

# How unchecked pumping is sucking aquifers dry in India

*In India, some areas are rapidly running out of groundwater*

**Ian James, USA Today, 12-14-15**

DAPEGAON, India – At dawn, as bells ring out from Hindu shrines, the people of this village get in line for water.

Wells have been going dry across the countryside, and the village's one remaining well yields just enough to run the communal taps for an hour or two a day. In front of the spigots, people leave their empty water jugs and buckets arranged in rows, and they crowd around to collect what they can while the taps are running. The water could stop flowing at any time.

For farmers here, finding sources of water underground is becoming exceedingly difficult. They've been drilling wells deep beneath the tilled soil into the volcanic rock – 700 feet, 800 feet, even 900 feet down. The few who strike water usually plant sugarcane, a thirsty crop that fetches fixed prices subsidized by the government. Lately, though, many farmers drill wells and find nothing at all.

“There's no water, so there's no harvest, so there's no income,” said Adinath Suryawanshi, a farmer whose family has gone into debt drilling wells that turned out to be dry. “I think there's really no way out. All I can do is cope. And I think that's the fate of every farmer.”

Falling water tables and crushing burdens of debt have contributed to a growing sense of desperation in the western state of Maharashtra, where farmers have been committing suicide in large numbers. Some families have turned to chopping down trees on their land to sell off the wood. Many young people have given up farming and moved away to cities to look for work.

In large portions of India, from the plains that spread out below the Himalayas to the country's southern plateau, water is being quickly drained from the ground and aquifers are rapidly declining. In some areas, government data show groundwater levels have dropped by an average of more than 30 feet since 2005.

Farmers with the deepest wells keep pumping, but those with failing wells are struggling. And some towns have been left on the brink of running out of water. It's a growing crisis that threatens the future of irrigated agriculture in some of India's prime farming areas, and it's also putting at risk the main drinking water sources used by hundreds of millions of people.

The major declines in India's aquifers are part of an alarming trend across much of the world. Water is being pumped out much faster than it can naturally be replenished in parts of Asia, Africa, the Middle East and the Americas.

In an investigation of the impacts of groundwater depletion worldwide, USA TODAY and The Desert Sun analyzed national and global water data and interviewed dozens of farmers, residents,

well drillers, researchers and government officials on four continents – in India, Peru, Morocco and the United States.

In most places where aquifers are overstressed, similar trends are colliding: heavy pumping for farming, growing demands on limited water supplies, and a failure to adequately manage or regulate the groundwater that's left. Droughts have added to the pressures on groundwater, and climate change is projected to intensify droughts in many of the same regions where aquifers are in decline.

Already in parts of India, people say water has become their biggest worry. The shortages have become so acute in some places that families have had to spend half the day or more searching for drinking water, walking for miles at a time.

India relies heavily on groundwater, with an estimated 25 million to 35 million wells in operation, many of them on small farms. Wells have enabled increasing water use in places where rivers and canals are too far away or are already tapped out or polluted.

As wells have proliferated over the past half century, the country has become the world's largest and fastest growing user of groundwater. Scientists estimate that about 250 cubic kilometers of water is sucked from India's aquifers each year – more than half the volume of Lake Erie, and more than the combined annual groundwater usage of the United States and China.

India's groundwater boom has come as the population has swelled to more than 1.2 billion people. But it's also the country's laws and farming policies that have long encouraged a free-for-all of drilling wells and pumping.

As the law stands, landowners have the right to draw as much as they see fit from their wells. A system of government-set prices encourages farmers to plant water-intensive crops such as sugarcane and rice. And state governments provide electricity to farms at no charge or at heavily subsidized flat rates, making the water completely free to pump in many areas.

State and national government officials have for years acknowledged the problem of falling water tables, but their responses have so far been meager. The state of Maharashtra, for instance, in 1993 passed one groundwater management act, which turned out to be ineffective, and is starting to put in place another groundwater law approved in 2009.

Meanwhile, drilling rigs have left the ground punctured with countless holes that are yielding no water. Some farmers have drilled dozens of times and found nothing. People here say the land has become a *chaalan*, which means sieve in the local Marathi language and can also refer to a body riddled with bullet wounds.

“Groundwater remains unregulated, entirely unregulated at this point of time, and that's one of the biggest challenges that India is facing,” said Parineeta Dandekar, a water researcher with the advocacy group South Asia Network on Dams, Rivers and People. “The picture is bleak. It has been bleak for some years now, and increasingly the groundwater levels are plummeting.”

Shobha Pandule fetches water for her family of five in the village of Dapegaon, in India's Maharashtra state. "If you get water, then you're at peace," she said. "If you don't get water, there's constant worry."

### A family's despair

The Suryawanshi family owns a 7 ½-acre farm where they till the soil using an ox-driven plow. Four generations share this land, a total of 22 people living in a collection of hardscrabble homes – some made of concrete and others of mud bricks and thatched roofs.

Along the road in front of their houses, jasmine vines wrap around a low wooden fence. In the mornings, the women of the family collect handfuls of white blossoms and present them at the family's small shrine to the Hindu god Khandoba.

Towering over the plowed fields in the surrounding countryside are the spires of Hindu temples, ornately decorated with idols and painted in a kaleidoscope of colors from sky-blue to saffron, each of which carries religious symbolism and significance. Prayers are a part of daily life, and the Suryawanshi family has been praying for more rain.

On the edge of their field sits a large pit, with rugged rock walls that plunge straight down 55 feet to the muddy bottom. There, at the end of a thick black hose that dangles into the pit, only a puddle of water remains.

Open-pit wells like this one have been used for centuries in India. And until about five years ago, the well had ample water for their household needs, enough that the Suryawanshis could share with neighbors.

Now, unable to pump out any more, they've been driving an ox cart each morning to the well of an absentee sugarcane farmer, where they fill up a 500-liter water tank. The water comes from 850 feet underground, so deep that it absorbs the Earth's geothermal heat. When the water gushes from the hose, it's warm to the touch.

Two years ago, in the midst of drought, the Suryawanshis decided to search for a source of water on their land and hired a well driller. On the first attempt, the drill bored down 900 feet, but it came up dry. Two weeks later, they tried again. This time, they hit water and immediately began pumping it onto their field.

The discovery sparked a celebration in the village of Nagarsoga. The family handed out sugar crystals to neighbors. About 200 people crowded around the well rejoicing, some of them dancing.

The family led a procession to the Hindu temple, carrying a jug of the water with them as an offering. The water flowed from the ground for two hours. Then, it suddenly stopped.

Everyone went home, and the family's elation turned to hopelessness.

"I was so fed up that I decided I'm not going to dig any more bore wells," Adinath Suryawanshi said through an interpreter, speaking in Marathi.

Standing with his arms crossed, he explained that the family borrowed 200,000 rupees, or about \$3,000, to drill the two boreholes. They also spent 135,000 rupees, or \$2,000, to deepen their two open-pit wells. They blasted with dynamite and used a crane to lift out loads of rock and mud. But the water in those wells also quickly disappeared.

As Adinath spoke, the creases on his forehead deepened. He said the family has been left with debts totaling at least 600,000 rupees, or \$9,000.

“There is no point in having feelings anymore,” he said. “We have to deal with it.”

The family hasn’t had enough water to grow sugarcane in years. They’ve been left to rain-fed farming, planting soybeans, millet, peas and beans when the monsoon rains come. This year, though, the monsoon brought little rain. Crops have been drying up during one of the worst droughts in years.

“It’s so unpredictable. It’s almost like a gamble,” Adinath said. He’s turned to doing construction work on the side to earn more money. Over the years, the family has cut down many of their trees – acacia, neem, and fruit trees such as mango and tamarind – to sell the wood.

His sister-in-law, Usha Suryawanshi, said the family fetches water from three or four different sources, often carrying the jugs home on foot. She said she’s getting too old for this sort of work. It makes her back and joints ache.

“It causes a lot of stress and tension, and a lot of times if there’s no water, we can’t do our housecleaning,” Usha said, wearing a green scarf and a brass ornament in her nose. “At times, even cooking becomes difficult.”

Two of the young men in the family – Usha’s 22-year-old son Shankar and her 26-year-old nephew Bankat – left years ago and moved to the city of Pune. Shankar now works for a natural gas company. Bankat has a job as an audiovisual specialist at a software company.

During a recent visit home, the two helped plow the fields and went with relatives as they fetched water.

Bankat, who regularly makes overnight train trips home, said if there were water and if farming brought in more money, he’d like to keep doing it. But it’s just not viable.

“If I stay here, we’ll be indebted even more. So I prefer to stay in the city and earn something, and then support my family,” he said.

A few years ago, he saved some money and helped his parents fix up their home, which at the time was a hut. They covered the mud-brick walls with plaster and painted them yellow. Over the doorway, on the occasion of Bankat’s wedding, they painted a single word – “Desire” – because the family’s hopes for their home had finally been fulfilled, in spite of their troubles.

Tracking changes from space

Since 2002, two NASA satellites have been orbiting the Earth in a joint U.S.-German mission, recording detailed measurements of the planet's gravity field and tracking changes in the total amounts of water, both aboveground and belowground. The wealth of data produced by the GRACE mission, which stands for Gravity Recovery and Climate Experiment, has allowed scientists for the first time to map large-scale changes in the world's aquifers.

Using the data, researchers at the University of California, Irvine, and NASA have found that more than half of the world's largest 37 aquifers are declining.

The Indus Basin of northern India and Pakistan is among the hotspots where groundwater is being depleted most rapidly. Others include the aquifers of the Arabian Peninsula, the Murzuk-Djado Basin and the Nubian Aquifer System of northern Africa, the Canning Basin mining region of northwestern Australia, and the North China Plain, among others. In the United States, groundwater levels are dropping especially quickly in California's Central Valley and the southern High Plains, and also declining along portions of the Atlantic and Gulf coasts.

The United Nations has warned that worsening water scarcity poses security risks and could aggravate tensions and conflicts.

The U.N. also estimates that the world will face a 40 percent shortfall in the global water supply by 2030 unless dramatic steps are taken to improve the management of water. Within a decade, 1.8 billion people are projected to be coping with severe water scarcity and two-thirds of the global population could be living with stressed water supplies.

In some areas, the water that's being pumped to the surface seeped underground when glaciers melted at the end of the last ice age, or from rains and snowmelt that accumulated over tens of thousands of years. As those ancient water sources are pumped and drained, they're lost for good.

Other aquifers are falling despite natural inflows of water from rainfall, rivers and canals.

Maps produced from the NASA satellite data show the declining water levels as a dark red patch spreading across northern India.

Those findings match measurements on the ground, where government records of water levels in wells also show dramatic declines.

A USA TODAY/Desert Sun analysis of data published online by India's Central Ground Water Board found that between 2005 and 2013, average groundwater levels dropped by 25 feet in parts of Haryana state and by 32-36 feet in parts of Rajasthan and Punjab states. This rapid depletion threatens major farming regions and if unchecked will lead to more wells going dry.

Even in areas such as southern India where the satellites have detected increases in water supplies since 2002, heavy pumping from aquifers has led to major drops in water levels.

"It's bad and it's getting worse," said Tushaar Shah, an economist and senior fellow at the International Water Management Institute who is a leading expert on groundwater in India. "The effects are profound, they are deep and they are very broad."

As water levels decline, costs are going up for farmers to deepen and drill wells, and to buy more powerful pumps. Spending by state governments on electricity subsidies is also ballooning.

Shah said the widespread depletion in India is the result of various shortsighted policies that have created a sort of groundwater “bubble.”

During the Green Revolution of the 1960s, as India was seeking to head off famine, the country promoted intensive farming of crops such as rice and wheat, and encouraged the construction of wells, setting off a trend that was nothing short of a revolution in groundwater pumping.

“The governments actually at that time thought that it was an inexhaustible resource,” Shah said. “Everybody thought that it’s a magic wand that can turn around Indian agriculture.”

But that emphasis on exploiting groundwater, together with free electricity for farmers, has left a system that encourages farmers to waste water rather than save it, he said. And it’s a system politicians have been reluctant to change, especially because influential agribusiness groups want to keep electricity free and could mobilize voting blocs to oust any leaders who cut the subsidies.

Researchers with Columbia University have been studying potential solutions that could help restore the country’s depleted aquifers. Professor Upmanu Lall, director of the Columbia Water Center, said the stresses on water supplies in India come down to “very bad management” and the inability or unwillingness of the political establishment to actually address the situation.

In the northern state of Punjab, for instance, farmers have been growing vast amounts of rice and wheat ever since those crops were promoted during the Green Revolution. Farmers choose to keep planting those crops – wheat in winter, rice in summer – because they fetch guaranteed “minimum support prices” and are easily sold through a government-run grain purchasing system.

But Lall said the amounts of water needed for those two crops dwarf the annual rainfall in Punjab, even in a wet year. He said wheat fields need approximately 1 meter of water to be applied over a season, and rice fields require 1.8 meters per harvest – together translating into 2.8 meters of water demand in a region where average rainfall, depending on the location, varies from about 40 centimeters to 1 meter per year.

“The solution is simple,” Lall said. “They just need to move rice out of there.”

Deeper by the year

The plains of Punjab stretch out to a hazy horizon, the furrowed fields interrupted only by rows of trees and brick pump-houses where water gushes from pipes into open tanks. Every summer, the alluvial plains are transformed into a sea of rice paddies.

The sowing begins in small “nursery” paddies, where workers hoe the soil into muddy channels and ridges as the water flows in. Then the rice plants are moved to about 7 million acres of flooded fields, covering more than half the state.

Kulwinder Singh Sanghera, a 30-year-old Sikh farmer with a warm smile and yellow turban, said he knows it makes no sense to plant rice and use so much water. But he was preparing to plant rice yet again, on all 20 acres of the family's farm.

"I have no other option. I have to grow rice," Sanghera said. "No other crop is giving me better returns."

Standing beside the inundated field, Sanghera said he's well aware the rice is depleting the groundwater and he's concerned that will leave less water for the next generation. But he said it's the government system of buying rice and paying a fixed "minimum support price" that makes rice so dominant.

"I would change to other crops if the government would give me better prices for other crops," said Sanghera, who has farmed alongside his father since he was a boy.

As water gushed from his well into an open tank, he stooped down and took a drink at the pipe. Then he walked along a flowing canal to check on a field of peppermint, which was soon to be replaced by rice. Picking a fragrant stem, he explained that the mint oil is sold for export.

Lately, the price of mint oil has fallen. Potato prices have also dropped. And the costs of farming are going up.

Every year, Sanghera deepens his three wells and lowers his pumps deeper. The water level has fallen about 30 feet in a decade. This year, Sanghera spent 67,000 rupees, or about \$1,000, on a new diesel engine to make sure he can pump enough water during the rice season.

Because the free electricity is sporadic and unreliable, most farmers leave their pumps on and wait, running them constantly when there is power. Sanghera runs his pumps for eight or nine hours a day during rice season, burning diesel part of the time.

The name of the state, Punjab, means "five waters" and refers to the five rivers of a territory that today is divided between India and Pakistan. The rivers – the Beas, Sutlej, Ravi, Chenab and Jhelum – tumble down from the Himalayas, merge as they cross the plains and then flow into the Indus River. Water from those rivers flows in irrigation canals, but three-fourths of the state's farmland relies on groundwater. And with water levels falling, business is booming for shops in the city of Ludhiana that sell the more powerful pumps farmers need.

In the countryside, crews are busy constructing new wells by pounding 20-foot-long sections of steel pipe into the ground.

At one work site among rows of mint, a diesel engine sputtered and hummed. The engine tugged a cable, lifted up a section of pipe and stood it vertically. Workers attached a bar to the pipe and pushed on it as they screwed the pipe together with another section below.

Then one of the barefoot men climbed a ladder and rode atop a weighted platform as the pipe was pounded into the ground. As the well grew deeper, a cylinder was lowered into the hole, and it came up with a load of sandy soil, dumping it in a wet heap.

In a nearby village where cattle wandered the streets, people welcomed visitors to their homes with cups of sweet tea. Some of them shared childhood memories of digging into the soil and finding water just beneath the surface.

Parminder Kaur cupped her hands as she explained how as a girl she would dig a little more than a foot deep. The water would seep into the hole and she would take it in her hands to drink.

“The water was so clean,” she recalled, speaking in Punjabi. She said she worries about the future of her grandchildren, and where they will get water.

The state government has begun trying to promote corn as a less water-intensive alternative to rice. The state also adopted a 2009 law that bars farmers from transplanting rice before June 15, effectively shortening the season and somewhat reducing the amounts of water used. When it promoted those changes, the government touted the slogan “Save Water, Save Punjab.”

Balwinder Singh Sidhu, Punjab’s commissioner of agriculture, said that although groundwater remains unregulated, the state is gradually trying to change the status quo.

“It is unsustainable, we know. Everybody understands unsustainable now, because everybody is feeling the pinch,” he said. That includes the state government. The cost of providing free power in Punjab, he said, is rising and now costs the state more than \$600 million a year.

“We are working on it, and we want to stabilize this situation,” Sidhu said. “Of course the pace is slow, but I think we will be able to tackle it. At least now everybody’s aware that it has to be tackled.”

Some Punjabi farmers, however, express skepticism that the government is capable of making real changes to safeguard the water supply or help them emerge from worsening debts.

Balwinder Singh Sandhu, an 86-year-old farmer who is deeply in debt, said the way things are going, “Punjab will be a desert one day.”

Punjab, India: Balwinder Singh Sandhu, 86, had to deepen his well last year but still grows rice, a crop that requires a lot of water and not traditionally grown in Punjab. "Punjab will be a desert one day." Photo by Steve Elfers, USA TODAY Staff This photo is part of the groundwater "Pumped Dry: The global crisis of declining groundwater" created in partnership with the Desert Sun and the Pulitzer Center for Crisis Reporting.

## Water emergencies

When the water is turned on in the village of Dapegaon, women wearing brightly colored saris line up at the taps alongside men and children. With barely enough for each family, there are sometimes squabbles or fights.

As people waited in line one morning, a man who tried to take what others considered an excessive amount received a scolding. Another man loudly told him: “You’ve had enough. Step aside.”

Carrying away a jug on her shoulders, Marisha Kawale said the six containers she filled wouldn't be enough for her family of eight. "I have to go searching for more water."

Others said when they don't get enough water from the spigots, they walk to farms with working wells to ask for water. Sometimes the farmers refuse to share and turn them away. People here have grown used to constantly searching.

"You just have to deal with these hardships," said Shobha Pandule, a housewife wearing a yellow sari. After carrying home the last of her orange plastic jugs, she said the family had enough for the day.

"If you get water, then you're at peace," she said. "If you don't get water, there's constant worry."

During 2012 and 2013, Dapegaon's main public well dried up. For nearly half a year, the village had no water, forcing people to walk more than 2 miles each day along the roads to other farms and villages to search for water.

Bharat-bai Kawale, a mother of four, remembered that some farmers turned her away with insults. She said the daily search usually lasted until the early afternoon.

"Until we'd get water, we would just keep roaming, no matter how much time it took," Kawale said. "It was the hardest time we have faced."

In 2013, the village drilled two wells, and the second time hit water at 700 feet – much deeper than in many other parts of India, where water can often be found less than 100 feet underground. That well now provides the limited amounts that are pumped up into a water tower. Each morning, a man opens the valves and the water flows to cisterns, where it runs from the taps.

In a field next to the town's rows of concrete and brick homes, water gushes into a lush field of sugarcane. This crop, which is grown for export, has been contributing to falling groundwater levels during the drought.

The aquifers in the state of Maharashtra are limited by their geology, with the water contained in fractures and fissures in layers of volcanic rocks. When the water is sucked out of those spaces, it can run out quickly. And in areas where groundwater has disappeared, it's compounding the pressures on farmers who are already heavily indebted.

Some farmers have been poisoning themselves by swallowing pesticides. Others have been hanging themselves.

More farmers have been killing themselves in Maharashtra than anywhere else in the country. Last year, 4,004 farmers and agricultural laborers committed suicide in the state, according to government statistics. From 2012 through 2014, the government reported 10,936 suicides among people working in agriculture in Maharashtra – an average of 10 suicides a day.

In at least some of those cases, the lack of water seems to be one of multiple problems pushing farmers beyond their limits.

In the countryside of Maharashtra, where the air is filled with the smells of dry grass, cow dung and cooking fires, many villages rely on hand-pump wells where people bring their jugs and draw out drinking water for the day. But some of those public wells are dry. Others barely reach water. Water researchers in India often describe groundwater as the country's "lifeline." Nearly 70 percent of irrigated agriculture in the country depends on groundwater, and nearly 90 percent of the drinking water for rural areas comes from groundwater.

When a well begins to suck air, people sometimes have to stop pumping for 10 minutes or more to allow water to seep back in.

"It's really hard to pump and our hands hurt," said Anita Kale, who was collecting water in jugs with other women and girls at a roadside pump. "We don't have any other sources of water in our village, so we have to get it here."

The state government in Mumbai is starting to step in, trying to prevent groundwater levels from falling further. This year, the Maharashtra Water Resources Regulatory Authority announced a ban on digging new wells deeper than 200 feet. Other states may be forced to take similar measures as aquifers continue to drop.

#### Groundwater 'anarchy'

With no limits on pumping or the drilling of wells in most places, there have been growing calls in India for changes to protect threatened aquifers.

In a 2009 book, Tushaar Shah described the challenge of managing groundwater as "taming the anarchy."

That chaos is affecting daily life in areas where tanker trucks make daily rounds delivering water, and where overpumping by farmers has left neighbors without water.

In the village of Gadakwadi, for instance, the water table has dropped as more wells have been drilled. Mangesh Gadage, a young man whose family runs a 15-acre vegetable farm, craned his neck to peer into the family's open-pit well, where just a shallow puddle was left at the bottom. The family has relied on the well for decades, but the water suddenly vanished this year after neighbors drilled two deep wells.

"I'm feeling helpless," Gadage said, standing at the edge of the well. "I cannot do anything because the law says that whoever owns land owns water. So everybody's free to drill a borehole."

The national government has announced several efforts focused on groundwater, including a program to study the state of the country's aquifers. That aquifer mapping project, which began in 2012 and will take more than a decade to complete, involves geological studies and exploratory drilling to assess how much water is held in aquifers.

“The government is very much concerned about groundwater, is very much aware also. It’s been trying to solve this issue,” said Sushil Gupta, former chairman of the Central Ground Water Board. He said studying aquifers will be crucial to managing them, in the same way that people need to know the balance of a bank account when managing money.

The government is also trying to encourage public participation at the local level, involving communities in decision-making about their aquifers.

“Ultimately we propose that the farmers should manage the groundwater themselves,” Gupta said. “We have to reduce our wasteful consumption.”

Groundwater levels are dropping in 9 or 10 of India’s 29 states, he said. “I perceive it as a very serious problem, very, very serious, because despite all the efforts, there’s no containment.”

The government is considering changes to water law, including doing away with the longstanding provision that those who own land also own the water beneath it. Instead, Gupta said, government officials have been discussing a measure that would define water as being owned by the public and protected by the state as a “public trust.”

Another proposed change would guarantee a minimum amount of drinking water for every citizen.

Some drinking water sources are tainted with severe pollution in parts of India, as well as with hazardous natural contaminants such as arsenic and fluoride that have leached into groundwater from layers of rock. The concentrations of those contaminants can increase as water is drawn from deeper underground, and state-led efforts to test water supplies have been spotty.

Raw sewage and industrial chemicals have also seeped into groundwater supplies. In the city of Ludhiana, the foul-smelling Buddha Nala stream looks as black and lifeless as ink, filled with sewage and industrial waste.

In the city of Bangalore, one badly polluted lake recently caught fire.

State governments in India hold responsibility for setting water policies, but the Central Ground Water Board has been prodding states to pass bills focused on groundwater.

“Every state government should have their own act and regulation of groundwater,” K.B. Biswas, chairman of Central Ground Water Board, said in an interview at his office in New Delhi. He said what India faces is “a problem in sectors,” stemming from growing demands for water and supplies that vary widely from one place to another.

“I don’t think it is a crisis,” Biswas said. “I am of the view that we are still having sufficient water, just to irrigate judiciously.”

He said community-based groundwater management will be important, and he’s optimistic about it. “Wherever there is a problem, definitely people will come up with solutions.”

Some argue, however, that the government needs to be doing a lot more.

“There is no credible attempt to regulate groundwater use,” said Himanshu Thakkar, coordinator of the South Asia Network on Dams, Rivers and People. “We are not realizing how bad the crisis is and how badly it can hit us.”

Himanshu Kulkarni, a hydrogeologist and executive director of the think tank Advanced Center for Water Resources Development and Management (ACWADAM), agrees the situation is serious.

He has been studying aquifers in India for 35 years and is focused on developing solutions to groundwater problems, which can vary greatly depending on the aquifer. Unraveling what’s occurring in a single aquifer, he said, can be something like cracking a mystery – “almost like a Sherlock Holmes story.”

Sitting at his computer, Kulkarni showed a photograph of a well in a forest, with an unusual ramp leading down to the water. That ramp, he said, was built to provide water for tigers at a reserve in central India. The reason: the regular watering holes the tigers depend on have been going dry during part of the year.

Flipping to a chart, Kulkarni pointed to a rising line on a graph representing the increasing demand for groundwater. In order to achieve sustainability, he said, that demand needs to be regulated and managed.

“I think if the status quo remains or worsens, the situation will actually lead us to conflicts,” Kulkarni said. “At the moment groundwater, being an invisible resource, being a sort of unfathomed resource, remains largely in the competitive arena. But I think there’s a threshold beyond which competition will turn to conflicts, and extremely serious implications could come about.”

While pushing for groundwater legislation, he said, his organization is also working with communities to help them study their aquifers and share them as common-pool resources.

“You need to facilitate communities. You need to change behavior,” Kulkarni said.

Some communities in India have had successes in recharging depleted aquifers. They’ve built small dams and ponds to catch the monsoon rains, and have dug into dry streambeds to create basins that capture more water and allow it to seep down into aquifers.

In the arid western state of Rajasthan, Rajendra Singh has helped villages restore their groundwater by promoting the building of small earthen dams called “johads” that collect rains and allow it to soak into the ground. Singh was awarded the 2015 Stockholm Water Prize for his successes in “improving water security in rural India.”

Some Indian researchers say parts of the country can benefit from incorporating traditional knowledge left behind in the johads and stone-lined open-pit wells built generations ago. For centuries, many communities were built around their underground water supplies, including wells with stairs leading down to water.

In the village of Ausa, near the hard-hit farming areas of Maharashtra, a centuries-old fortress built by the Mughal Empire stands above a dry moat. Inside the stone ramparts are open wells, some of which are dry and filled with trees and vines. In the middle of the fortress, one of the deepest wells still has a shallow pool at the bottom, apparently because in this low-lying area, some groundwater is still seeping in.

In other areas of Maharashtra, where water levels in wells are falling, some people have decided to work together to avert disaster. The village of Javulke, for example, has begun a three-year project with the support of ACWADAM to study its groundwater and come up with a management plan.

Minakshi Karale, a woman who runs a public day care center and feeding program, is helping to lead the effort. She said the worsening water situation has left farmers unable to grow as many crops, and some have started migrating elsewhere for part of the year to look for work.

She and a group of villagers walked together to a farmer's stone-lined well, which was built in the 1930s. The stone stairs circle down to a level where there used to be water. Now the stairs are high and dry, about 20 feet above the pool of water that remains in the bottom of the well.

“The use of water has increased, and if we do not do something about it right now, the next generation will not have any water,” Karale said. “And whether the village will exist will itself become a question if we don't do something.”

If India is to prevent more of its aquifers from running out, real changes may start with the sort of simple decision that Karale and her village have made: to act before it's too late.