

West's challenge is still water scarcity, wet winter or not

February 23, 2017 Pioche, Nev.—The number of “For Sale” signs compete with “Open” in the storefronts along the main street in this hilly town, where fortunes evaporated with the silver and zinc mines that created it. There’s no bank or grocery store. Mining has mostly vacated the area, leaving a clutch of retirees, some county workers, and not too many others.

But this part of Nevada still has one resource that residents to the south in glitzy Las Vegas desperately want and need – water.

A controversial proposal would send a big chunk of this region’s water southward, through a 250-mile pipeline that, critics say, would dry up ranchers and farmers to supply a sprawling metropolis defined by its embrace of nightlife and all-day pool parties.

“The people in Clark County want to put a pipeline in here to drain our water. We don’t want to give it away to them. We do just fine up here,” says Don Spaulding, a retiree in Pioche.

But there’s a larger reality, too: Whatever happens with the pipeline, water has been getting harder to find for urban and rural residents alike. Even with big snows and rains across parts of the West this winter, aquifers and forests remain taxed. Long term, the water challenges of the American West look increasingly beyond the scale of traditional infrastructure projects to resolve.

Lake Mead, a major reservoir serving the Southwest, has recently been at record lows, pressuring Las Vegas to look for water sources outside the Colorado River system. And here in Pioche, residents say a long drought has taken its toll.

"We're not getting as many tourists," says Ann Mills inside her trinket shop called Rag Doll. "They come up for recreation, but even the lakes are low. Echo Lake gets really low. It's not even good for fishing anymore. Eagle Valley is getting mossy and stinky."

A new era of water management

Yet in the face of these challenges, residents of the West aren't resigning themselves to a bleak future. Instead, states in the Colorado River basin have been turning a page toward a new era of water management. With climate change affecting water supplies that are already strained by urban growth, the region is being forced to innovate and adapt.

Jacob Turcotte/staff | Caption

- Cities are conserving through steps like encouraging desert landscapes, by prohibiting grass lawns for newly built homes, and paying people with existing lawns to abandon them.
- Advancements in treatment technology are making it more possible to recycle water and harness rainfall for later use.
- Farmers are shifting to drip irrigation and other methods to use less water.
- Increasingly farmers are trading water through formal and informal markets to use it more efficiently, shifting away from a system of use-it-or-lose-it allotments.
- Water managers are making dams more efficient at serving both hydropower and irrigation needs.
- And a pragmatic outlook is prompting states, cities, and rural areas to bargain over water, not just fight over it.

Behind all this is a slow, cultural shift that recognizes conservation and

scarcity – and the need for innovative and multi-layered responses.

"We've got to make sure we don't adopt a zero-sum game attitude towards these things, that somehow if Phoenix does well it comes at the expense of our rural areas, or vice versa," Phoenix Mayor Greg Stanton says in an interview. "In times of drought, we have way more in common [between] urban and rural interests in Arizona than we do disagree on things. So my attitude is we've got to work together."

Systems under stress

It's a story of hope in a region that continues to be defined in general by growth and vibrancy. But there's no sugar-coating the challenges.



Zack Colman/The Christian Science Monitor | Caption

Ms. Mills, interviewed here this past summer, saw the drought literally killing her modest tourist-related business. She was laying plans to close her store. She isn't the only one here to view Las Vegas as a city of greed that grew beyond its means – and the potential pipeline as a menace.

States throughout the West face a conundrum: Urban centers grew much faster and larger than the original architects of the bedrock 1922 water-sharing agreement between the seven Colorado River basin states ever envisioned. Those urban centers now boast an economic output that overshadows agriculture, and development has strained water resources.

In California, Central Valley farmers use 80 percent of the state's water, and have resisted calls from major cities to use less. In Arizona, drought conditions could pit rural interests against city-dwellers if the state needs to curtail the amount of water it pulls from the Colorado River. Some cautionary tales come from Colorado, where some rural outposts sold their water rights to thirstier towns and later turned into dust bowls.

"There is no such thing as a non-controversial water project. It does not exist," says Patricia Mulroy, the former Southern Nevada Water Authority chief who was deeply involved with the pipeline debate. "People get very emotional about it, they get very hyperbolic about it. They will look at everything far more rationally than they do about water."

The climate factor

Now climate change is increasingly expected to drive water shortages in the future. Scientists predict the shifts will include earlier snowmelts, increasingly frequent droughts, and more evaporation (due to higher temperatures). And this would follow a long period that may, if anything, have had higher-than-normal precipitation.

"A lot of the people I work with and visit with are under the assumption or impression that the last 40 to 50 years in the Intermountain West have been abnormally wet prior to this last 10 or 15," said Bevan Lister, a rancher near Pioche. "So if that actually is a truism that a lot of our data – a lot of our suppositions – are based on an abnormally wet period, then that is going to be a significant challenge for our future."



Andrew Seng/The Sacramento Bee/AP/File | Caption

Major infrastructure projects to reroute water are a staple of the past, but mind-sets are changing, says David Hayes, the former No. 2 at the Interior Department who approved the SNWA pipeline in 2012.

"Municipalities don't want to go into a big fight with folks and negotiate what's going to bring very expensive water from out of basin if they don't have to," Hayes says.

For residents of Pioche who oppose the pipeline, there's some solace knowing that Utah hasn't approved the plan. That deprives the Southern Nevada Water Authority of a valuable aquifer that would incentivize the agency to move forward with construction.

In any event, climate change will make water supplies and sources more "erratic," Mulroy predicts, limiting the effectiveness of singular, silver-bullet infrastructure projects. Water transfers will still occur, but "in a different format than you probably are envisioning it."

'We need ... to sit at the table'

She says water agencies will be seeking access to diverse resources, "each intended to be there in the eventuality of need.... So water resources become a mosaic made up of all kinds of different pieces brought to bear when they're needed."

Mulroy has been through the wringer with the SNWA pipeline proposal, a project with roots predating her 20-year stint atop the utility, which ended in 2014. If her experience has taught her anything, it's that collaboration – whether between different states, between the environmental community and agriculture, or between rural and urban parties – is always preferred.

"I think that we need to stop the rhetoric, change our language, and look for ways to sit at the table together to find common solutions in a very difficult setting," she says. "It's going to be a fragile balance and it's going to be a constant back and forth. That static environment that we lived in in the 20th century doesn't exist anymore."

Reporting for this story was supported by a fellowship at the Bill Lane Center for the American West, at Stanford University.

This is the first article in a series on solving water challenges in the American West.

Part 1: West's challenge is still water scarcity, wet winter or not

Part 2: [In arid Southwest, cities expand but use less water](#)

Part 3: [America's biggest water users – farmers – learn to use less of it](#)

Part 4: [How water swaps help the West manage a precious resource](#)

Part 5: [Why solar panels bloom in Southwest's land of hydropower](#)

In arid Southwest, cities expand but use less water

Zack Colman



Julie Jacobson/AP/File | Caption

Climate Impacts and Adaptations

Phoenix reduced its residential water consumption in the past decade despite a 23 percent rise in population. Las Vegas recycles water from indoor drains and outdoor fountains.

February 28, 2017 LAS VEGAS AND PHOENIX—Mat Baroudi used to have a backyard of grass, consuming 55 gallons of water per square foot. Now it's stone floor with a gazebo and a fire pit in the center. Jasmine, flowering plum, and Australian bottle trees dot the yard. Two tortoises, Blaze and Dmitri, bask in what passes for early morning cool.

For Mr. Baroudi, the benefits are many: Lower water bills, conserving water, reducing waste, and no lawn mowing. On top of that, the local water authority here in Las Vegas pays people \$2 per square foot to replace their grass lawns with desert landscaping. By his reckoning that can cover about half the cost for the conversion.

Baroudi, born in Uganda and educated in England with an accent to match,

runs his own landscaping company named, cheekily, An English Gardener. He's been involved with landscaping ever since maintaining the grounds at his English boarding school.

His landscaping work in Las Vegas is far different. Now he tears out the lawns that never had much rationale to exist here in the first place, and swaps them for desert landscapes.

"If you look around at the landscaping in Las Vegas, you'll see a lot of desertscape," he says. "It's a lot of rock, cacti, and various plants that don't use a lot of water."

Across the West, cities may still have a long way to go in adapting to hotter, and often drier, climate realities. But progress is under way with conservation and water reuse on the rise.

Not that everyone wants to trade in their patches of green.

Baroudi, for one, looks askance when he sees water flowing from a neighbor's lawn into the gutter.

"People come from wherever in the States, and they're used to having acres of grass from wherever they came from," Baroudi says. But often lawns in Vegas are barely big enough to stretch your arms in. "So why do you have that? Everyone knows that [Lake Mead] is low and water is an issue here."

Investing in lower water use

For the Southern Nevada Water Authority (SNWA) spending money on lawn overhauls makes sense, given that it's especially vulnerable to water shortages. So far, 52,000 homes have participated in the program.

"The water that we use outdoors is what we don't get back again," says Bronson Mack, a spokesman for SNWA.

Las Vegas isn't the only city offering incentives. California has a statewide program offering \$2 per square foot to replace turf and \$100 for installing more efficient toilets. The Salt River Project, an Arizona utility, credits homeowners in cities such as Glendale (\$750), Scottsdale (\$1,500) and Peoria (\$1,650) for landscape conversions and other efficiency or water recycling upgrades. Albuquerque pays people \$1 per square foot for ditching their lawns.

Las Vegas is also recycling water, spurred in part by a regional accord that allows it to take more from the Colorado River water if it puts some back into the system. SNWA recycles nearly all the indoor water – think toilets, sinks and showers – that makes up 40 percent of its total consumption. That iconic Bellagio fountain on the Las Vegas strip? It's also recycled water. The green golf courses that emerge from the Las Vegas desert? More recycled water.

"That helps us to stretch our existing supplies," Mr. Mack says.



In Phoenix, Greg Peterson is watering a peach tree that needs some love in his front garden. An urban farming advocate, Mr. Peterson lives on a block flush with green lawns. Not his fault, he says – the neighborhood is part of what used to be agricultural land and has valuable water rights, keeping his and his neighbors' front yards a healthy hue.

"I am a farmer, I consider myself a farmer. But I'm on a street with 22 other houses and none of them are farmers. Pretty much, they're farming grass," Mr. Peterson says.

Peterson practices "permaculture" at his urban farm, meaning in part that everything that goes into the system remains in the system. Stormwater and "greywater" from non-kitchen sinks, showers, and washers help him grow 80 fruit trees that range from papaya to mango, guava to watermelon. He does this by running a tiny canal from his storm gutter, rerouting the wastewater from an outdoor sink, and harvesting rainfall in a tank.

"Our single biggest problem in our culture is waste. We need to figure out how to reduce and eliminate waste because we throw so many things away, and there's energy in those things," Peterson says.

Phoenix actually has in many ways been doing just that.

In Phoenix, progress and opportunity

It has reduced overall residential water consumption in the past decade despite a 23 percent population growth that's seen its suburbs sprawl into former farms and pastures, according to the Greater Phoenix Economic Council. But Mayor Greg Stanton, who credits Peterson for helping raise the profile of water recycling in Phoenix, says he thinks the city can do better. He pushed for expanding greywater use during his 2015 re-election campaign, and now wants to update more infrastructure to decentralize water

treatment, allowing for easier reuse.

"The more we can recycle water, if you will, the better it is long-term for this community. So we need to invest – it's not going to be inexpensive – we need to invest in the infrastructure to better use reclaimed water," Mayor Stanton says.

His comment is one indicator of how, for cities, the future is not just about conservation – finding ways to use less water – it's also about recycling more of what's already flowing in their drains and gutters.

California is investing in the idea. It's funding an expansion of a \$3.5 million wastewater treatment plant at Stanford University that can recycle eight gallons of water per minute. That's a small amount by most standards. But the system has significantly reduced energy use and carbon dioxide by relying on microorganisms that don't require oxygen to filter impurities in the water and produce methane that's later used as energy. Membranes then snag the larger particles.

Zack Colman/The Christian Science Monitor | Caption

Many wastewater treatment firms have resisted such a so-called "purple pipe" to decentralize treatment. They worry that removing water from the current pipe system will leave behind more solid particles that degrade infrastructure, adding to maintenance costs. Municipal water regulators also are hesitant to approve new projects financed by raising customers' rates.

Helping cities keep what they have

The counter argument, though, is that the status quo cannot hold and that cities will need to make tough financial decisions to boost water supplies. That's the view of Dick Luthy, who co-directs Stanford University's Re-inventing the Nation's Urban Water Infrastructure, or ReNUWIt, where he is working on technology spread deployment of stormwater and recycled

water.

Mr. Luthy says the heavy rainstorms that climate scientists expect to accompany climate change (alongside frequent droughts) could be a boon for city water supplies. The trick is to help cities better manage flash downpours, reducing waste and improving urban flood management at the same time.

He's helping Los Angeles guide stormwater to a detention pool where it can store more than 290 million gallons of water (900 acre feet) before filtering out pollutants and metals through a membrane. Then the water would be fed to recharge zones in the surrounding area to replenish underground aquifers.

It's a big project. But as with other moves by cities, the steps don't all need to be on this scale. Luthy says water-recycling projects can be small, some fitting in places like grassy boulevard medians.

"The sad truth is we can't conserve our way out of this," Luthy says.
"Everyone has to do their part."

Reporting for this story was supported by a fellowship at the Bill Lane Center for the American West, at Stanford University.

This is the second article in a series on solving water challenges in the American West.

Part 1: [West's challenge is still water scarcity, wet winter or not](#)

*Part 2: **In arid Southwest, cities expand but use less water***

Part 3: [America's biggest water users – farmers – learn to use less of it](#)

Part 4: [How water swaps help the West manage a precious resource](#)

Part 5: [Why solar panels bloom in Southwest's land of hydropower](#)

America's biggest water users – farmers – learn to use less of it

[Zack Colman](#)



Zack Colman/The Christian Science Monitor/File | Caption

[Climate Impacts and Adaptations](#)

In the Southwest and beyond, irrigation technology and other steps such as planting 'cover crops' to enrich the soil are making a difference.

March 3, 2017 Scottsdale, Ariz.—Kevin Rogers, a fifth-generation farmer near Scottsdale, sees how technology is helping him use less water. Wearing an off-white cowboy hat while driving his silver truck around his farm, he points to a flood-irrigated field that uses laser-leveling technology. The sensor gathers a signal from satellites to ensure fields are cleared as smooth as possible, preventing water from pooling.

Water efficiency is improving at farms across the West. That's important because agriculture consumes 80 percent of the nation's water – and actually more than 90 percent of what's used in many Western states, according to the US Department of Agriculture.

Agriculture in the Southwest, however, often comes under fire for water use. Vast pasture lands that require water seem out of place in the arid climate. Cotton and alfalfa hay, used largely as feed for cattle, consume a lot of water and are often targets for criticism.

But as Mr. Rogers sees it, the constant heat makes it perfect weather for drought-tolerant alfalfa hay. It gives the region's farmers steady income while simultaneously underscoring the West's delicate balance of supporting its legacy economic engine while preserving resources for a bigger, more urban population.

"The Colorado River is probably the best place to farm, and that goes hand-in-hand with technology," Rogers says. "Farmers are the very first guys to adapt to a new technology because if we can be more productive, if we can do a better job, if we can use less water, produce more crops – all those things – it's advantageous for us."

As of 2008, farms use 12 percent less water to harvest an acre of crops, on average, than they did in 1998, according to the most recent USDA data. At the same time, though, total water used on farms declined just under 1 percent as smaller farms consolidated into larger, more industrialized ones.



Zack Colman/The Christian Science Monitor | Caption

One way or another, farms are likely to have to keep getting more efficient with their water resources, as rising urban populations intersect with climate

change that, scientists say, is making drought years more common in this region. Despite a wet winter in the West, the groundwater aquifers upon which farmers rely remain strained. That will likely be the case for decades.

Efforts to reduce water waste might need to come through policy. Western water rights are awarded to users on a “first come, first served” basis and typically require rights owners to use all their allocation to maintain their rights. On top of that, most states have incomplete data on groundwater or can’t easily verify whether farmers are using more water than allowed.

California, which has poor water data, is implementing a new groundwater management law that policymakers hope will curb waste by establishing a floor for water levels, beyond which restrictions would kick in. But even getting that system established is complicated – big California agriculture producers resisted a centralized program for data collection, instead opting for local information gathering that then must be scaled up and matched with the rest.



Arizona is dealing with similar pressures from agriculture. If there's ever a Lake Mead water shortage along the Colorado River, the state's cities are protected but farmers won't get their full allocation. Amid the strain of a long drought, some state lawmakers have advocated opening water supplies by rolling back a landmark 1980 groundwater conservation law.

But farms across the West are adapting on their own as well. To the north, in cooler but still-dry central Washington, Scott McIlrath is doing just about all he can on his fruit farm.

"Climate change is all it's been here and no doubt Washington [will] become like northern California in 20 to 50 years, but we'll just have to adapt to it," he says.

He's converted to drip irrigation and uses smaller sprinklers to reduce waste. He now monitors his soil content everyday for moisture. He's added magnesium and clay in his soil to help mitigate the effects of hotter temperatures by reflecting ultraviolet radiation.

Family-owned farms in the region have every incentive to conserve water, says Mike Walker, who deals with a lot of them as the field manager for fruit marketer Cowiche Growers Inc.

The growing season is coming earlier these days, putting the region's cherry growers into competition with large, industrialized California farms.

Reusing and reducing water is a way to buffer against that shock while also yielding environmental benefits, Mr. Walker says. On his own farm, he plants cover crops to enrich the soil and uses metered sprinklers to slash water use.

"That's just being good stewards of the land," Walker says. "We take care of our runoff. We don't waste water."

Reporting for this story was supported by a fellowship at the Bill Lane Center for the American West, at Stanford University.

This is the third article in a series on solving water challenges in the American West.

Part 1: [West's challenge is still water scarcity, wet winter or not](#)

Part 2: [In arid Southwest, cities expand but use less water](#)

*Part 3: **America's biggest water users – farmers – learn to use less of it***

Part 4: [How water swaps help the West manage a precious resource](#)

Part 5: [Why solar panels bloom in Southwest's land of hydropower](#)

How water swaps help the West manage a precious resource

Zack Colman

Ann Hermes/The Christian Science Monitor/File | Caption

Climate Impacts and Adaptations

Water markets are in many ways in their infancy. But the idea is a big one, potentially helping water flow to where it's most useful, and maintaining both farms and ecosystems.

March 8, 2017 —When a market for trading water rights opened in central Nebraska last year, one of the initial bidders wasn't a corn farmer, or even a water user at all in the traditional sense. It was the Platte River Recovery Implementation Program, a conservation group investing to replenish the region's major river, the Platte.

By buying some water and then not using it, the group is allowing more to stay in the river.

The move bucked tradition, for sure. Typically, water rights aren't traded at all or they are swapped among farmers. But the West may be at the dawn of a new era in water management.

Markets for water trading are on the rise, backed by many conservationists and farmers alike. They say there's a major opportunity here if done right – the chance to make the most of a precious resource.

The idea is to depart from systems of largely fixed water rights for the farms that use 80 percent or more of water in the West. Instead, markets can help water flow to where it's most valuable and needed – and promote

conservation by farmers in the process. Farmers who learn to get by with less water make extra income by selling or leasing their surplus.

"Nationwide we're seeing more and more water transactions, and the number of participants in these markets is going up," says Reed Watson, executive director of the free-market conservation think tank Property and Environment Research Center in Bozeman, Mont.

But there's no guarantee that water markets will be a success. The fact that a conservation group felt the urge to conserve Platte River water at all hints at the challenge: Without safeguards, the combination of farms and growing cities could easily start sucking up more water than nature can provide. Rivers and aquifers can run low.

In short, water markets hold great promise, but states across the West are learning that markets also take some careful management to do right.

And they're working at it: Nurturing water trades remains a priority despite heavy snows and rains this winter, because groundwater tables remain under stress.

'Something needs to be done'

"There's pretty widespread acknowledgement that something needs to be done," says Brian Richter, chief water scientist with The Nature Conservancy. "But it's going to take time. It can be politically contentious to make changes with anything to do with water."

Colorado offers a warning about unfettered trades. While many consider Colorado's water markets the most well-developed in the country, some rural communities turned into virtual ghost towns when Denver suburbs bought their water rights.

"You don't have to look any further than our past history, that all water rights in our state originated in agriculture and as cities began to pop up and grow

more water rights were converted," says Marc Arnusch, a third-generation farmer near Keenesburg, Colo. "We certainly can't gut our rural economies to the benefit of our urban economies, but I believe this water will continue to gravitate to our urban cousins for the rest of time."

Conservation groups hope to work hand-in-hand with farmers to prevent worst-case outcomes.

The Nature Conservancy is seeking investors to help it buy and manage a 10-year water rights portfolio modeled after a project the group helped create in Australia's Murray-Darling basin. Some of those rights would be sold or leased to generate revenue for the investors. Others would be used for environmental purposes – such as leaving water in-stream for fish.

While managing its water-rights portfolio, The Nature Conservancy would also help farmers employ conservation methods, potentially creating surplus water for farmers to sell or lease.

New income potential for farmers

"We're very explicit that it's our intention to keep farmers on the ground farming," Mr. Richter says. "What we're really shooting for is trying to make them more profitable by creating opportunities for them to grow crops and creating the opportunity for them to grow water."

For environmental groups, keeping US agriculture productive is key. The relatively rich farmland of America, after all, can produce bounteous harvests more efficiently than many other nations.

But the idea of non-farm investors participating in agricultural water markets raises ethical questions. If markets open up, how can rural economies protect enough of their resources if thirsty cities dangle wads of cash, or if resource speculators become key middlemen? And should it really be a philanthropy's job to make sure rivers have enough water for wildlife

protection?

"I think [conservation groups] are filling a void that the states have left," says Richael Young, co-founder and president of water market company Mammoth Trading. "So in an ideal world that would be something that our governments would take care of and we wouldn't have to rely on nonprofits."

Water districts are also taking their own actions. Many now have triggers for trades out of a watershed, to check for undesirable effects on the local economy. In some cases, other rights holders can object to transfers.

As Ms. Young sees it, green groups are playing a helpful role at present, correcting state failures to get a handle on water-management challenges. "We're sort of evolving from the old school 'buy and dry' and trying to create these win-win solutions."

Steps of progress

Where markets are up and running, many show promise.

- In central Washington State, low water levels in the Yakima River meant farmers with "junior rights" saw their supplies curtailed in 2015 to ensure those with more senior rights received their legally awarded amounts. But thanks to an existing water market, junior rights holders like those in the Roza Irrigation District leased water to keep fruit-tree production relatively steady.
- Colorado's South Platte basin showcases a trend toward water leasing, which allows farmers to offer water on the market without permanently giving up their rights. In the South Platte, which is one of the most active water markets at \$57 million in transactions in 2015, leasing now accounts for 80 percent of water volume traded, according to consulting firm WestWater Research.
- In Nebraska, the Twin Platte Natural Resources District deployed an

automated trading platform, which Young created through a federal grant while at the University of Illinois, to make sure that cumbersome paperwork doesn't discourage trading. Ann Dimmitt, a manager for the district, says the market is succeeding at shifting water from unproductive, water-intensive soil to acres where farmers need less to maintain yields.

Steps like those are helping to meet a need for better water management across the West – and the need is growing.

Nati Harnik/AP/File | Caption

The Cornhusker State, for instance, must replenish the Platte River under a state law, and officials worry about the health of the Ogallala Aquifer – a rapidly depleting major water source underlying most of Nebraska and parts of seven other states.

Challenges: climate, demographics, old laws

Meanwhile, scientists say climate change is expected to bring more frequent and severe droughts. In 2012, Ms. Dimmitt's district got just 10 inches of rain, less than half its historical average.

"I'm curious to see where we're going to be in 2022. We had that drought in 2002 and then the one in 2012," she says. "Living through that, now people farm differently. They're very conscientious. Not that they weren't before – but less than 10 inches? That's desert."

Between climate change and urban population growth, the West's water challenges look hard to meet without changing old ways. Many state water laws operate on a "use it or lose it" philosophy, which gives farmers little incentive to emphasize conservation. At the same time, water in the West is often over-allocated, meaning there's not enough to supply all the legal claims.

Water markets hold the potential to change that dynamic, allowing crops and conservation to coexist.

The problem: The markets so far are fragmented and small, and face challenges tracking water use.

For markets to work well, such tracking is vital, says Ms. Young of Mammoth Trading. Rights holders need to know how much water they and others are entitled to. Water managers must be able to monitor whether water-rights owners use only what they're allowed. And they need to understand the interactions between groundwater and surface water – such as how pulling groundwater in one place affects a surface-rights owner in another.

Many states flunk those tests.

In California, for example, groundwater data is so poor that regulating water use has been all but impossible. Only 3 percent of the state's water is traded. Under pressure from drought, the Golden State passed a law in 2014 to collect groundwater information. But gathering the data and then ensuring rights holders stay honest will take considerable monitoring and expense.

In Montana, Mick Seeburg and other farmers grew concerned about rapid development in the area around Bozeman, when they heard that some new homeowners had to double their well lengths to reach declining groundwater.

Late last year, Montana's state Supreme Court issued a ruling that could help water markets address the challenge. The court outlawed a loophole that exempted housing developments from needing permits for wells that affect the local water table. Now such projects must purchase water from another user to replace whatever they take from the ground.

Shifting politics

And beyond the courts, the political landscape surrounding water is

changing. In a state like Montana, where support from the agriculture community or Republicans is vital for water-rights changes to pass, new policies oriented toward conservation might have seemed fanciful in the past, says Laura Ziemer, senior counsel at Trout Unlimited. But that's no longer the case in Big Sky Country and other western states.

"Since the early 2000s we've had a lot more frequent back-to-back drought years," Ms. Ziemer says. "I think that recognition that we're going to be living with drought and we need to have some preparedness for it is driving some of these changes. What they really are is recognizing is that water is a finite resource."

To Mr. Seeburg, the farmer near Bozeman, a water market simply looks pragmatic in the face of strained water supplies. He's on a committee exploring a water exchange system for the Association of Gallatin Agricultural Irrigators.

"I don't think it's possible to fix it all, but I think it's possible to keep it from becoming a disaster," he says. "My crystal ball about what the valley is going to look like in 2050 is pretty cloudy, but it's going to need water and it's going to need the river flowing."

[Editor's note: *This article has been updated to clarify who set up the automated trading system in Nebraska's Twin Platte district.]*

This is the fourth article in a series on solving water challenges in the American West.

Part 1: [West's challenge is still water scarcity, wet winter or not](#)

Part 2: [In arid Southwest, cities expand but use less water](#)

Part 3: [America's biggest water users – farmers – learn to use less of it](#)

*Part 4: **How water swaps help the West manage a precious resource***

Part 5: Why solar panels bloom in Southwest's land of hydropower

Why solar panels bloom in Southwest's land of hydropower

Zack Colman

Pablo Martinez Monsivais/AP/File | Caption

Climate Impacts and Adaptations

Electric utilities are seeking a new power mix, as shifts in precipitation diminish the role that dams have long played for western states.

March 14, 2017 Panaca, Nev.—It didn't really matter that Kyle Donohue hadn't built an array of solar power panels before: Lincoln County wasn't getting the same amount of electricity from the Hoover Dam as it used to.

The lake behind the dam had dropped amid a historic drought, pushing up power costs for Lincoln County. At the same time, the community asked more about solar.

So Mr. Donohue, a staff engineer at the Lincoln County Power District that sits about 150 miles north of Las Vegas, and Dave Luttrell, the general manager, began looking into the idea.

At first blush, solar didn't seem cheap enough to rival natural gas as an alternative to hydropower. Hiring an outside company to build the panels would be too costly.

But what if Donohue's team built it in-house? As Mr. Luttrell penciled out the math, comparing with projected future natural gas prices, building a 1 megawatt community solar system would be cost competitive.

All they had to do was learn how to build the thing.

"It was a real learning curve – definitely – for us. But it's not the hardest thing we've done out there," says Donohue.

Now the utility is drawing some of its power from these arrays, just off a main state highway. Especially when they get full sun. "It's a little brighter, so the minute that cloud cleared out those things kicked into full gear," says Luttrell, surveying his new little empire of sun.

Across the West, utilities and federal officials are planning for a future with less of a mainstay energy source – hydropower – to draw on, as climate change pushes up temperatures and alters patterns of rain and snow.

Utilities like Seattle City Light and Lincoln County Power District are increasingly supplementing their hydropower with renewable electricity. Meanwhile, hydropower itself is being upgraded for a new era, as federal dam operators and users invest in wringing whatever electricity they can from rivers like the Colorado.

Zack Colman/The Christian Science Monitor | Caption

This shift is monumental. The federal buildout of cheap, affordable hydroelectricity through massive, ecosystem-altering public dams projects is one of the fundamental building blocks for the West, vitalizing cities and far-flung rural enclaves alike.

"The correlation between water, annual water supply and hydropower production is one of the strongest correlations out there," says Dave Raff, science advisor with the US Bureau of Reclamation. "So any projection of changes in annual water supply is a direct reflection of generation of hydropower."

The power grid's changing math

Today, hydropower supplies 22 percent of all electricity across 13 western states, according to the National Hydropower Association.

Utilities are increasingly adding other renewables into their mix. For power companies that own their own hydropower generation, like Seattle City Light, this makes a lot of sense: Hydropower reservoirs can act as storage systems for electricity sources like wind power, which depends on breezy conditions to generate power.

Portland General Electric, a privately owned utility in Oregon that gets 18 percent of its electricity from hydropower, isn't sure whether it will renew expiring hydropower contracts. That's because less of it is projected to be available, and population growth has brought more demand that's increased prices – meaning the utility may instead replace that power with renewable sources, says spokesman Steve Corson.

"They're no longer going to be as, shall I say, spectacularly low-cost as they once were," Corson says of federal hydropower contracts. "If we can get access to that power we won't get as much or as at as good a price."

In response to the challenge, hydropower users are also paying for efficiency upgrades at dams, installing turbines that can more effectively generate power with less water. A 10-percent efficiency boost could offset losses from reduced water flows, according to a January 2016 study in *Nature Climate Change* that studied climate change effects on 24,515 hydropower facilities worldwide.

Zack Colman/The Christian Science Monitor | Caption

The investments come as federally operated dams have routinely fallen short of delivering agreed-upon amounts of hydropower, a risk that buyers understood was possible. When they signed the contracts decades ago, though, they didn't envision it being a perpetual problem.

The Colorado River Commission of Nevada, the entity in this state that bargains for federal hydropower, negotiated triggers into its next round of contracts, beginning in October. If electricity generation declines past a certain point, federal agencies will have to work to reduce costs.

Otherwise, the commission has been purchasing power – mostly natural gas – from other providers to meet customers' needs.

"We're going to have to find alternative sources to meet people's loads. It won't be met as much over the next 50 years with hydropower as it was the last 50 years. I think that's the reality," says Jayne Harkins, the commission's executive director.

California is an instructive example. The state gets close to one-fifth of its electricity from hydropower, but increasingly turned to natural gas as drought hit the Golden State. Between 2011 and 2015, the state replaced lost hydropower with natural gas, costing ratepayers an extra \$2 billion, according to a report by think tank the Pacific Institute.

The role of climate change

While this winter has seen big snows or rain in many parts of the West, that doesn't shift the long-term outlook for tighter water supplies. Scientists say the region faces rising impacts from climate change.

Historically, much of the summer surface water has come from snowpack that melts as the air warms. But in a warming climate, a rising share of precipitation is falling as rain rather than snow, and snow is melting faster than before.

That's challenged dam managers, because earlier runoff periods could cause overflows at the dams, causing major floods. But releasing water too early could leave systems depleted of water when it's needed for agriculture, hydropower, and recreation.



Jacob Turcotte/staff | Caption

The scenario of low reservoirs in summer is vexing for the Southwest, since it means less water to generate power in a season of peak demand.

The federal government has been trying to understand what climate change would mean for hydropower and other uses tied to water. Some of the projections are daunting. The Colorado River basin, for example, would see a 3 percent decline in hydropower generation for every percentage-point reduction in precipitation, according to a 2014 Government Accountability Office report. A massive report on climate change and hydropower last year predicted trouble maintaining output for nearly every Western river basin.

Hoover dam: still big, but ...

Luttrell says he is already seeing those effects. Lincoln County used to look to Hoover Dam for all its power. Now it's about 80 percent, with natural gas filling most of the gap.

The solar project, even when fully built out in 10 years, will provide 4 percent of the utility's capacity. That still means a great deal, though, by buffering against daily swings in customer demand, prices, and supplies from Hoover.

More utilities that rely on hydropower today are likely to look like the one Luttrell runs.

"We'll figure out how to manage a different mix of energy systems, but we're learning. And hydropower will be an important piece of that," says Peter Gleick, a water expert and co-founder of the Pacific Institute.

Luttrell says he didn't lean on climate change to convince his board that Lake Mead would be unreliable into the future. Really, he didn't even have to.

"I don't want to polarize a discussion I'm having with my consumers right off the bat by saying climate change or something like that," he says. "But nobody can deny that the Colorado River has seen drought conditions since 2005. Statistically, it's there. What the cause is, you know, I'll leave that to other people to debate."

Reporting for this story was supported by a fellowship at the Bill Lane Center for the American West, at Stanford University.

This is the fifth article in a series on solving water challenges in the American West.

Part 1: [West's challenge is still water scarcity, wet winter or not](#)

Part 2: [In arid Southwest, cities expand but use less water](#)

Part 3: [America's biggest water users – farmers – learn to use less of it](#)

Part 4: [How water swaps help the West manage a precious resource](#)

*Part 5: **Why solar panels bloom in Southwest's land of hydropower***

For water users on Colorado River, a mind-set of shared sacrifice

March 27, 2017

Page, Ariz.—Jason Tucker’s job title is facility manager at the Glen Canyon Dam. But you could also say he’s also a kind of banker.

Colorado River water flows into his bank – the reservoir behind the dam. He can then loan it out to create electricity. Some even call the dam here a kind of “savings account,” tapped as needed to replenish Lake Mead and the Hoover Dam, which lie past the Grand Canyon to the west.

But the currency here is, of course, water – a lifeblood of any community and particularly precious here in the arid American West. Mr. Tucker marvels when ponders the role that this one river plays.

“When I look at this itty bitty strip of water and the fact that it is supporting life in the Southwest for tens of millions of people – that little span right there is all the water for the southern Southwest. It just blows my mind,” Tucker says while standing on a bridge above Glen Canyon Dam, nestled into the red rock holding back Lake Powell and all its tourist-filled house boats.

Now, though, the analogy of Lake Powell as Lake Mead’s safety net has been coming under increasing doubt. Last year, the agency that oversees federal dams was projecting a near 50-50 chance that in 2018 Lake Mead would for the first time fail to deliver enough water to the states that depend on it.

Snows and rainfall this winter have eased that worry, but the long-term threat of water shortages is real, as climate change and population growth create new pressures on supplies. Stakeholders here are responding, with potential answers that range from better management of dams to new conservation efforts.

One contentious proposal is to tear down Glen Canyon Dam, allowing the river to flow straight to Lake Mead. In all likelihood, though, states that rely on the river will continue a recent pattern of negotiation that contradicts the basin's reputation for "water wars."

Negotiators are aiming to reach two separate deals across seven states and Mexico, and the agreements could encourage water users to proactively curtail how much they pull from the river in order to stave off more drastic, automatic shortages in the future.

"It's often referred to as the most litigated river in the world. That might have been true in the 1960s, but I think in the last 20 years it's become a model for compromise and shared-sacrifice among the states," says John Entsminger, general manager of the Southern Nevada Water Authority. "The real question is what's the next iteration of that cooperative partnership?"

Climate forecast

Climate change is drawing that question into sharper focus. Scientists' models predict a drier, more drought-prone Southwest. And warmer temperatures promise to increase evaporation rates at reservoirs, further challenging the dams.



Jacob Turcotte/staff | Caption

Already, conditions at these huge lakes have changed. Lake Mead hit a

record low in 2015, and outflows have exceeded inflows by more than 9.2 million acre-feet, or nearly 3 trillion gallons of water. Much like the previous two years, Lake Powell began 2017 near the 2005 record low of about 50 percent capacity, though the snowy winter indicate water levels could top two-thirds of storage capacity by 2018.

Here's where things can get tricky.

If Lake Mead were to fall for the first time ever below 1,075 feet elevation from sea level, that would trigger a delivery shortage that largely hits Arizona. The region barely avoided a shortage in 2016, as Lake Mead sat just shy of 1,081 feet.

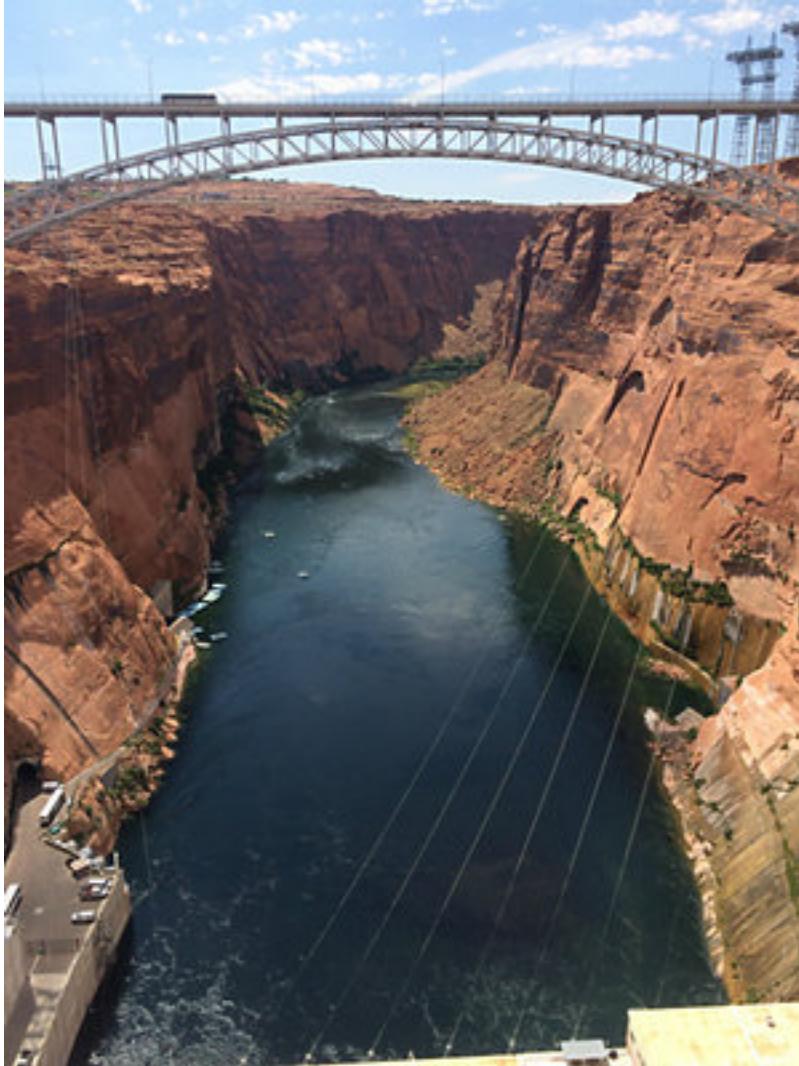
Though far off, a "deadpool" scenario looms that would threaten hydropower production. If Lake Mead falls below 895 feet, Hoover Dam turbines would suck in air, rendering them inoperable.

"Continuing to conserve water is not going to be enough. Perhaps sooner or later you'll actually have to take the shortages outlined," predicts Tom Buschatzke, director of the Arizona Department of Water Resources. "Hope for rain and snow is not a plan."

At the bargaining table

The three lower basin states – California, Arizona and Nevada – have begun to address the issue.

In a deal that's been under negotiation for some time, and with talks still under way, the states would voluntarily reduce the water they take from the Colorado River to avoid more severe reductions later. They want to save 1.2 million acre feet, a big deal for states that have a total allocation of 7.5 million acre feet per year.



Zack Colman/The Christian Science Monitor | Caption

Arizona, and especially its farmers, could face the steepest water cuts. In a 1968 deal for water, the state agreed to a “junior” rights, meaning every other state must get their water before Arizona can get a drop. The state is agreeing to curb consumption from the Colorado River by at least 7 percent, if Lake Mead is below 1,090 feet elevation. The cuts would jump to nearly 25 percent in a worst-case scenario in which Lake Mead drops 45 feet or more below that.

Nevada would take a 10-percent reduction in a worst-case scenario.

Perhaps the biggest potential concession would involve California forgoing some of its Colorado River water for the first time. The state has senior rights, meaning it gets all of its water first. A proposal by state representatives, would leave 4.5 percent to as much as 8 percent of the state’s 4.4 million acre-feet of water in Lake Mead, if trigger levels of 1,045 feet or 1,030 feet are breached.

"If everyone is intransigent and does nothing, then we all lose," says Jeffrey Kightlinger, general manager with the Metropolitan Water District of Southern California, a big water user that serves the Los Angeles area.

The incentive to cooperate

Each state has reasons to deal because the federal government can order cuts in the event of a shortage, making supplies uncertain. Congress also could butt in, which is a tantalizing proposition for some Western lawmakers – especially non-California ones – who might seek a greater slice for their states than today's 95-year-old water-sharing pact affords.

"The lower basin states wanted to control their own destiny rather than have to take an order from the secretary of the Interior or a judge," says Mr. Buschitzke in Arizona.

But even beyond the negotiations, federal and state actors are trying to extend the life and water supplies of Lake Powell and Lake Mead.

The federal Bureau of Reclamation, which manages the two big dams, is funding retrofits that would make turbines more efficient in low-water conditions. The enormous waterwheels at Glen Canyon Dam have been rusting, the corroded stainless carbon steel blades creating a drag as water flowed through them to spin the turbines. Tucker says the eight new turbines will improve hydropower efficiency enough to pay off the \$400 million upgrade in eight years.

"As you know, we're limited by how much comes in. But how we manage it and use it – that can change," Tucker says.

At Lake Mead, meanwhile, the Southern Nevada Water Authority was worried enough about the water levels that it paid \$817 million to install a third intake at lake-bottom, to help safeguard water customers from the risk of falling lake levels. The intake, funded by a 9-percent rate increase for customers

over three years, was finished in late 2015.

Tear down a big dam?

But despite all the bargaining and investments, some observers argue that conditions are changing too drastically to sustain both big lakes.

"Fill Mead First" is the slogan of those who want to remove a dam and let Lake Powell flow directly into Lake Mead. The plan's proponents, led by the Glen Canyon Institute, contend climate change means that Lakes Powell and Mead are unlikely to ever refill.

On top of that, they say a significant amount of water escapes Lake Powell through porous sandstone. They contend combining Lake Powell and Lake Mead would reduce water loss due to evaporation.

The proposal is contested by state and federal water officials, among others.

"I think it is scientifically dubious, legally implausible and politically suicidal," says Mr. Entsminger in Nevada.

While federal dam operators don't deny there's a structural imbalance for Southwestern water, they question some of the science behind "Fill Mead First." They say water lost through Lake Powell leakage hasn't been proven and that evaporation would increase if all the water was stored in Lake Mead, which is in a hotter climate. On top of that, Lake Powell holds back sediment that would considerably reduce storage capacity in Lake Mead if its northeastern neighbor didn't exist.

The drive for efficiency

If authorities are opposed to "Fill Mead First," they can't afford to sit on their hands. The realities on the river are changing faster than they ever believed possible. That's largely due to climate change.

"The situation is more dynamic and moves faster," says Mr. Kightlinger in Southern California. "Here we are essentially a decade later trying to update those shortage guidelines," reached in 2007.

"We'll probably be in a world where we have to update this every decade," Kightlinger says. He quickly reevaluates. "I think we'll be lucky if we only have to do it once a decade."

For him and others, there's hope in the imperatives of continued negotiation and a drive for efficiency. Already cities like Los Angeles are using less water than had been predicted a generation ago.

It might sound like a risky strategy to hope that conservation and efficiency outpace the reduction in water supplies, but Buschatzke in Arizona says there's more coordination on the Colorado River than people realize.'

"I can think of a bunch of radical ideas that are not in the realm of the possible," he says. "If we can do these incremental additions and achieve the same goals with a lot less pain, we're going to do that."

Reporting for this story was supported by a fellowship at the Bill Lane Center for the American West, at Stanford University.

This is the sixth and final article in a series on solving water challenges in the American West.

Part 1: [West's challenge is still water scarcity, wet winter or not](#)

Part 2: [In arid Southwest, cities expand but use less water](#)

Part 3: [America's biggest water users – farmers – learn to use less of it](#)

Part 4: [How water swaps help the West manage a precious resource](#)

Part 5: [Why solar panels bloom in Southwest's land of hydropower](#)

Part 6: For water users on Colorado River, a mind-set of shared sacrifice