's office in Garden City. Patches of brown border the green circles of center-pivot irrigation systems.

Moving a hand across the map, Rude pointed out spots where springs and streams have dried up. One spring was a popular swimming hole half a century ago, he said, and it doesn't flow anymore.

Decades ago, the Arkansas River used to flow between Garden City and Dodge City. Now all that's left are scattered patches of reeds in the dry riverbed.

Jay Garetson's wife Jill, who is a teacher, lived near the flowing river as a child. She has watched it disappear, drained by diversions upstream and the declining water table. As a girl, she used to follow her father into cornfields while he fixed sprinklers. Now he's out of water and relying on several oil wells for income.

"I don't think we can continue to do things the way we're doing them," she said. "Some serious action has to be taken quickly."

The Garetsons' 17-year-old son, Jared, is cautiously assessing the future and thinks it may be difficult to return home to farm after college.



Corn for cattle feed is harvested on the Garetson farm near Sublette, Kan. Jared Garetson, 17, flies his drone to capture the action. He says he's concerned that if the severe depletion of the Ogallala Aquifer continues unchecked, it will be increasingly difficult to keep irrigating the area's farmland in the future.
(Photo: Jared Garetson)

Every year he helps out during the corn harvest, and as a hobby he flies a drone to film the harvester mowing down golden rows. But he said the aquifer now seems like a gas tank with its gauge approaching "E."

"If we lose the aquifer, we lose probably 80 percent of our crops out here," Jared said. "If our water supply is shut off, that's a huge amount of food that we're going to have to find elsewhere."

They are a close-knit family, and stories of their farming history are woven into conversations around the kitchen table. It's a legacy that may be slipping away for Jared.

"I've thought, why don't we just pack up, sell the farm and leave? And we'll find somewhere else that's got water and that's going to continue to have water, where we can build?" Jared said. But that's a difficult idea for his parents and grandparents to accept. "It's been our home for 113 years now, and for all that to go away and just stop that, that hundred-year-old investment, and that'd be really hard to just pack up and say goodbye to everything."

As for Jared's future, he said in order to make long-term investments in farming, it would

be crucial to secure enough water for the next 40 years.

"Until we've got our water issue taken care of, then I basically have no future here," Jared said. "It's kind of sad, but it's the harsh reality."

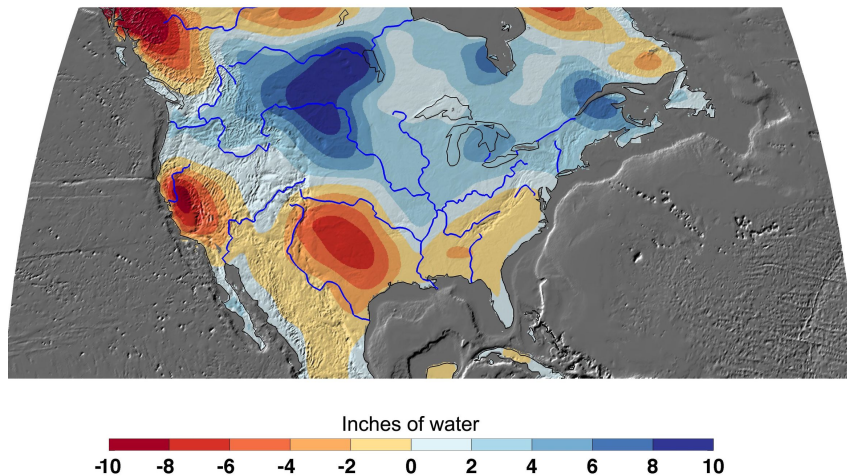
A center-pivot irrigation system rotates around a field near Garden City, Kan. In some parts of the southern Plains, groundwater levels have plunged over 100 feet in the past 20 years.

(Photo: Steve Elfers, USA TODAY)

Large rice farms in the Mississippi River Valley depend heavily on water pumped from wells. So do fields of cotton, soybeans and corn across portions of Mississippi, Louisiana, Arkansas and Missouri. The farms are drawing out significantly more than is naturally replenished, and the valley's alluvial aquifer system has been declining.

"Here, we actually get a lot of rain so you tend to not think of it as being in danger of running low on water," said Brian Clark, a USGS hydrologist in Little Rock, Arkansas. "But just the sheer amount of use kind of poses that issue."

GRACE TWS trends: increases & decreases over 13 years (2002-2015)



NASA's GRACE satellites have measured losses of freshwater across much of the western and southern United States. This map provided by NASA's Jet Propulsion Laboratory shows cumulative total freshwater losses in the country from 2002 to 2015. Much of the northern half of the country had an increase in total water storage during this period. Areas where groundwater depletion

had a major effect included California's Central Valley and the southern High Plains Aquifer.

(Photo: NASA JPL/Caltech)

Officials in Arkansas, which is the country's [top rice-producing state](#), are updating the state's [water plan](#) with proposals for coping with a growing "groundwater gap" in the eastern portion of the state. They've recommended building infrastructure to make surface water the primary irrigation source for areas that now depend on a declining supply of groundwater.

Other proposed regulatory changes aimed at addressing strains on groundwater are being debated elsewhere, in wet regions as well as dry regions of the country.

In Arizona, state lawmakers have been under increasing pressure to consider groundwater regulations for some of the same rural areas that fought off restrictions about 35 years ago. Some farmers and residents in southeastern Arizona are concerned that unregulated pumping is drawing down groundwater levels, and have been pushing the legislature for action to limit the expansion of irrigated farmlands and begin charging fees for groundwater use.

In Wisconsin, where some people are concerned about farms' wells drawing down streams and lakes, a [bill](#) pending in the legislature would allow state regulators to establish "groundwater protection areas" where there would be tighter permitting rules for new high-capacity wells in order to prevent environmental impacts. The proposed measures would also ease the permitting process for redrilling or repairing existing wells.

In Iowa, growing demands are being placed on the [Jordan Aquifer](#) as water is pumped for cities, farms, and industries such as ethanol plants. In June, the Iowa Environmental Protection Commission approved a new [rule](#) aimed at limiting pumping. The measures divide wells into tiers based on how much water levels have declined, and lay out procedures for reductions in water use in areas where the aquifer has dropped significantly.

Florida has also faced problems with groundwater declines as expanding development has strained water supplies. As the vast Floridan Aquifer has been drawn down, the amounts of water flowing from some of the state's natural springs have decreased significantly, altering the sensitive environments where fish, turtles and other wildlife have long flourished.

"We have springs that are going silent because they're not bubbling with the artesian pressure that they did in the past," said Robert Knight, president of the Gainesville-based Florida Springs Institute, which [advocates](#) reducing the extraction of groundwater to safeguard the natural springs. He pointed out that much of the water pumped from wells is being sprayed on lawns.

As freshwater is pumped out, more seawater has been moving inland underground. And water managers across Florida have been tracking the problem and investing in remedies, including more desalination plants.

The Tampa Bay area built a seawater desalination plant that can churn out 25 million gallons of drinking water a day. The Tampa Bay Water plant, which has been operating since 2008, has helped reduce the stresses on the area's groundwater supplies. But that has come at a price, with cost of construction alone totaling \$158 million.

As the Ogallala Aquifer has declined beneath their land, Jay and Jarvis Garetson have been locked in a bitter dispute with a neighboring landowner over water.

They're suing the company American Warrior, which owns adjacent farmland, in a case that could set a legal precedent in Kansas.

The case revolves around one of the Garetsons' wells. They own a vested water right that is one of the oldest in the area, and they have priority under the state's "first-in-time, first-in-right" system. They've claimed "impairment" of that well by two of the company's nearby wells.



Jarvis Garetson replaces a wheel and a tire on a center-pivot irrigation system in Haskell County, Kan. He says in order to effectively address the declines in the Ogallala Aquifer, everyone in their area would need to reduce pumping.

(Photo: Steve Elfers, USA TODAY)

American Warrior holds junior water rights, and a judge issued an injunction temporarily barring the company from using the wells while the case proceeds.

Mike O'Brate, vice president of the family-owned American Warrior, accused the Garetsons of suing out of "greed" and said a lawsuit isn't the right way to settle the dispute. He said if the Garetsons win, it will set a bad precedent and more suits will follow.

"Everybody will want to file these to shut off their neighbors," O'Brate said. "Attorneys are going to get filthy rich in a fight over water. It's not a good thing."

The Garetson brothers said the 2012 lawsuit was necessary to defend their family's livelihood.

"The fact of the matter is, we have a vested right to their junior rights, and Kansas water law is very clear," Jarvis said. "And the sad thing is we had to get the courts involved to make it happen."

Jay said that in addition to pressing the state to enforce its laws, they hope to call attention to the urgent need for action to preserve the aquifer.

"I guess our family's decided we'd rather call a question and force everybody to make an informed decision one way or the other than to be complicit in the death of something that didn't have to go out this way," he said.

After the lawsuit was filed, the Garetsons faced hostility – even death threats.

As aquifers decline, more legal conflicts are likely to flare up in places across the country. Many disputes have already ended up in the courts.

Mississippi, for instance, is in a long-running [legal battle](#) with Tennessee and the city of Memphis, claiming the neighboring state is taking groundwater that belongs to Mississippi. In California, where many aquifers have been divvied up by courts, the Agua Caliente Band of Cahuilla Indians is [suing](#) two Coachella Valley water districts in a fight over rights to groundwater.

In Kansas, the state Water Office and the U.S. Army Corps of Engineers have studied a [proposal](#) to build an aqueduct that would carry water from the Missouri River to the High Plains, and have estimated the cost at \$18 billion.

When Jay and his family start talking about water, the conversation touches on mega-fixes, such as the idea of building a wind-powered pipeline from the Mississippi River.

In the meantime, Jay holds out hope there is still time to save what's left and extend the use of the aquifer. "But it's going to take immediate action and it's going to take mandatory action, and that's something that is hard for most of us out here, who are pretty individualistic and self-reliant, to contemplate."

Any imposed cutbacks would be painful for everyone, though the pain could be spread around, he said. And water credits could be traded, creating a market that would help deal with scarcity and put the limited water toward high-value uses.

Jay sometimes wonders if roadside billboards would help increase the sense of urgency. He envisions signs with cross-section drawings of the aquifer "that show the reservoir declining and force people to admit at least, if we're not going to act, that it was an informed decision not to act."

Driving down a dirt road through farmland, Jay talked about what losing the aquifer would mean for his family.

"Thinking about Jared and the challenges that his generation faces, that's what leaves you gasping for air. It kind of leaves you at a loss for what to do next," he said, wiping a tear.

Jay said he and his brother keep trying to gain five or 10 years by using a new crop or new irrigation technologies. He said their father, Jesse, encourages them to "keep pushing" and keep praying.

"We'll succeed somewhere. I just always thought it would be here," he said as he pulled into his gravel driveway next to a cornfield.

He stood beside the mud-splattered pickup, petting his dog.

"In spite of everything I do and we do, it's still not enough," he said, sniffing softly. "My boys and my nephews will never have the ... they won't have the same opportunity."

He paused, keeping his composure.

"If they stay here, it'll be a salvage operation. It won't be an expansion or a growth or an improvement. It'll be a salvage operation," he said. "That's the mentality they'll have to have – unless everybody can come together. The problem is everybody won't come together, in my experience, until it's too late."

As he began to cry, he walked away.

Ian James reported from Kansas and Steve Reilly reported from McLean, Virginia.

Steve Elfers of USA TODAY, Caitlin McGlade of The Arizona Republic and Chad Gillis of The News-Press in Fort Myers, Fla., contributed to this report.

This special report was produced with a grant from the Pulitzer Center on Crisis Reporting.

Jay Garetson looks into a cornfield next to a pump on his family's farm in southwestern Kansas. He said when he thinks about the challenges the next generation faces due to declining groundwater levels, "that's what leaves you gasping for air."

(Photo: Ian James/The Desert Sun)



[Next Slide](#)