TWCA® QUARTERLY

2021 VOLUME 8 ISSUE 2

TURFGRASS WATER CONSERVATION ALLIANCE

TWCA

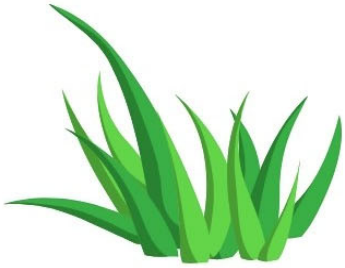
DROUGHT TOLERANCE TRIALING

TWCA 10 YEARS

EVALUATION BY THE NUMBERS

21k PHOTOS

TWCA Cooperators will have taken over 21000 images this year

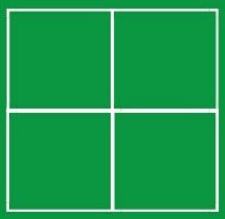


134 CULTIVARS

qualified in every major seeded species over 10 Years trialing

1500 PLOTS

In the 2020 Tall Fescue trial across North America



13 LOCATIONS

running TWCA trials this year to collect objective drought tolerance and turf quality data

make every drop count

Home Innovation NGBS GREEN PARTNER

Learn more at tgwca.org

CONTENTS

They always say time changes things, but you actually have to change them yourself – Andy Warhol-

This is a wild time for the industry. Drought is ravaging the West, seed supplies are.. Something. Coming out of the wilderness of last year into the tumult of this year we have taken a hard look at where the value and service come from in the program. After evaluating engagement and reception, we have chosen to discontinue the TWCA Quarterly. Thank you for your continued support of the program, we look forward to serving our membership.

We are committing our resources to punching up the trialing, building on our legacy of supporting the future turf professionals in their academic careers, and developing relationships beyond our industry. This effort is generously supported by the Research Review Committee members and the members of the TWCA Executive Board. Finally, we are formalizing a long-term trialing schedule that delivers predictability for long term planning by seed breeders and producers.

We are focusing our outreach efforts on easy to use, simple to integrate infographic style content to help members communicate the benefits of TWCA Qualification.

TWCA is a members driven organization; if there is something you would like to see in the TWCA Quarterly, please contact Evanne Gutierrez at evanne@tgwca.org or Jack Karlin at jack.karlin@tgwca.org.

MISSION STATEMENT

TWCA is committed to water conservation and dedicated to preserving the ecological benefits of turfgrass in the managed environments

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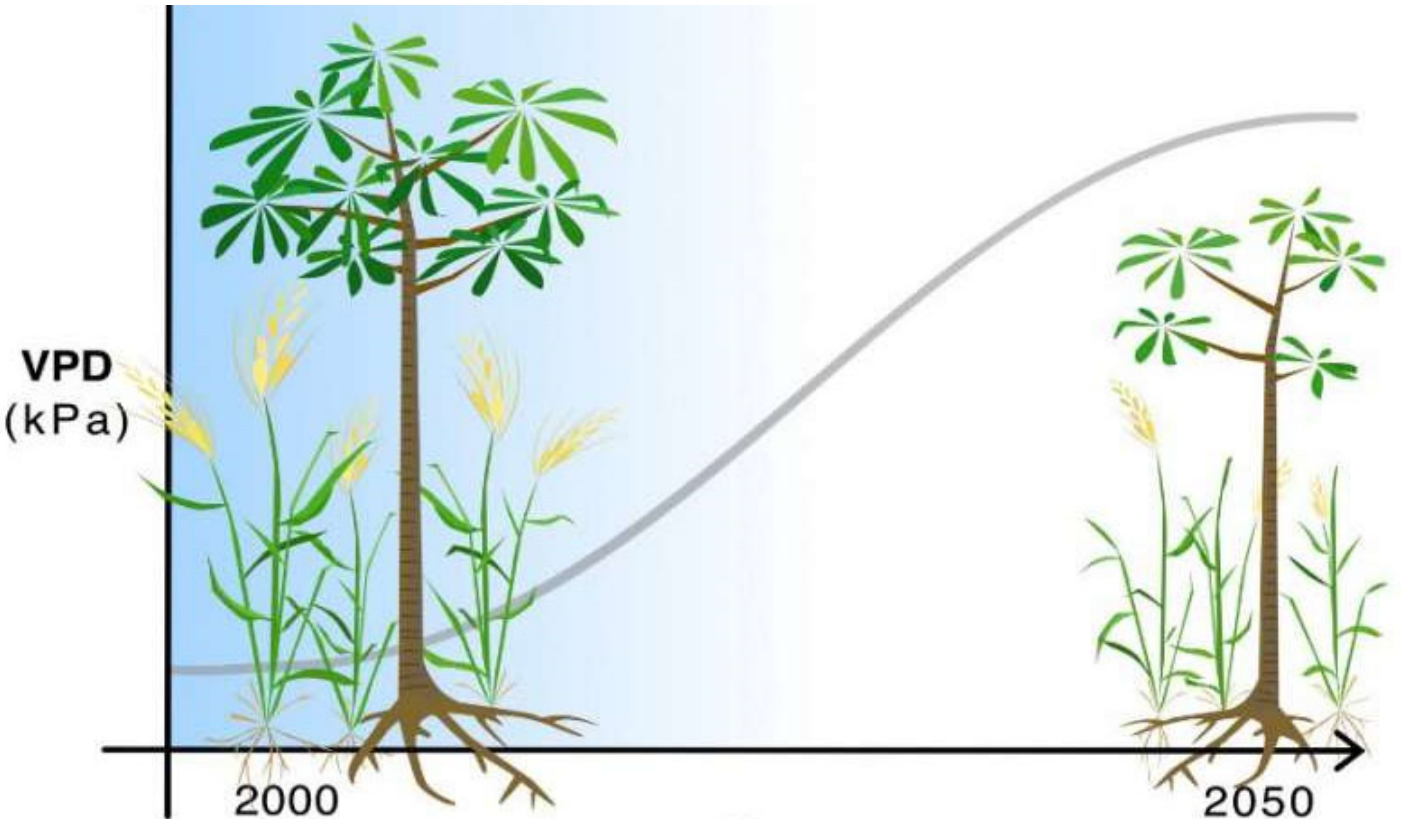


Atmospheric drying (referred to as water vapor pressure deficit or VPD) is expected to increase as a result of climate change. This could reduce crop yields and make trees shorter. Credit: Maria H Park

Atmospheric drying will lead to lower crop yields, shorter trees across the globe

by University of Minnesota

A global observation of an ongoing atmospheric drying—known by scientists as a rise in vapor pressure deficit—has been observed worldwide since the early 2000s. In recent years, this concerning phenomenon has been on the rise, and is predicted to amplify even more in the coming decades as climate change intensifies.

In a new paper published in the journal Global Change Biology, research from the University of Minnesota and Western University in Ontario, Canada, outlines global atmospheric drying significantly reduces productivity of both crops and non-crop plants, even under well-watered conditions. The new findings were established on a large-scale analysis covering 50 years of research and 112 plant species.

"When there is a high vapor pressure deficit, our atmosphere pulls water from other sources: animals, plants, etc.," said senior author Walid Sadok, an assistant professor in the Department of Agronomy and Plant Genetics at the University of Minnesota. "An increase in vapor pressure deficit places greater demand on the crop to use more water. In turn, this puts more pressure on farmers to ensure this demand for water is met—either via precipitation or irrigation —so that yields do not decrease."
"We believe a climate change-driven increase in atmospheric drying will reduce plant productivity and crop yields—both in Minnesota and globally," said Sadok.

In their analysis, researchers suspected plants would sense and respond to this phenomenon in unexpected ways, generating additional costs on productivity. Findings bear out that various plant species—from wheat, corn, and even birch trees—take cues from atmospheric drying and anticipate future drought events.

Through this process, plants reprogram themselves to become more conservative—or in other words: grow smaller, shorter and more resistant to drought, even if the drought itself does not happen. Additionally, due to this conservative behavior, plants are less able to fix atmospheric CO2 to perform photosynthesis and produce seeds. The net result? Productivity decreases.
"As we race to increase production to feed a bigger population, this is a new hurdle that will need to be cleared," said Sadok. "Atmospheric drying could limit yields, even in regions where irrigation or soil moisture is not limiting, such as Minnesota."
On a positive note, the analysis indicates different species or varieties within species respond more or less strongly to this drying depending on their evolutionary and genetic make-up. For example, in wheat, some varieties are less responsive to this new stress compared to others, and this type of variability seems to exist within other non-crop species as well.
"This finding is particularly promising as it points to the possibility of breeding for genotypes with an ability to stay productive despite the increase in atmospheric drying," said Sadok.

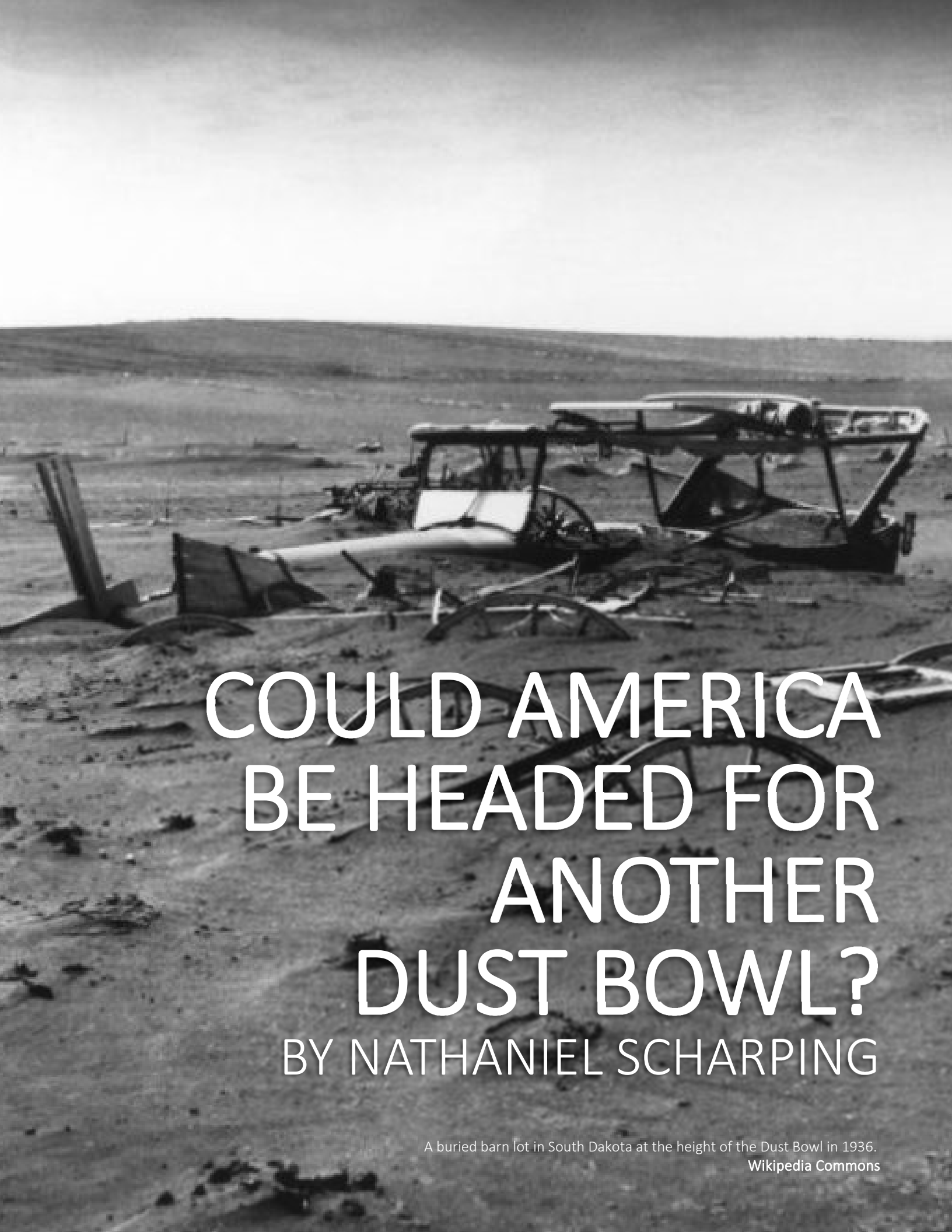
Danielle Way, a plant physiologist and co-author of the study from Western University, sees similar outcomes when it comes to ecosystems.

"Variation in plants' sensitivity to atmospheric drying could also be leveraged to predict how natural ecosystems will respond to climate change and manage them in ways that increase their resilience to climate change," she said.

In the future, researchers believe these findings can be used to design new crop varieties and manage ecosystems in ways that make them more resilient to atmospheric drying. However, new collaborations are needed between plant physiologists, ecologists, agronomists, breeders and farmers to make sure the right kind of variety is released to farmers depending on their specific conditions.

"Ultimately, this investigation calls for more focused interdisciplinary research efforts to better understand, predict and mitigate the complex effects of atmospheric drying on ecosystems and food security," Sadok and Way said.

The research was funded by grants from the Minnesota Wheat Research & Promotion Council, the Minnesota Soybean Research and Promotion Council and the Minnesota Department of Agriculture.



COULD AMERICA BE HEADED FOR ANOTHER DUST BOWL?

BY NATHANIEL SCHARPING

A buried barn lot in South Dakota at the height of the Dust Bowl in 1936.
Wikipedia Commons

Growing up in rural Iowa in the 1990s, Isaac Larsen remembers a unique herald of springtime. The snowbanks piled along roads, once white or gray, would turn black. The culprit was windblown dust, stirred from barren farm fields into the air.

Even as some of the region's farmers have adopted more sustainable practices, the dust still flies. Not long ago, Larsen's mother told her son about an encounter with a dust storm, saying "the soil was just blowing across the road—almost like a blizzard, but black."

Larsen, a 42-year-old geoscientist at the University of Massachusetts-Amherst, recently published a paper on soil loss in the US Corn Belt. Since farming began, Larsen and his coauthors estimate that more than one-third of the Corn Belt—nearly 30 million acres—has lost all of its nutrient- and carbon-rich topsoil. Similar processes also are taking place on the neighboring Great Plains, a sprawling region that includes Kansas, Nebraska, and the Dakotas, as well as parts of Texas, Oklahoma, Missouri, Montana, and Colorado.

Each dust storm represents a thin layer of the earth, exfoliated by the atmosphere and relocated. Over time, as countless such storms have swept across the Midwest and Great Plains, they have removed the legacy of thousands of years of plant life and death there. The most striking example was the 1930s Dust Bowl, the environmental and agricultural catastrophe that stripped topsoil from millions of acres across the American interior, plunging farmers into bankruptcy, destroying crops, and fundamentally reshaping the heartland.

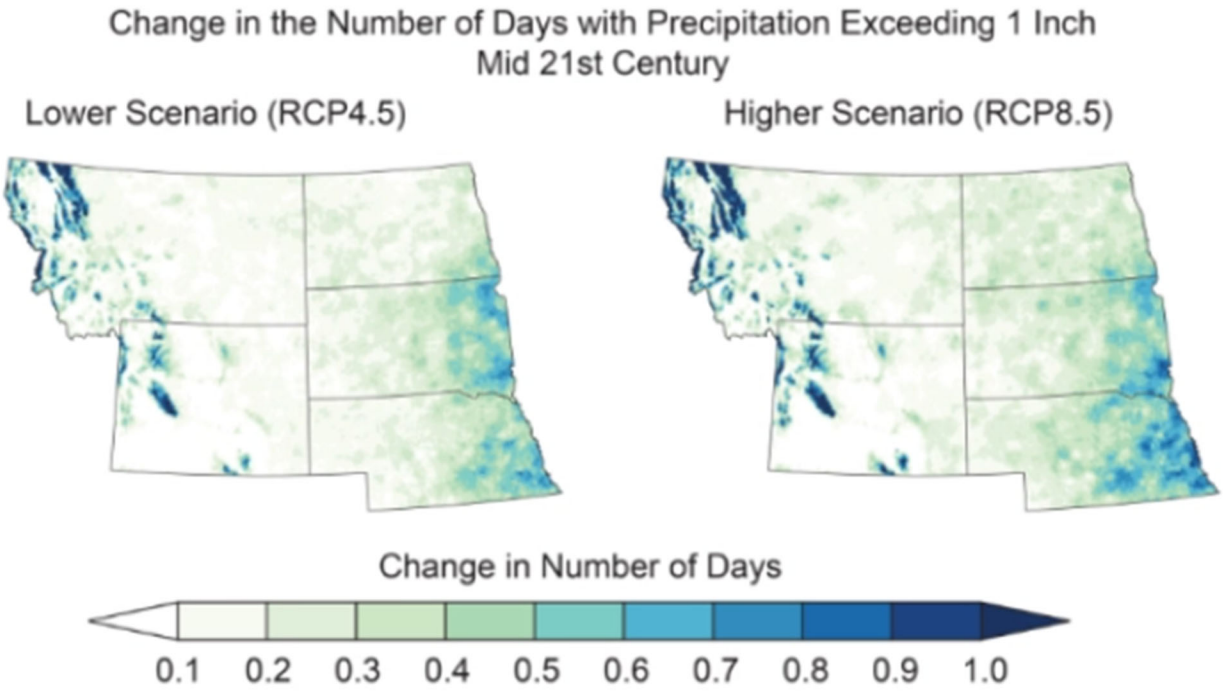
Much has changed in the US heartland since the 1930s, with widespread irrigation and—on some farms—improved agricultural practices. But given the rising temperatures and worsening droughts caused by gobal warming, some scientists are asking whether the US breadbasket is headed for another Dust Bowl.

In a 2018 National Climate Assessment, US scientists warned that under current warming scenarios, temperatures in the southern Great Plains could increase by 3.6 to 5.1 degrees F by 2050 and by 4.4 F to 8.4 F by 2100, compared to the 1976-2005 average. The region is projected to be hit by dozens more days with temperatures above 100 degrees F. Temperature increases are likely to be less severe in the northern part of the region, but the entire Great Plains is nevertheless expected to weather both more heatwaves and periods of extreme drought, according to the National Climate Assessment.

> By 2100, the southern Great Plains is projected to be hit by dozens more days each year with temperatures exceeding 100 degrees F.

The seeds of the Dust Bowl were sown when farmers in the early 20th century tore out millions of acres of hardy native grasses to plant wheat and corn during a relatively wet period. Then, when a historic, multi-year drought and heatwave occurred in the 1930s, the crops died and the exposed topsoil was left dry and loose, ripe to be swept away by strong winds. The ensuing storms could be immense: On April 14, 1935, the "Black Sunday" dust storm lofted central plains topsoil all the way to the cities of the East Coast. By the time the Dust Bowl was over, millions of migrants had fled the once-promising Great Plains for California and other western states.

But the catastrophe spurred innovation, too. In the midst of the Dust Bowl, the government acted



Projection of the change in annual days of heavy precipitation by mid-century. GlobalChange.gov

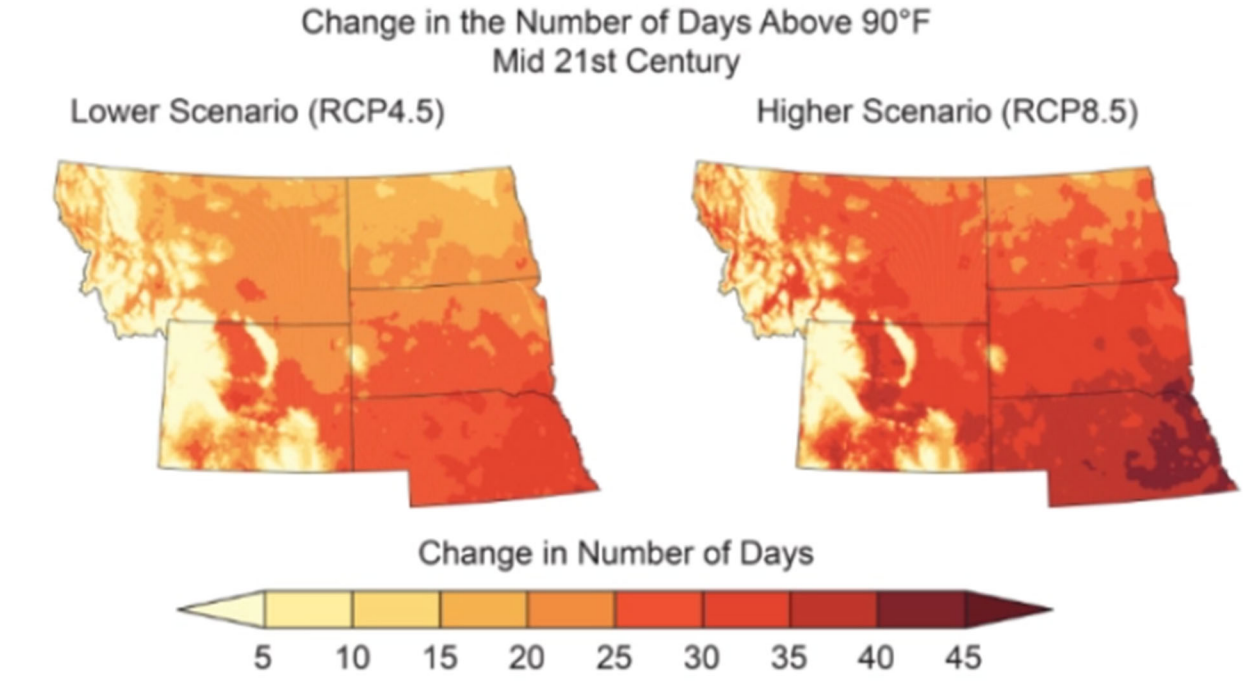
quickly to establish the Soil Conservation Service, which helped promote more sustainable techniques like no-till agriculture and cover cropping, which reduce the amount of exposed soil. Many of the heartland's industrial-scale farming operations, however, did not adopt these practices, though in recent years no-till agriculture has become more widespread.

Since the 1940s, many farmers on the Great Plains also have extensively irrigated their crops, allowing them to weather dry periods and further preventing topsoil erosion. But that reliance on irrigation has left the Great Plains open to new dangers. The Ogallala Aquifer—which makes up most of the High Plains Aquifer System and supplies the water for 30 to 46 percent of irrigated land in some Great Plains states—has been steadily overdrawn in recent decades; by some estimates, the Ogallala Aquifer could be 70 percent depleted within 50 years.

"There comes a point where if you're not replenishing those resources like aquifers, then all you need is the next minor drought to come along, and if you don't respond, then you run the risk of another Dust Bowl-like event," says Tim Cowan, a senior research fellow at the University of Southern Queensland who studies the effects of climate change on precipitation and heatwaves.

Heat and drought are intimately linked, meaning that worsening heatwaves mean more droughts and vice versa. That one-two punch has many scientists concerned. "Dry soils have this exacerbating effect," says Wim Thiery, a climate scientist at the University of Brussels. "There is this positive feedback where dry soils lead to more warmth."

When the soil contains a lot of moisture, incoming energy from the sun gets absorbed by the water as it turns from a liquid into a gas. But when the soil contains little water, that energy is converted directly into heat. The result is that droughts lead to more severe heatwaves, and those heatwaves in turn lead to drier conditions.



Projected changes in very hot days each year by mid-century. GlobalChange.gov

Data shows that both drought and heat are becoming more common—and perhaps increasing the feedback effects between them. In a recent study in Nature, Cowan and his coauthors found that greenhouse gas emissions have made a period of Dust Bowl-like heatwaves more than two-and-a-half times more likely compared to the 1930s.

Corn and soy yields would decline by around 40 percent, according to one estimate, and wheat yields would drop 30 percent.

Ben Cook, a climate scientist at the NASA Goddard Institute for Space Studies, says the same goes for drought. "What we're seeing in a lot of regions is this kind of amplified evaporation effect that's making it … easier to get into drought, a little bit harder to get out of drought, and making the droughts themselves a bit more intense than they would have been in a colder world."

Meanwhile, agriculture continues to thrive in the Midwest and Great Plains. The combined regions are top producers of crops like corn, wheat, and soybeans, as well as livestock. That level of agricultural intensity, paired with increasingly hotter weather, raises the stakes for the United States should another historic drought occur.

One paper in 2016 relied on computer simulations to model the effects of Dust Bowl conditions on modern agriculture. Corn and soy crop yields would decline by around 40 percent, the authors estimate, and wheat yields would drop 30 percent. And every

one degree Celsius (1.8 F) increase in temperature would cause the effects to worsen by 25 percent.

In a world where drought and heatwaves become routine, the two might combine to tip the country into a situation where agriculture becomes increasingly threatened, with profound impacts on US food supplies.

The United State got a recent taste of Dust Bowl-like conditions. In 2012, the country experienced one of its worst droughts on record, along with a sizzling heatwave. La Niña conditions in the Pacific Ocean, combined with the lingering effects of a dry 2011, resulted in the driest summer in the US since 1988. By July, nearly two-thirds of the country was in drought conditions, according to the US Drought Monitor. Meanwhile, July 2012 was the second-hottest month on record at the time.

The effects on the nation's farmers were substantial. Estimates put agricultural losses at around $30 billion, and corn yields declined by 26 percent. But even though the 2012 drought was similar in character to the Dust Bowl, billowing dust storms and wholesale agricultural collapse were absent. Similarly, a severe drought in the 1950s also failed to kick off another Dust Bowl.

"We've had bad droughts in the Central Plains since the Dust Bowl, but we haven't had the same level of land degradation and dust storm activity," Cook says. "And part of the reason for that is because our land use practices have changed."

For the time being in the Great Plains, irrigation allows farmers to weather even severe droughts by drawing on water stored in underground aquifers. But the overuse of the High Plains Aquifer System, especially the Ogalalla Aquifer, is taxing the region's groundwater supplies. Since 1987, the US Geological Survey (USGS) has been gathering yearly data on water levels in the High Plains Aquifer by monitoring thousands of wells.

Though changes vary across the region, the overall picture is one of persistent decline, says Virginia McGuire, a hydrologist with the USGS who's been monitoring the aquifer for more than two decades. The volume of water in the aquifer in 2015 had fallen by 273.2 million acre-feet since irrigation began in the 1940s, according to a USGS report she authored. A map in the report shows red blotches spread across Texas, Oklahoma, and Colorado, revealing stark declines in the amount of water infusing the soil. Water levels in some places are less than half of what they were a century ago, McGuire says.

"If that trend doesn't change, at some point there's going to have to be a reckoning," she says.

> "You will reach the point at which there is no more water coming from the wells."

So much irrigation is taking place on the Great Plains and in other global agricultural zones that the added water is actually cooling regional temperatures. In a 2020 paper in Nature Communications, Thiery and his colleagues compared average temperatures in heavily irrigated regions to those in the rest of the world. "We found that irrigation has a pretty pronounced cooling effect," he says. Regions that were irrigated warmed on average by 0.8 C (1.5 F) less on hot days than the rest of the world, they found. But the cooling effect of large-scale irrigation is ultimately unsustainable.

"We are putting massive pressure on our groundwater resources by irrigating," Thiery says. "At some point you will reach the point at which there is no more water coming from the wells."

Water managers and farmers are already making changes to reduce water use, such as irrigating just

half of their fields, or using multiple smaller wells to increase water yields from parched groundwater reserves, according to McGuire. But depleted aquifers take a long time to recharge, especially in areas like the southern Plains, where the water table is far below the surface. Meanwhile, dry years continue to stress the aquifer. During the three-year period between 2011 and 2013, the aquifer lost nearly as much water as it did between 1980 and 1995.

In 2012, says Cook, "the system was resilient enough to deal with a single year of really bad drought in the central US Now, if that 2012 drought had lasted three, four, or five years, would our system have been able to handle that? That I don't know."

A key reason for the resilience of US agriculture is the government's ability to provide aid to farmers when times are tough, Cook says. But climate change is affecting the entire world, with hotter, drier conditions predicted to increase in regions—such as South Asia and East Africa—that may have little ability to cope with more extreme weather. In the Indian state of Punjab, where more than 80 percent of the land is used for agriculture, water tables are dropping quickly. A 2019 heatwave in India saw temperatures climb above 120 F, while water shortages led to violent clashes.

A European drought has also strained groundwater resources across much of the continent. Data from NASA's GRACE-FO satellite from June 2020 revealed dangerously dry soils in Germany, Poland, the Czech Republic, Ukraine, and parts of Russia. Similarly, a record-setting drought in Australia from 2017-2019 battered farmers, with extreme heat also sweeping across the country. Even if nations—particularly developing nations—adopt more sustainable irrigation and agricultural practices, a rapidly changing climate means they could still face crop failures that imperil food supplies.

The Dust Bowl is a uniquely American touchstone, a story of hardship and eventual triumph that has come to define both our country's historical narrative and physical reality. But in a world where climate conditions grow steadily more extreme, that unparalleled disaster could become far more common.

Lake Mead/Shutterfly Images

This stunning time-lapse shows the megadrought's toll on the West's largest reservoir

Lake Mead's levels have dropped significantly since 1985, a bad omen for the regions that depend on it.

Just how bad is the drought in the Western US? The shrinking of Lake Mead, the country's largest reservoir, is a troubling indicator.

The massive man-made lake, which straddles the border of Arizona and Nevada, is now only at 39 percent of its full capacity, down from 44 percent in April 2020. That's equivalent to a 10-foot drop in the water level, according to the latest data from the Bureau of Reclamation. Which means mandatory restrictions on the amount of water surrounding states draw from Lake Mead could be triggered in the next few months.

"This year will be really telling because it will provide a stress test of the newest policies that we thought were stricter but likely will need to be even more strict in the future," said Elizabeth Koebele, a political scientist at the University of Nevada who focuses on water policy.

The impending restrictions have been a long time coming — the reservoir started contracting well before 2020, as Vox writer Brad Plumer explained in 2016. The latest drought in the West is but one episode in a two-decade megadrought, and it has taken a toll on the Colorado River, which feeds Lake Mead.

The animated map below, from Google Earth's new Timelapse feature, shows just how much the reservoir's boundaries have shriveled since 1984.

Lake Mead's dropping water levels will affect Arizona's water supply as soon as next year

Lake Mead's recent contractions are concerning because the body supplies water to 25 million people across Arizona, Nevada, California, and Mexico. Built in 1936, the Hoover Dam and the attached reservoir have shaped the geography of the West, making life in Las Vegas and Los Angeles possible.

As the lake level has dropped, states have so far managed to avoid reaching the point where mandatory water restrictions kick in, but it looks like they are coming soon.

The Bureau of Reclamation keeps tabs on the lake by measuring its height at Hoover Dam. There, the water level is currently at 1,081 feet, and the Bureau projects it will drop below 1,075 feet as soon as June. After it crosses that threshold, the federal government will declare an official water shortage. Under a Drought Contingency Plan agreed upon by the affected states in 2019, some states will start to see big cuts in how much water they receive from Lake Mead starting in 2022.

Based on the pecking order from past negotiations, Arizona will have the biggest reductions in allocation from Lake Mead while California won't face restrictions until the reservoir drops below 1,045 feet. The agreement dictates that Arizona will have one-third of its water supply from the reservoir cut, Ian James reported for AZ Central. Farmers will be among the most impacted, according to the state's drought plan, but they will be allowed to use groundwater resources to compensate to some extent.

As a result of the preemptive drought planning, states have already prepared for the inevitable point when they will have to endure such cuts, said Koebele. "The basin has become increasingly collaborative over time, and people are thinking about it

Lake Mead marina, south of Las Vegas, Nevada, on August 23, 2020. Daniel Slim/AFP via Getty Images

as, 'It's not if this happens, it's when it happens and how do we best handle it.'"

Generally speaking, she said, cities will be relatively unaffected by any cuts for now, whereas farms, which consume the vast majority of the basin's water, will have to start investing in technologies like drip irrigation to become more efficient.

Climate change poses a serious long-term threat to the millions who depend on the Colorado River

The imminent resource crunch is just the beginning of the problems for the millions of people in Arizona, Nevada, California, and Mexico who depend on Lake Mead and the Colorado River for their water.

Rising global temperatures are expected to bring more frequent and more intense droughts to the Southwest, according to the latest National Climate Assessment, which was authored by 13 US federal agencies in 2018. Climate change is also increasing the likelihood of long-term megadroughts like the one we are seeing now.

In a 2020 study published in Science, US Geological Survey researchers found that warming will reduce the flow of the upper Colorado River by 14 to 26 percent by mid-century under a moderate climate action scenario.

"Climate change is really severely impacting the basin," said Koebele. Rising heat increases evaporation, she explained, "Even when we get a good snowpack, if the soil is super dry we can see really big reductions in run-off." That means less precipitation from the mountains ultimately makes it to the river.

To adjust to an increasingly water-scarce future, basin states and stakeholders are starting to negotiate a post-2026 deal, which will set the framework for the coming decades. In the meantime, cities and farms will need to continue to find ways to make their water use more efficient. Arizona is even considering building a desalination plant with Mexico to import water from the sea.

"We are going to hit a peak with efficiency and conservation, or hit a limit eventually, but there is still more to do there," Koebele said.

As for the coming year after Lake Mead drops below 1,075 feet, it will be the first stress test for states as they collaborate to conserve Lake Mead's water for the future.

By Lili Pike

Counties projected to have the most extreme precipitation days in 2050

Gina-Marie Cheeseman
Microsoft News

Climate change will not just affect temperature, it will also affect how much precipitation towns, counties, states, and countries receive. Wet regions are projected by the National Climate Assessment to generally become wetter, with rising overall air and water temperatures increasing heavy downpours across the U.S., according to the Fourth National Climate Assessment. Studies widely show that across the country, heavy precipitation events are increasing—and projected to continue doing so.

Over the last century, there has been a 10% increase in annual precipitation in Pennsylvania, for example, with experts predicting a continued increase in precipitation and flooding through mid-century. By 2050, precipitation in Pennsylvania is expected to increase by 8% annually, with 14% of that occurring in winter. Average annual precipitation in New York has similarly increased since 1900; throughout the 21st century, winter precipitation in the state is projected to continue to rise while higher temperatures mean more rain and less snow.

To determine which U.S. counties will see the most extreme precipitation days in 2050, Stacker consulted the Centers for Disease Control and Prevention & National Environmental Public Health Tracking Network, which uses a 30-year rolling average to calculate the projected amount of days with extreme precipitation. These predictions were last updated in December of 2018.

Counties are ranked by low emission days of extreme precipitation in 2050. The number of extreme precipitation days is relative to days in a year, with the measure calculated annually and representing a 30-year rolling average.

Keep reading to see if your own home county is projected to be among those with the most extreme precipitation days in 2050.

How Your Hot Showers And Toilet Flushes Can Help the Climate

By: Sam Brasch

A secret cache of clean energy is lurking in sewers, and there are growing efforts to put it to work in the battle against climate change.

The U.S. Department of Energy estimates Americans wash enough energy down the drain every year to power about 30 million homes. The sources are often everyday items inside homes. Think hot showers, washing machines and sinks. Evolving technology is making it easier to harness that mostly warm water.

Denver is now constructing what is likely the largest sewer heat-recovery project in North America, according to Enwave, a Canadian energy company set

Over the next few years, a $1 billion remodel will turn the 250-acre site, home to the National Western Stock Show and Rodeo, into a hub for art, education and agriculture. The revamped National Western Center will include about a million square feet of new indoor space, all of which will be heated and cooled with energy from the sewer pipes below.

Brad Buchanan, the CEO leading the redevelopment, said the project has already changed how he thinks about the best location for real estate. Big pieces of sewer infrastructure have long repelled development. Now he imagines they might be sought out as a way to save energy costs and avoid greenhouse gas emissions.

The National Western Center estimates the project will help it annually avoid the carbon equivalent of driving an average gas-powered car around the equator 250 times.

"It'll be interesting to see if folks start to look at not just where light rail lines or good schools are located, but what's the proximity to a large sanitary sewer line," Buchanan said.

How to mine for sewer heat

The technology to harvest sewer heat isn't complicated.

At the National Western Center, construction crews have already completed a pit exposing the main sewer line. The wastewater inside stays a mild 55 to 75 degrees year-round, local officials say, no matter the weather outside. That consistent temperature can be tapped to heat and cool aboveground buildings.

The key is a massive heat pump, which will be housed in a central plant on the campus. The device works like a reversible air conditioning unit. In the winter, it will transfer energy from the sewage into a clean-water loop connecting the buildings, adding heat to indoor spaces. The process can then be flipped to keep things cool in the summer.

And to answer an obvious question: No, the raw effluent is never exposed to the air, so people occupying the buildings won't get hit with waves of sewer stink.

Shanti Pless, a research engineer with the National Renewable Energy Laboratory in Golden, Colo., said the technology opens up a vast world of "renewable heat mining."

"With the advent of large-scale heat pumps, we can cost-effectively use, say, 70-degree wastewater to heat our buildings and our hot-water systems," Pless said.

Rethinking how we heat and cool buildings

Pless said the biggest barrier isn't technology — it's helping developers rethink the size of their heating and cooling systems. Sewer heat recovery often works best as the heart of a district-size energy system, where a central plant provides energy to a whole neighborhood or office complex.

Denver itself shows how this kind of centralized strategy has fallen out of favor in the United States.

A 141-year-old steam heat system warms many of the city's downtown buildings, supplying energy from a central gas plant operated by Xcel Energy. As costs to improve the system have landed on customers, many building operators have disconnected from the steam service in favor of smaller, independent heating and cooling systems.

Nevertheless, Pless said district energy often makes sense, but it requires a careful study of the energy needs and resources in a specific area. NREL has developed tools to help communities model the viability of heat-recovery systems. He said the National Western Center could also help blaze a trail into the sewers.

"This has been a great local example for us to take the idea to the rest of the country," Pless said.

A sewer energy gold rush?

If sewer energy catches on, one reason could be the potential benefits for wastewater districts.

That's because warm sewage causes its own environmental problems. In Denver, wastewater is often hotter than the South Platte River, its final destination after running through a treatment plant. This "thermal pollution" can imperil native plants and wildlife.

Mickey Conway, Metro Wastewater district manager, said it'd be possible to build cooling towers to chill the treated sewage, but the National Western Center project could showcase a better alternative. New homes and buildings could harvest this heat, cooling the water while avoiding climate-warming emissions and potentially reducing energy bills.

"It's kind of a perfect storm of win-win situations," Conway said.

Metro Wastewater has produced slick brochures to entice other developers with sewer heat. Conway said there are no solid plans just yet, but the district has had "discussions with Denver and Thornton," a metro Denver suburb.

Meanwhile, the National Western Center has moved to protect its supply in the event of a kind of sewer-heat gold rush. The City and County of Denver, a partner in the project, exercised a three-year option for exclusive access to the energy inside the pipelines running through the campus.

Buchanan, the project CEO, said it amounts to a new sort of environmental resource. Instead of mineral rights or water rights, his development holds sewer thermal energy rights.

"We have it protected because we're counting on that energy in perpetuity," he said.

The Last Hurrah

TWCA Newsletter ends

After the tumult of 2020 and the uncertainty of 2021 TWCA has decided to cease production of this magazine the TWCA Quarterly.

Beginning June of 2014 TWCA has issued a quarterly newsletter. The first Issue was two pages front and back, stapled in the corner and was physically handed out to four people. This, the final issue of TWCA Quarterly, is 104 pages of content with no advertisements, focused on the issues surrounding water conservation in the managed environment. The audience has grown from those first four recipients to more than three hundred members and turf professionals around the world.

So much has changed for the Quarterly, distribution methods, layout, content; but the one thing that has remained at the heart of the project has been the sincere desire to communicate both the scope of the water crisis and TWCAs commitment to providing resources central to balancing the responsible use of a finite resource and the livability and equity or our communities.

We are proud to lower the flags on this rag with our longest and best issue yet. Not only have we collected some of the best content of our run but we have done so with consistent and predictable formatting providing a consistent, informative and enjoyable experience.

Your TWCA will continue to offer updates and valuable content monthly as well as consistently updating through social media. Follow us on twitter @_tgwca and on facebook at TurfgrassWaterConservationAlliance.

Thank you for your continued support of the program, we look forward to serving our membership.

How John Deere is teaching small farmers better agricultural techniques to end 'hunger season'

The farm equipment company launched Rayuwa—a winner of Fast Company's 2021 World Changing Ideas Awards—to provide education that could improve the yields of farmers in Nigeria.

BY KRISTIN TOUSSAINT

Across Nigeria, the COVID-19 pandemic exacerbated poverty, worsened food insecurity, and particularly hit the country's agriculture sector—one reliant on small farmers, who account for 88% of Nigerian farms and produce more than 95% of the country's agricultural output. But a subset of those farmers saw their food insecurity decrease and total earnings increase in 2020, thanks in part to a program from John Deere called Rayuwa.

In Nigeria, more than a third of the country's labor force works in agriculture. Small farms are crucial to that economic pillar, especially as its population grows; Nigeria, already the most populous country in Africa with 200 million people, expects its population to increase to more than 400 million people by 2050. That growth could hurt farmers there who struggle with food security, poverty, and challenges such as the "hunger season," the period from June to August when the last harvest has been depleted but the new one isn't yet ready.

John Deere was founded 184 years ago, and over that time, says Nate Clark, president of the John Deere Foundation, the company has seen "how farmers have produced really widespread prosperity—not only by making food and other agricultural products more widely available but actually creating communities and economies that have improved the quality of life for billions of folks." The company saw potential in Nigeria's farmers, in a country where small farms are so crucial and yet so many farmers are still struggling. So the company and its foundation—its philanthropic arm, which gives out grants and corporate sponsorships oriented toward issues such as hunger, education, and sustainability, and which recently announced a goal to invest $200 million over the next 10 years in part to bolster farmers around the world—created Rayuwa, which means "life" and "livelihood" in Hausa.

The goal of Rayuwa was never to deliver machinery or equipment to Nigerian farmers, but to impart agricultural training and youth education to help both

current farmers and the farmers of the future. Rayuwa is the winner of the corporate social responsibility category of Fast Company's 2021 World Changing Ideas Awards.

"One of the things that our nearly two centuries of business has taught us is if you have educated farmers and farm families, those farmers and farm families are more successful and resilient," Clark says. "With a program like Rayuwa, we're investing simultaneously in the farmers of today, and those who will be the farmers of tomorrow." It was crucial that Rayuwa be rooted in the communities it serves, so it's staffed, owned, and managed locally. Students from local universities trained in agriculture and education, some of whom were from the villages Rayuwa was established in, were tapped to lead the programming. John Deere was also intentional about not prioritizing mechanization; these farms are so small, machinery isn't necessary. One emphasis was on offering agronomic training, "to learn things like when to plant, how to plant, how to space their crops," Clark says, along with access to high-quality seeds and fertilizers, and links to markets where farmers can sell their products.

Rayuwa began in November 2019, in partnership with the nonprofit PYXERA Global, which advises corporations on sustainability initiatives, and which in December 2020 completed its first year of working with 2,500 smallholder farmers and 4,000 youth across 11 northern Nigerian villages. Despite the pandemic, the results were positive: Rayuwa farmers reduced their "hunger season" food insecurity rate from 63% to 53% because of improved crop yields (thanks to better fertilizers, seeds, and planting techniques) and the ability to get higher prices for those crops, along with income from other sources such as livestock, which allowed them to buy more food. The farmers increased their total earnings by $1.3 million. Rayuwa youth also increased their top scores in letter and number recognition by 60% and 77% respectively, and 300 youth returned to their villages from cities to further their education and to farm.

Rayuwa is now expanding, with a 2021 goal of doubling its reach from 11 villages to 21, and Clark says John Deere is thinking of how else the program can grow. "While there is certainly a sense of urgency to work with Nigeria's farmers to secure nourishment and food and growth and all the things that they will need," he says, "there's also an awareness that it will take time, and that John Deere is in it for the long haul."

Mount Hood pictured from Mount Tabor, in Portland, Oregon. The glacier provides water for drinking and growing crops. Photograph: Jon Bilous/Alamy

‘It’s like a rotting carcass of its former self’: funeral for an Oregon glacier

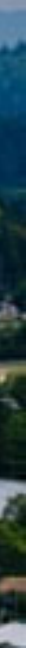
Worried researchers hold ceremony for Clark glacier to illustrate how climate crisis is eroding icepacks

By: Oliver Milman

The funeral was a suitably solemn affair. The small casket was placed on a table covered in a black drape, a maudlin yet defiant speech quoted a Dylan Thomas poem, a moment’s silence was held.

Inside the casket, however, was not a body, but a vial of meltwater from Clark glacier in Oregon, once an imposing body of ice but now a shrivelled remnant.

The funeral, a stunt held by worried glacier researchers on the steps of the state capitol in Salem, illustrated how the climate crisis is rapidly gnawing away at the majestic icepacks that used to throng the mountains of the northwestern US, potentially posing a threat to the region’s water supplies.



"There is just this immense sadness because we all knew it was going to be bad, but didn't think it would be this bad," said Anders Carlson, president of the Oregon Glacier Institute, who read the eulogy for Clark glacier at the "funeral" in October.

Clark glacier is, or was, found if you took a moderately strenuous hike amid the Cascade mountains, a range that stretches from British Columbia in Canada down to the northern reaches of California.

Once spanning about 46 football pitches in size, the Clark glacier is now about three football pitches in area, or what Carlson calls a "stagnant scrap of ice".

"It's like a rotting carcass of its former self," said Carlson. Glaciers move via gravity under their own vast weight, but once they have lost a certain amount of volume, they become dormant patches of ice. Other nearby glaciers found on the three sisters, a chain of volcanic peaks, and Mount Hood have similarly "died" in this way.

"You go back through old photographs and glaciers have disappeared just in the last 20 years – it's really dramatic," said Carlson, who has calculated that at least a third of the state's glaciers named by the US government in the 1950s are now gone.

Among their other benefits, the meltwater from glaciers each spring feeds streams and rivers that supply a water source for apple and pear orchards, vineyards and even some drinking water for towns situated in the shadows of the mountains.

Researchers have estimated that river volumes in the late summer could drop by 80% by the end of the century due to decreases in glacier and snow melt. These huge losses raise tough questions over how to replace the water.

"These glaciers are not just nice to look at – they are our water towers, where we store our water," said Carlson.

"Places like Hood River and Eugene are drinking and growing crops with water from glaciers. If you like Oregon wine, the chances are it was grown with glacier water. If you lose that, it's not going to be a pretty picture. You either try to get groundwater or build new dams, which is not popular with anyone."

The decline of glaciers is part of a broader trend that has seen vast bodies of ice wither away from the Himalayas to Switzerland as global temperatures climb. The glaciers of America's Pacific northwest aren't as well known as those overseas, but they play an important role in the local environment and are suffering stunning losses.

Since the mock funeral, researchers have found that the Cascades are particularly vulnerable to the melting of glaciers, which can cause maladies ranging from increased wildfire risk to the loss of species such as steelhead trout that rely on the frigid cold of glacier-fed streams. In the longer term, the glaciers of the American west face almost complete obliteration.

"The glaciers in the western US continue to shrink and will largely disappear by the end of the century," said Andrew Fountain, a geologist at Portland State University who has submitted new research that found the glaciers of the Olympic Mountains, in the state of Washington, will probably vanish by 2070.

"You might get icy remnants on the peaks of tall mountains like Mount Rainier or Mount Baker, but they will be pretty small. Rising temperatures are doing this, without a doubt."

Beyond drastically cutting planet-warming emissions, there is little that can be done to salvage the glaciers, a sobering reality for those who have long hiked and climbed the peaks of the US north-west.

"It's really hard to stop the decline," said Carlson. "People don't realise we are a glacierised country – we rely upon them, like the Swiss and Norwegians do. They are important and we need them."

START PLANNING FOR A WORLD WITH A LOT LESS WATER

Opinion by Ban Ki-moon and Patrick Verkooijen

World leaders need to start planning for a world with a lot less water. The world's population consumes six times more of this life-sustaining element than our ancestors did 100 years ago, and with population and economic growth, demand continues to rise.

Furthermore, climate change is playing havoc with the water cycle, disrupting weather systems and rainfall patterns that deliver either too much or too little, and rarely where and when it is needed.

That is why the theme of this year's United Nations World Water Day is valuing water. This is about considering the value of water for our households, food, culture, health, education, economics and the integrity of our natural environment. This is important because there is a growing disconnect between the urgency of our water needs for its multiple uses and the resources available to address them.

This is not due to a lack of capital, expertise or solutions -- all three are available in abundance.

It is a failure of national and international foresight, planning and cooperation. With a better understanding of the multidimensional values of water, we will be better able to safeguard this critical resource for everyone's benefit.

Over the last year, we have seen how water is the connecting thread linking the myriad impacts of our health and climate crises. Billions of people on every continent face a future of increasing water scarcity. And the Covid-19 pandemic has worsened the situation.

At the onset of the pandemic, we were urged to wash our hands frequently -- an instruction that was difficult to obey in the crowded slums of Rio, Nairobi, Jakarta and Mumbai, and by the 3 billion people globally who lack access to basic hand-washing facilities.

In a world without water, food production stops, cities cease to function, economic activity grinds to a halt and greenery turns to desert. The World Economic Forum's 2020 Global Risks Report, published in January, ranks risks from water crises higher than either infectious diseases or food crises.

In 2021, we are experiencing all three at once, with Covid-19 claiming over 2.7 million lives worldwide so far and leading to a severe increase in global food insecurity impacting vulnerable households in almost every country.

The World Bank estimates an additional capital investment of $1 trillion will be required over the next 10 years to meet the needs of the 2.2 billion people who still lack access to safe drinking water today, and to treat the 80% of the effluent that currently goes untreated, polluting ecosystems and carrying waterborne diseases.

Against a funding gap of more than $100 billion a year, the Global Center on Adaptation (or GCA), an international environmental organization that partners with the public and private sectors to accelerate action to tackle climate change, just under $10 billion was invested globally in 2018 to improve water and wastewater management.

This means water projects attracted less than 2% of the $546 billion of funding from governments, com-

panies and households available to fight climate change in 2018. In National Climate Plans, which set out how countries intend to reduce their greenhouse gas emissions, water projects figure at all.

But there are reasons to be hopeful. First, water projects are beginning to figure prominently in National Adaptation Plans in countries such as China, Ghana and Bangladesh. These plans help communities identify and adapt to the impacts of climate change, such as water scarcity and droughts.

Major institutional investors and banks, through groups such as the Valuing Water Finance Task Force, are also increasingly playing a role in addressing water issues by catalyzing capital markets to value water as a financial risk and influencing companies to take action.

Funding for climate adaptation, however, attracts only a fraction of climate finance. This must change.

Secondly, the fight against Covid-19, which is consuming huge amounts of money, is forcing us to think more strategically about where to invest scarce public resources. In a post-pandemic world, we must use what we are learning about the dynamics of interconnected systems to "build forward better." GCA, in its "State and Trends in Climate Adaptation Report 2020" identifies climate-smart adaptation initiatives that can help economies recover faster and better from the ravages of the pandemic by delivering triple wins for the economy, health, and climate.

For example, a little-known fact is that wetlands such as the Flow Country in Scotland to the swamp forests in South East Asia can store twice as much carbon as forests, making them the most effective carbon sinks on Earth. Investing in nature-based solutions to restore wetland ecosystems offers multiple benefits in addition to trapping carbon emissions, including flood and drought mitigation, water purification and the protection of biodiversity.

Another opportunity is increasing wastewater treatment. Effluent that is released untreated not only carries diseases and pollutes our environment, but also ferments and releases dangerous greenhouse gases such as methane, which contributes to global warming.

Modern wastewater treatment plants use bacteria to break down organic matter. The byproduct, biogas, can be used for cooking, heating and cooling, and to generate renewable energy in waste-to-energy plants. Investing in wastewater treatment is therefore good for our health, our environment, the economy, and our climate.

One of the reasons why water initiatives are underfunded is that funding for building resilience, cutting carbon emissions and development often exists in silos. Harnessing resources from different finance pools is complicated. This is particularly true when water projects transcend national boundaries, like the current crisis.

Even at local and national levels, expertise to put together multi-sectoral project proposals is often lacking.

That is why GCA is mobilizing support for a Project Preparation Facility (PPF) to invest in building that local and national expertise by bringing innovation and prowess to investments made by multilateral development banks and other public and private financiers. Faster, better and smarter project preparation is needed to make water projects bankable and to drive investments at the speed and scale required.

Water deserves a greater share of climate and development finance, and a much bigger role in our post-pandemic recoveries.

It underpins all 17 UN Sustainable Development Goals, from fighting hunger and poverty, to building sustainable cities and achieving universal access to clean water and sanitation. There are so many practical ways to invest smartly in our water security. We urgently need to reexamine our priorities and make water the foundation of our health and economic recoveries.

Judge rules against Los Angeles in Long Valley irrigation fight

by LOUIS SAHAGÚN

A judge has ordered the Los Angeles Department of Water and Power to continue providing historic quantities of irrigation water to lessees of its pasturelands east of Yosemite, despite the agency's assertion that climate change is making water resources in the Sierra Nevada watershed increasingly unreliable.

Alameda County Judge Evelio Grillo's ruling could have significant implications for water agencies statewide as they face the complex challenges of servicing ratepayers and meeting environmental requirements in a time of rising temperatures, drought, dwindling snowpack and changing water availability.

The case was brought in a lawsuit filed against the city of Los Angeles by Mono County and the Sierra Club and was triggered by new leases the LADWP proposed in 2018 indicating that ranchers on its 6,400 acres in Long Valley should expect little to no irrigation water when they renew, according to court documents.

The plaintiffs argued that making significant changes in water management policies without first conducting an environmental review of the consequences was a violation of the California Environmental Quality Act.

Grillo agreed. In a recent ruling, Grillo ordered the DWP to continue providing lessees with about 3.2 acre-feet of water per acre, per year until it completes an environmental review.

In a statement following the order, the DWP said it was concerned the ruling "could set a precedent for all water agencies trying to responsibly manage environmental needs and water operations when faced with volatile water supply conditions and a changing climate reality."

"What the ruling neglects to recognize is that a water system simply cannot be static," the statement read. "Every year, LADWP must adapt its water operations to respond to changes in weather, be it wet or dry, and the needs of the environment and communities we serve."

"Our operations in Mono County," it added, "have always been and continue to be a reflection of changing factors that any responsible agency must consider including annual runoff, storage capacity, environmental needs and more."

Extreme weather conditions are making it harder for Los Angeles to meet state and federal requirements and court settlements in the highly litigated Sierra watershed.

Recent scientific studies suggest meteorological trends are likely to accelerate in decades to come. The implications stretch from Owens Lake north to Mono Lake, the high-desert water body east of Yosemite National Park best known for its cragged and towering tufa formations.

A bitter history also confounds problem solving along the eastern Sierra.

The DWP's diversions after the turn of the last century, critics say, helped set the stage for major air pollution problems at Mono Lake and at Owens Lake, about 140 miles to the south.

In the early 1900s, city agents posed as ranchers and farmers to buy land and water rights. Then the DWP built dams and diversions that drained Owens Lake and made it all but impossible for the region's ranchers and farmers to make a living.

More recently, DWP ratepayers have spent at least $1.4 billion for vegetation, gravel, furrowing and shallow flooding that have reduced dust pollution on the Owens Lake playa by more than 99% — the largest dust mitigation effort in the United States. Each year, that project uses about 60,000 acre-feet of water worth about $42 million, officials said.

An acre-foot equals about 326,000 gallons, or enough water to cover a football field one foot deep. An average Los Angeles household uses about an acre-foot of water for indoor and outdoor use.

In 2018, Mono County complained that the DWP's proposed changes on leased lands that are also habitat for the rare bi-state sage grouse appeared "to be part of a larger plan by the city to completely discontinue water deliveries to the eastern Sierra," according to court documents.

"We take this to mean that the city plans to increase exports of eastern Sierra Nevada water by reducing or completely discontinuing deliveries to Mono County ranches and habitat," the county said in court papers.

Siding with the county, the California Natural Resources Agency criticized what it described as "potentially devastating impacts to the natural environment, habitat and wildlife if the LADWP pursues its proposal to upend 70 years of water manage-

ment policy and practice by eliminating irrigation and stock water from its ranch leases."

DWP responded by saying it had no intention of "dewatering Mono County" and would continue to provide water to protect the environment.

However, it also said, "The free water LADWP has provided to commercial ranchers is separate and unrelated to the water LADWP provides to serve the region's environment — in fact diverting less water for commercial ranching may have additional environmental benefits for Mono County," according to court papers.

Before approving new leases, the LADWP said it would complete a full environmental impact report, according to court documents.

Grillo, however, determined that the DWP had already commenced changes in water use without an environmental review, as required under the California Environmental Quality Act, through the proposed new leases announced in 2018.

Water experts expressed mixed feelings about Grillo's ruling.

Max Gomberg, climate and conservation manager at the California State Water Resources Control Board, suggested that it underscored how the California Environmental Quality Act "could be used as a blunt instrument that can kill opportunities. It's not up to the task of confronting the complex and cumulative challenges facing water utilities."

Peter Gleick, a climate and water scientist at the Pacific Institute, a water think tank, however, said the case demonstrated how the law "can be used as a modern tool to try and address past environmental mismanagement in a state where the history of water comes with some very ugly politics."

Looking ahead, Stacey Simon, an attorney representing Mono County, said, "I hope that Mono County and Los Angeles can work together in the future to ensure that water supply decisions respect and protect the valuable resources of Mono County while contributing to the need of the City for a safe and reliable water supply."

We can't plant our way out of the climate crisis

What if planting more trees isn't the climate solution we want it to be?

By: Adele Peters

There were once around 6 trillion trees on the planet; now, thanks to human civilization, there are around half that number. Reversing that trend is a key pillar in the fight against climate change. And for companies and countries aiming to use carbon offsets for net-zero emissions, planting more trees can seem like an obvious option. Trees capture carbon, and planting them is a relatively cheap way to fight climate change. But there's also a risk: Many of those trees might not survive, and could end up adding to emissions themselves.

"I think the emphasis on planting trees is risky or even a misplaced dream unless we first put priority on reducing or halting climate change, because the trees are going to be stressed—they are getting stressed now," says Jonathan Overpeck, a climate scientist at the University of Michigan and one of the authors of an op-ed in Science arguing that the world needs to rethink how much we rely on tree planting as a climate solution.

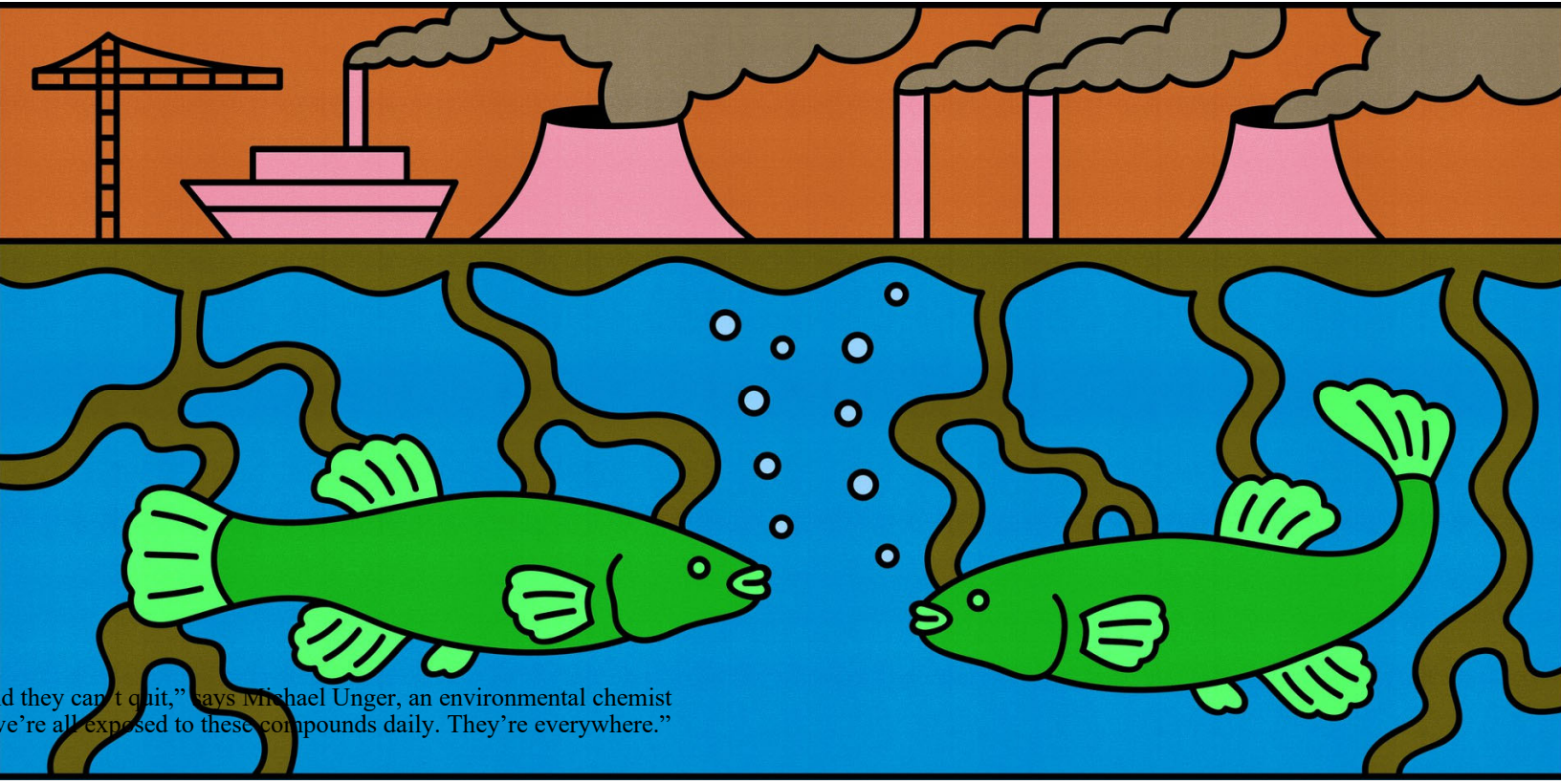
Vegetation is being stressed by climate change "in ways that are increasingly unprecedented," he says. In California, hundreds of millions of trees died in the last drought, after a combination of heat, lack of rain, and attacks from pests, and then many burned in the record-breaking wildfires in 2020. In Australia, millions of acres of forest burned in 2019 and 2020, emitting more CO2 than the rest of the economy combined. Zombie fires are burning forests in Siberia now.

Even in areas where large wildfires aren't common now, such as Michigan, climate change is killing some trees. "Part of the story is the same thing as in the west: Trees are getting stressed out by the warmth," Overpeck says. "And because they're stressed, they can't fight the diseases as much." Hotter temperatures dry out soils faster, and dry out plants. The changing climate also means that some species are no longer growing in the right place to survive.

There's a risk, then, that trees that are newly planted in a forest might end up dying from disease or burning in a fire. "When you get these large wildfires, of course, you're converting carbon that's in vegetation—and often in soil that's accumulated over hundreds of thousands of years—you're converting that carbon to carbon dioxide in the atmosphere," he says. "You're also putting soot into the atmosphere, which is dark colored, and therefore also acts to warm, just like greenhouse gases. And that's accelerating the climate change that is stressing the vegetation out." (In other cases, tree planting projects might happen so haphazardly that even without the added stresses of climate change, the trees are unlikely to make it.)

Any trees that are planted need to be planted carefully—like a project in Paradise, California, where species have been chosen to have the best chance of surviving in a hotter, drier climate, and planted in a way to minimize the likelihood of spreading fire later. But there also needs to be much more done to protect existing forests and to study new ways to help them survive, Overpeck says. In another example in California, some trees are being thinned out in forests to reduce fire risk and then converted into biochar, a material that can be put back in the soil to sequester carbon. Companies and countries should focus on directly cutting emissions rather than relying on trees for offsets. "It's an easy way out to plant trees instead of making the harder choice to limit greenhouse gases," he says.

"You have a lot of folks say, 'well, our best way to fight climate change is to plant more trees,'" he says. "Or to buy carbon offsets for these existing forests. And we're saying, 'whoa, wait a minute. That's okay. But the first thing we have to do is we have to stop the damn climate change that is stressing out these forests.' Because the carbon isn't safe."



THIS TINY FISH CAN WITHSTAND ALMOST ANYTHING

In Virginia's Elizabeth River, the unremarkable-looking mummichog has survived decades of industrial pollution—but the price it has paid has worrying implications for human health.

by Carrie Arnold

Originating in the Great Dismal Swamp of Virginia, just south of the Chesapeake Bay, the Elizabeth River is turbid and brackish, its banks redolent with the nose-wrinkling stench of rotting vegetation. These muddy, pungent waters support an array of life—oak and maple trees, herons, otters, and oysters. But the Elizabeth empties into the massive Norfolk Harbor, making it ideal for shipping and shipbuilding; for decades, local industry spilled thousands of tons of creosote, a wood preservative made from coal tar, into the river.

Over time, the stench of tar and mothballs replaced the natural Eau de Liz. When the Duke University toxicologist Richard Di Giulio first walked along the Elizabeth in the late 1990s, its waters were some of the most polluted in the country. By 2009, there were half a dozen Superfund sites within a mile of the river.

Below the iridescent slime covering much of the river's surface, though, a greenish minnow-size baitfish called the mummichog—also known as the Atlantic killifish—was managing to eke out a living in the waters that abut the Elizabeth's Superfund sites.

For Di Giulio and others, the mummichog is a case study in the costs of survival: The fish have managed to endure in the river, but some have undergone fundamental genetic changes.

For the humans who continue to live along the Elizabeth's shores, mummichogs raise uncomfortable questions. A 1990 study discovered that one-third of the mummichogs from a notoriously polluted site had liver cancer, and more than 90 percent had precancerous lesions—rates that declined precipitously following cleanup efforts. Some residents wonder: If the chemicals in the Elizabeth have done all that damage to the fish, what are they doing to us?

By the time Lindsay Jasperse and Melissa Chernick pulled up to the chain-link fence surrounding the former Atlantic Wood Industries site, the late-July sun was already high in the sky. The researchers had left Di Giulio's lab in Durham, North Carolina, before dawn, charged with bringing back a new batch of mummichogs for the lab's experiments, and despite the heat they got right to work. Wearing masks and waders, they tossed a succession of stainless-steel minnow traps into the Elizabeth. Mummichog researchers used to bait the traps with high-end fish food, but then someone—no one remembers who—figured out that what the fish really like is cheap, store-brand hot dogs.

"They just love them," Chernick told me.

After anchoring their string of traps to a low-hanging branch, Jasperse and Chernick beat a quick retreat to their air-conditioned car and drove to another site to repeat the ritual. Each site is distinguished by a slightly different toxic stew, and because mummichogs only travel 300 to 500 meters from their birthplace during their lifetime, the researchers know that the fish they collect have only been exposed to the chemicals at their capture location. Through close study of the mummies at each site, the team hopes to better understand how the pollutants influence living systems.

"Unlike most coastal fish, if you catch a killifish and see something about it—it has cancer or whatever—you can pretty well take it to the bank that it is due to something where you caught it," Di Giulio told me. "The fish didn't bring it in from New Jersey."

After two hours, Jasperse and Chernick returned to their starting point and hauled in their traps. The first was mostly empty. The next trap, however, was filled with dozens of mummichogs—a mass of mottled olive backs and pale bellies, flashing in the sun as the fish struggled to escape.

The researchers emptied the trap into a large bucket of water and began sorting the fish by size and sex: Larger mummies with round bellies are older and healthier than their smaller counterparts, making them more likely to produce lots of eggs or sperm back in the lab. Those were gently placed in a large cooler for the four-hour drive back to Durham; the smaller fish were returned to the river. As Chernick and Jasperse bent over the bucket, their waders puddled around their feet to relieve the oppressive heat, a passerby gave a shout.

"Y'all catchin' crawfish?" he hollered.

Jasperse shook her head. "Mummichog!" she called back.

The man raised an eyebrow beneath his tattered baseball cap. "That's a lot of bother for some bait," he said.

While Jasperse and Chernick finished sorting their catch, they explained that specific sites on the river had high levels of pollution that would have likely killed most species of fish, and that they were trying to figure out why this one had survived. The man nodded at this explanation and walked away; inquisitive passersby are rare, but the researchers are used to answering the most common questions:

Are the sites being cleaned up? Some have, and others will be.

Does the creosote harm the fish? Yes, the chemicals are hard on their livers, and might cause longer-term problems, too.

Will the pollution cause similar problems in humans? Scientists aren't sure. Though creosote contains substances that are carcinogenic in both fish and humans, it's unclear what the developmental effects observed in fish might mean for us. But mummichogs do give toxicologists like Di Giulio an opportunity to understand if and how organisms can adapt to heavily polluted environments.

The mummichog's remarkable survival abilities were first recognized in the early 1970s, when the marine ecologist Judith S. Weis and her husband, Peddrick, decided to use the species to investigate the effects of the toxic chemical methylmercury on marine life. They collected mummichogs in Montauk, an unpolluted spot at the tip of Long Island. Back in the lab, the couple spawned them and raised the embryos in water containing methylmercury. The eyes of some embryos, they found, were closer together than usual; a few were so close that they formed a single cyclopic eye. Many also had heart and skeletal problems. But a few appeared to be completely unscathed by their noxious surroundings. And when the couple later performed the same experiments on fish from a polluted area in New Jersey, the embryos were nearly all resistant.

Elsewhere along the Eastern Seaboard, scientists found other mummichog populations that could tolerate staggering pollution levels. Some researchers worried that their persistence provided ammunition to those who argued against cleanup: If these fish could survive, perhaps the pollution wasn't that bad. But when Wolfgang Vogelbein, an animal pathologist at the Virginia Institute of Marine Science, or VIMS, anesthetized some mummichogs from the Elizabeth and filleted them open, he found that their livers were mottled and visibly enlarged. Their surfaces were covered in nodules and bumps, as if the organs had a bad case of acne. In total, Vogelbein found that 93 percent of the mummies near Atlantic Wood had liver problems, and one-third had cancer. Other studies found that mummies living near industrial sites in New York, Boston, and Los Angeles also had elevated rates of liver problems.

"Fish like the mummichog—these fish are smoking four packs of cigarettes a day, and they can't quit," says Michael Unger, an environmental chemist and a colleague of Vogelbein's at VIMS. "Their environment is contaminated. And we're all exposed to these compounds daily. They're everywhere."

Di Giulio first heard about the mummichog work being done by scientists at VIMS about 25 years ago, as a freshly minted Ph.D. toxicologist at Duke. He learned that when researchers placed mummichog embryos from the unpolluted waters of the York River—50 miles north of Norfolk, Virginia—into aquariums with sediment from the Atlantic Wood site, all the fish died. But when the Atlantic Wood

offspring were raised in clean laboratory water, those fish also struggled. In order to survive in the Elizabeth, it seemed, the population had reduced its ability to live in clean water.

Mummies in polluted sites along the Elizabeth River and elsewhere on the Atlantic and Gulf Coasts had somehow found a way to tolerate highly polluted water. What Di Giulio wanted to know was whether the fish had just acclimated to the pollution or had evolved a tolerance for it.

The mummichog fish smoke four packs of cigarettes a day due to contaminated environments.

The difference is important: If you or I were to travel to a Mount Everest base camp, we would initially struggle to breathe in the oxygen-depleted air, but our bodies would start to produce more red blood cells to help us cope in that environment. Once we returned to sea level, our bodies would return to normal. That's acclimation. Some of the Indigenous peoples who live high in the Himalayas, however, have inherited genetic adaptations that let their bodies make more efficient use of scarce oxygen. If they were to travel to Virginia, they would have the same physiology, no matter how long they stayed. This is what scientists call adaptation.

With his colleague Joel Meyer, Di Giulio collected some Elizabeth River mummichogs and raised several generations of them in large aquariums filled with clean water and mud. Despite their lack of exposure to the river's contaminants, these subsequent generations of Atlantic Wood fish continued to show increased resistance to the birth defects elicited by these compounds when placed back in dirty water to breed compared to control-site fish. Whatever enabled the mummichogs to survive in the Elizabeth was clearly heritable—a sign that the fish had genetically adapted to the pollution.

"It was like they were actually better off, at least in the short term, in the presence of these pollutants," Meyer says. But it came with a price. While the Elizabeth River mummichogs might have figured out how to survive these toxicants, they died after less than 90 minutes when exposed to a compound that became toxic when the fish were placed in direct sunlight—an hour sooner than the York River mummies. In the cloudy waters of the Elizabeth, with limited UV penetration, this wasn't an imminent problem, but it was worrying nonetheless.

In recent years, new genetic tools have allowed scientists to ask questions about the fish's ability to withstand pollution, however poorly, at the DNA level.

"How are these killifish doing this?" asks Andrew Whitehead of the University of California at Davis. "How did they get from this sensitive little fish to this super-resistant fish in, you know, a few dozen generations?" To find answers, he sequenced the mummichog genome, comparing genome sequences of 384 mummichogs from non-polluted sites with those from four highly polluted areas, including the Elizabeth River. All the mummichogs from polluted sites exhibited modifications in genes that code for proteins that help regulate the detoxification of chemicals such as polycyclic-aromatic hydrocarbons, polychlorinated biphenyls, and many other harmful chemicals. Whitehead concluded that only mummichogs with variations in these genes can survive in tainted waters.

A follow-up study revealed that the species has a tremendous reservoir of genetic diversity, making it more likely that at least a handful of fish were naturally more able to tough it out in toxic watersheds and live long enough to pass on their genes. And while it didn't prepare them to cope with pollutants, the fish also had to tolerate changes in salinity and temperature, since they lived in shallow, tidal waters, Di Giulio explained.

"They're a tough fish," he said. When the rare mummie escapes from its tank, it can survive on the dry floor for a while before being rescued. Other species would have been long dead, but the mummichog is no worse for wear.

The irony is that scientists know far more about the effects of the Elizabeth's pollution on mummichogs than about the river's impact on its tens of thousands of human neighbors. As Di Giulio and other biologists unraveled how the mummichog adapts to poisoned waters, a few residents of Norfolk and the nearby city of Portsmouth were asking how the same chemicals were affecting their families.

As she does most afternoons now, Pat Burns sat outside her Portsmouth home on a rickety folding chair with a basket of old fabric. While her granddaughter played with Tonka trucks on the sidewalk, Burns crocheted together rags, draping the rug in progress over her lap. For someone who has spent most of her adult life as an activist, these quiet afternoons are a novelty.

Since leaving Jamaica and immigrating to the U.S. in her early 20s, Burns has lived near the Elizabeth's polluted waters. When she moved to Portsmouth in 1989, she could often smell the river before she saw it.

"It was awful," she told me, with a shake of her long gray braids. "I just … I can't even describe it."

Everyone knew that the Elizabeth was polluted, but it didn't stop Burns's neighbors from fishing in the river and eating their catch. Free food was hard to pass up, Burns said, especially with few grocery stores within walking distance.

As an activist, Burns often spoke at city-council meetings on issues ranging from public housing to education to mass transit, and she noticed that the pollution in the Elizabeth River never seemed to appear on the agenda. Burns had long suspected that the smell she endured as a young woman meant that health threats were lurking below the river's surface.

She has plenty of nearby beaches to visit, but that's not the point, she said: "I shouldn't have to go to the reservoir to go fishing. I should be able to go right downtown. I should be able to jet-ski from right here."

Few other locals spoke up about the pollution until Marjorie Mayfield Jackson, a local newspaper reporter, left her job to found the nonprofit Elizabeth River Project in 1991. Unlike Burns, the ERP had enough connections and social influence to convince corporations to clean up their act. Early on, Burns helped plant sedges and marsh grasses as part of an

ERP-led restoration of Paradise Creek, a tributary of the Elizabeth River that winds through Portsmouth. The ERP has also built dozens of oyster reefs, which are designed to filter the river's water.

Many of these projects have been organized by Joe Rieger, who has worked with the ERP for the past 18 years. I first met Rieger not far from the former Atlantic Wood site where Chernick and Jasperse baited their traps. Our brief introductions on the side of the road were drowned out by the deafening rumble of dump trucks and tractor trailers driving to and from the nearby industrial sites. Motioning me away from the racket, Rieger led me between a chain-link fence and a dense stand of phragmites. Gesturing at an expanse of bare grass the size of several football fields and dotted with squat cement fuel silos, he welcomed me to Money Point, a crescent of land along a bend in the southern branch of the Elizabeth River.

The ERP began working on a cleanup of this site in 2006, eventually carting away 39 million pounds of toxic sludge. After removing or capping the creosote-laden sediment, ERP contractors installed an oyster reef. With funds from local industry and the Environmental Protection Agency, Rieger and the ERP then planted five and a half acres with native flora. After more than a decade of work, polycyclic-aromatic hydrocarbon levels at Money Point have dropped from some of the highest in the region to levels similar to nearby unpolluted areas.

Rieger led me up a small rise covered in marsh grass, dogwoods, flowering asters, and other native plants. The leaves of a holly tree tugged at his blue chinos as we picked our way through the brambles and down the other side of the berm. A hundred feet in front of us were the muddy waters of the Elizabeth, ambling toward the Atlantic.

For the ERP, the Money Point project is a shining star. But for the area's few remaining residents, the restoration isn't nearly enough.

In the 1980s, construction of Interstate 464 divided Money Point and the South Hill neighborhood from the rest of South Norfolk. The city rezoned the area west of the highway as industrial, leaving its residents physically and financially stranded. Due to this rezoning, new houses and additions can't be built. The residents can't sell their property, either, since no one will move in. These homeowners, Rieger observed, are no more mobile than the mummichogs.

We knocked on several doors to see if residents would talk about their experiences. No one answered, their doors locked tight against noise, pollution, pandemics, and reporters. South Hill was a thriving neighborhood, Rieger said, until pollution and rezoning starved its life force.

Although no new creosote pollution threatens the river and those who live alongside it, other projects do. Several years ago, Virginia Natural Gas announced the construction of the Southside Connector pipeline. The connector became operational in 2019, linking the region's existing supply lines and crossing under the Elizabeth River on its eight-mile journey.

The community activist Kim Sudderth worried that the pipeline would not only pose a direct safety threat—its route passed close to an elementary school—but would also imperil the river's recovery. As the Virginia manager for Mothers Out Front, a group working to fight climate change and environmental racism at the local level, Sudderth knew that low-lying Norfolk's chronic flooding problem was getting worse because of climate change, and that the floods were already bringing pollution with them.

"Knowing that the water is contaminated—it's that threat multiplier," she told me. Flooding could damage her car, or even her home. "And now I might get this awful skin infection through the water," she says.

Sudderth said she doesn't need a cancer-ridden bait fish to know that the waters aren't healthy, but neither she nor anyone else knows much about the specific health threats the pollutants pose. VIMS is funding a community-based environmental-health study in which an interdisciplinary team of scientists—including mummichog researchers—will engage with community members such as Burns and Sudderth, documenting their river-related health concerns and laying the groundwork for a formal study of the pollution's effects on human health.

It's the type of work that Diane Nacci, a research scientist at the EPA, has often contemplated in her nearly 30 years of mummichog research. The clues contained in the fish, she told me, provide "a real unique opportunity and a really interesting way to try to estimate how these contaminants might affect human beings."

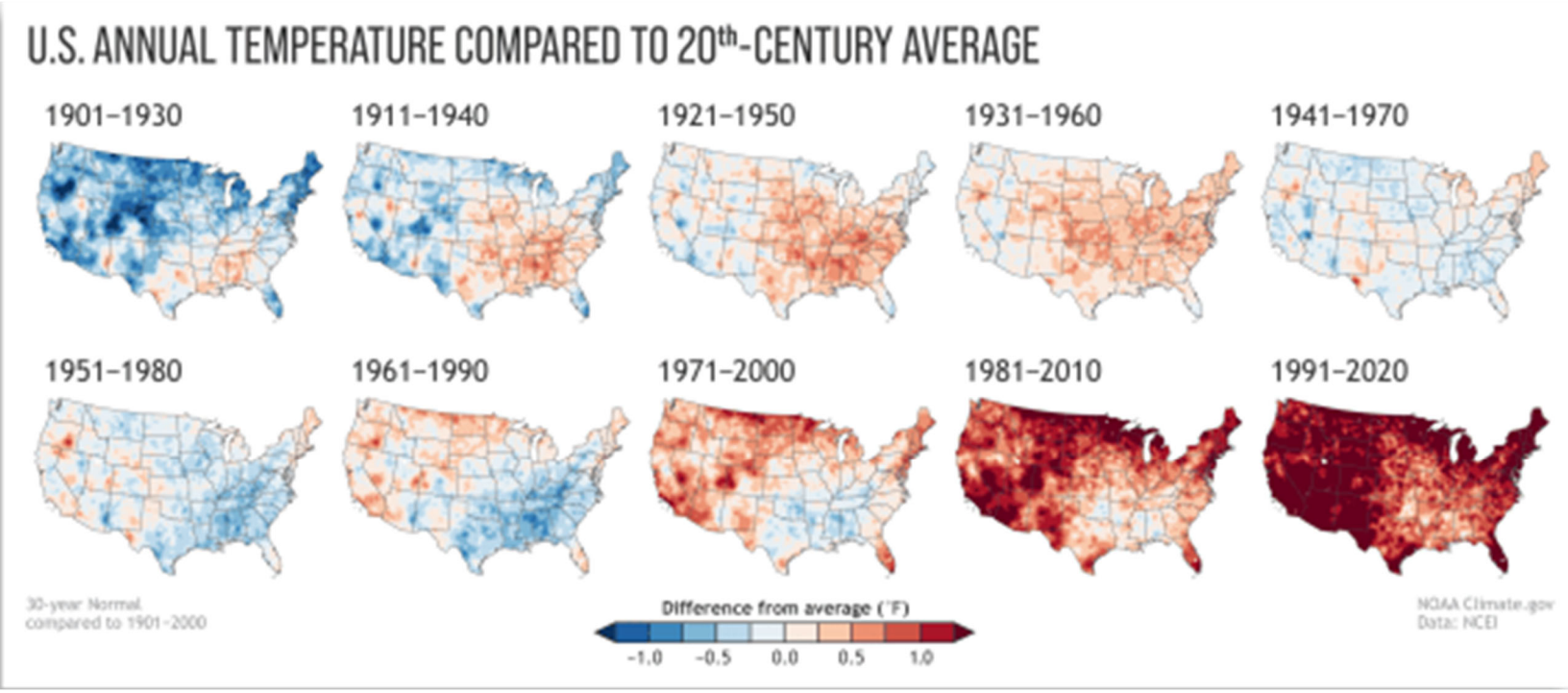
For Burns, the community-health study is a huge relief. She has been worrying about the dangers posed by the river's pollution for nearly half a century; that someone is finally investigating her concerns, even by way of a common bait fish, means that she might one day get some answers.

"Every time I hear about something else that's positive, I get really excited, because there's a possibility of the future being better," she said.

With the mummichogs that Jasperse and Chernick captured this summer, Di Giulio's lab is studying some of the more subtle impacts of polycyclic-aromatic hydrocarbons and other pollutants. Jasperse has found preliminary evidence that long-term creosote exposure alters mummichog behavior; the team is also beginning to perform direct studies on mummichog brains. Whether the Elizabeth's creosote-laden waters have similar impacts on humans isn't clear, but the studies underscore that just because mummichogs have evolved to survive doesn't mean they're unscathed by their toxic lifestyle.

Now that the EPA has begun cleaning up some of the area's Superfund sites, toxicologists have documented a sixfold drop in liver cancer in mummichogs trapped at Money Point. Yet when Di Giulio analyzed the genomes of fish caught at Money Point in 2019, they hadn't reverted to their pre-polluted state. Persistent creosote exposure was still writ large in their DNA. And none of the fish that Jasperse and Chernick collected in the past two summers showed signs of regaining their species' original physiology. "It's going to probably take awhile for these fish to re-evolve and then go back to the wild type," Di Giulio said. But if the river stays clean, they eventually should.

Standing near the edge of the Elizabeth at Harbor Park, where the river's eastern and southern branches converge before traveling on to the Atlantic, Sudderth and I discussed the outlook for humans living near the river. As we chatted, a pale heron glided in on ghostly wings, landing silently on the decaying timbers of an ancient pier. It glanced at the two brightly clad bipeds standing on the grass, then disappeared behind a collapsed pylon. The Elizabeth might yet return to her former fetid glory—if all her species can get a chance to heal



This map of the U.S. heating up is horrifying

The U.S. looks like it's on fire.
By: Mark Wilson

Was it a hot day? Or is the world actually getting hotter over time? It's hard to be sure on a day-to-day basis. Isn't summer always a little too sweltering? Aren't there always a few unseasonably warm days in winter?

A new map proves it's not just you: The U.S. really is getting hotter, whether you live in California, Florida, or Indiana. The National Oceanic and Atmospheric Administration (NOAA) has tracked U.S. weather for more than a century. And every decade, it releases the latest 30-year average. An average is considered the "new normal." This month, NOAA released its latest new normal, the U.S. map from 1991 to 2020. (The last update only took us to 2010.)

To put it bluntly, the map looks bad—especially when compared to the last 120 years of averages. What we see is that the nation has transitioned from a cool blue to a hot red—marking a 2.5-degree shift that happened in a blink of Earth's history. The U.S. looks like it's on fire.

Look closer, however, and you'll see the regional heat map does tell a slightly more nuanced story than "things are getting warmer." The entire West is now red, with mountainous areas like Colorado just as susceptible to global warming as the Nevada desert. You can see cities, like Chicago, which used to be cooler areas of the state, becoming hotter areas. (It seems likely that this is due to the urban heat island effect, in which concrete and buildings trap heat.) And then we have the East and West coasts. Both were painted in blue, even as late as the 1980s. Now they're deep, solid red.

Maybe you're thinking, This looks overly dramatic. Indeed, the blue-to-red trend marks just a couple of degrees of temperature shift. But the fact is that this small temperature shift has a major impact on our global habitat. It takes just a few degrees to raise ocean levels enough to flood cities, to bleach the coral of our oceans, and to bring food production to its knees. This climate data looks dramatic because it has been visualized with a purposeful and proper scale.

"The influence of long-term global warming is obvious," NOAA writes of these trends. "The earliest map in the series has the most widespread and darkest blues, and the most recent map has the most widespread and darkest reds." I'm not sure how much clearer scientists can make the terrible reality of our environmental situation than that.

Australia is a terrifying preview of a world ravaged by climate change

by AJ Dellinger

After a year of historic drought and devastating, unprecedented wildfires, Australia is once again getting hammered by extreme weather. Over the course of the last week, the country has endured the worst flooding that it has experienced in nearly a century. The destructive downpour of water has already forced tens of thousands of people to abandon their homes in search of safety, and things are only expected to get worse this week, with more torrential rains expected through at least Tuesday.

While the storms, which have been ongoing for the last five days, have pummeled much of eastern Australia, perhaps no area has been hit harder than New South Wales, the most populous state in the

country. Nearly 20,000 people were evacuated there over the weekend, according to CNN. Gladys Berejiklian, the premier of New South Wales, said during a press conference Monday that 38 locations across the state have been designated as natural disaster areas and 19 evacuation orders have been issued, with more expected to come as conditions could worsen in the coming days. The Australian Bureau of Meteorology reported that more than 16 inches of rainfall have already hit the state, leading to significant flooding.

While no deaths have been reported from the rising water thus far, more than 500 rescue missions have been launched to save people who had their escape cut off by flooded roads. There have been several reports of houses uprooting and floating away, carried off by the unexpected rush of water. At least another inch of rain is expected Tuesday night, according to The Weather Channel, which could lead to as many as 54,000 people being displaced as they seek shelter from the storms.

The torrential rainstorms and resulting floods are unlike anything that Australia has seen in decades. Berejiklian referred to the flooding as a "one-in-100-year event" made worse by the devastating wildfires that Australia suffered last year and the ongoing coronavirus pandemic. "I don't know any time in our state's history where we have had these extreme weather conditions in such quick succession in the middle of a pandemic," she said during a press conference.

Most countries are not equipped to handle one-in-100-year weather events, which are defined as events that have a 1% chance of occurring in any given year. But the weather could not come at a worse time for Australia, which is still recovering from its worst wildfire season in over a century, too. In late 2019 and early 2020, record high temperatures combined with one of the worst droughts in recent memory to create the perfect conditions for wildfires to spread. They did just that, scorching 46 million acres of land, destroying nearly 10,000 buildings including 3,500 homes, and killing more than 1 billion animals. The country is still dealing with the fallout — economic and environmental — from those fires, and now it has a whole new climate change-related crisis on its hands.

Australia's experience with these once-a-century weather events should serve as evidence that extreme weather is getting worse and more frequent, and climate change is to blame. What were once outlier weather events, like the extreme cold in Texas last month, are becoming more common. And we are largely unprepared.

As the planet continues to warm, we will continue to experience more of these types of storms. While climate deniers will do things like point to snow and cold temperatures to try to disprove global warming, Australia serves as an indicator of what we can expect as the planet's temperature continues to rise: extreme weather of all kinds, hot and cold, dry and wet. And the gap between these so-called "100-year" events will continue to get smaller. Addressing climate change can help to hopefully minimize the damage to the planet in the future, but in the near-term, extreme weather is likely here to stay.

Dam reservoirs may be much bigger sources of carbon emissions than we thought

We thought dams were good for the environment, but they may actually release immense amounts of carbon.

By: Philip Kiefer

Dams were once thought to sequester carbon in the sediment that piled up in their reservoirs. But new research based on 30 years' worth of data, suggests they may release potentially huge amounts of carbon, and the problem may only be getting worse.

"Carbon emissions from dams had been significantly underestimated," wrote Matthias Koschorreck, a biogeochemist and the study's senior author, in a press release. Where climate policymakers had once considered them a carbon sink, he argues, they should now be thought of as a source.

Reservoirs hold a surprising amount of carbon. After a dam is built, its reservoir inundates fields, wetlands, and forests. And the water accumulates more dead plant material all the time: as streams and rivers dump plants from upstream, some of it sinks to the bottom.

"One of the main aspects of reservoirs is they trap a lot of sediment," says John Downing, director of the University of Minnesota Sea Grant. "They trap a lot of carbon." Taken together, he says, freshwater bodies of water are more important to the global carbon cycle than all the world's oceans.

The key is how quickly all of that plant material decomposes into greenhouse gases. When it's deep underwater, it rots slowly. Eventually, it may even become buried in low-oxygen mud, removing it from the short-term carbon cycle entirely.

"Sometimes you'll find bodies on the bottoms of lakes that have been there for decades, but they look like they went in yesterday," Downing says. Elsewhere, people have found intact meat from mastodons at the bottom of ponds, or the preserved wrecks of Roman ships.

But reservoir levels change depending on seasonal rainfall, agricultural patterns, and management decisions, and not all the carbon stays submerged.

According to the researchers' analysis of satellite data, an average of 15 percent of global reservoir area was dry between 1985 and 2015. That means that the drowned carbon those reservoirs accumulate could rot quickly in the open air.

Reservoirs used to irrigate crops tended to use far more of their water—averaging a quarter of their surface area dry—than those used primarily for hydropower. Meanwhile, reservoirs in the far north and around the equator were steadier than those in mid-latitudes. That's partly because more far northern dams are used for hydropower, and partly because seasonal cycles of drought and monsoon are more common near the equator.

Reservoirs therefore emit double the carbon they sequester, the researchers estimate.

That's especially significant since we're drawing down reservoirs more and more. This year, the Southwest is likely to activate the drought contingency plan and sharply curtail use of the Colorado River, as the huge reservoirs that supply cities and farms across the region fall to critical levels. (However, because those reservoirs largely fill deep desert canyons, they leave less exposed land than a reservoir on gentler terrain, like in Quebec.) All of California's major reservoirs are below historical averages.

But the exposed area is just one piece of an emerging portrait of the carbon emissions of reservoirs. Other recent research from Downing estimates that humans are pumping so many nutrients—a nice way of saying sewage and agricultural runoff—into lakes and reservoirs that by 2100 the waterways will cause half as much warming as our current fossil-fuel consumption.

That's because those nutrients spawn algae blooms, which then die en masse. As microorganisms break down the algae, they deplete oxygen and release methane. That process could also be accelerated by changing water levels, Downing says. "When you dry sediments out and wet them again, they're going to release a lot of nutrients, so you'll get a lot more mobile nutrient material."

A 2018 estimate (which wouldn't have included the recent calculations on water drawdown or nutrient levels) found that, in the tropics, hydroelectric power could create emissions on the same scale as fossil-fuel.

Of course, algae blooms aren't inevitable—they can be controlled by better fertilizer and sewage management. And reservoir drawdowns are the product of human decisions and policymaking as well.

But the findings might also apply to natural lakes, which are likely to experience more seasonal water levels as the climate warms.

"We're going to have a lot of lakes that are losing water," Downing says. "And we have new lakes being made in northern climates. I believe we're going to have more intermittent systems that could have really high rates of greenhouse gas released to the atmosphere."

After Us the Deluge Captures Images of a Sinking World

Kadir van Lohuizen photographed nations affected by climate change. His book documents the present, but offers a glimpse of the future.

Lohuizen's forthcoming photo book, After Us the Deluge: The Human Consequences of Rising Sea Levels, the climate crisis is fundamentally a water crisis. With the melting ice caps in Greenland as the catalyst for rising waters, the aftermath of their destruction, coupled with the complacency of governments, is leaving people in unlivable circumstances.

People in nations including Panama, Bangladesh, and Kiribati are witnessing the sea come up to their homes during high tides. The Netherlands and the United States, though well-protected in certain areas, continue to experience terrible storm surges near coastal cities, and large parts of Jakarta in Indonesia are predicted to be submerged by 2050. "We talk about the climate crisis, it seems that we always think that it wouldn't be as bad as predict-

ed," says Lohuizen. "It is strange that we don't act, although we know."

Lohuizen's goal is to go beyond publishing a traditional photo book in the hope of reaching a wider audience. Sections on the effects rising waters are having on six regions are authored by a mix of local politicians, scientists, activists, and journalists familiar with their countries' impending fates. While the accompanying photographs show the frightening consequences of human decisions, they also depict what Henk Ovink, the Netherlands' special envoy for international water affairs, calls in the book's introduction "the fine line between the power of nature and human hope."

Lohuizen's documentation of human experiences, and the struggle between people and nature, is a prevailing motif. In a photograph taken in Tebike Nikoora on Kiribati, a woman stands outside, watching as seawater overtakes dozens of sandbags. In an image from Jakarta, people walk through knee-level flood water after canals failed due to garbage buildup.

The dramatic and evocative imagery of dangerous ocean currents and flooding was achieved through Lohuizen's reliance on the tide table, data used to predict high and low tides. Lohuizen said shooting at high tide would be the best way for viewers to imagine the future severity of rising waters in coastal cities. "If you can show what happens already at high tides, you don't have to have a very wild fantasy to realize what would happen if the sea level would rise one, two, or three meters on top of that," he says.

Lohuizen also relied on drones, and even a kite rigged with a camera in the project's early stages, to show the fragility of coastal cities. "There was a very important component to have those aerials—and specifically for the Netherlands—because then you see, in some of the images, how close we are to the sea," he says.

Lohuizen, who hails from Utrecht, started this project in 2011 while he was working on a project about migration in the Americas. He has also photographed projects about the world's rivers and the diamond industry.

While the aerial shots show the relationship between rising waters and coastal cities, others show the attempts by residents to leave those places. In Bangladesh, boats fill Sadarghat, the main river port in the capital city of Dhaka, carrying people hoping to relocate from the delta. Similar situations are shown in Guna Yala, an indigeneous province in Panama, where Lohuizen captures a woman at the construction site of where her new home will be built. The idea of resettling communities, which Lohuizen documents in almost half of the countries he photographed, feels normalized yet controversial. "If people have to relocate, where do they go?" he asks. "I think in the US you have enough space, but in countries like Bangladesh, also the Netherlands or Indonesia, we don't have the space to relocate people."

In Jakarta, which is sinking at a rate between 15 and 25 centimeters a year due to the extraction of groundwater, most of the city floods during high tides. "They put the sandbags with the hope that the water doesn't come into their houses, which doesn't work. So they're almost used to that this has become part of their life," says Lohuizan. The Indonesian government intends to move the capital to Borneo and rebuild there, but, says Lohuizan, "the problem is that it seems that the government is moving and not the people."

Meanwhile, people in coastal Bangladesh are forced to migrate from their homelands to densely-populated inland cities. The University Corporation for Atmospheric Research estimates that about 18 million people currently live in the area likely to be affected by flooding caused by sea level rise. Panama is also grappling with migration challenges. The government approved funding to evacuate four of the 300 islands that are a part of the Guna Yala archipelago for reasons that include flooding in the Cartí River, vulnerability to extreme weather condi-


PHOTOGRAPH: KADIR VAN LOHUIZEN/NOOR

tions, and overpopulation. But budget obstacles and Covid-19 delayed the initiative. In addition, some of the islands' older population is hesitant to leave their ancestral grounds and culture behind, even as tsunamis and hurricanes grow worse.

Kiribati faces similar challenges, but remains at the forefront of the climate crisis "by acknowledging that climate-induced migration is inevitable," writes former president of Kiribati Anote Tong, who authored the "Pacific" section of the book. Tong implemented the concept of "migration with dignity," which was intended to be a community response that would help people successfully adapt to the nations they migrate to by training them to become employable there and educating them to meet the immigration qualifications of specific countries.

Even large, rich nations and cities may not fare well over the coming century. After Superstorm Sandy hit the eastern United States in 2012, New York City officials quickly began plans to build a wall around the lower half of eastern Manhattan. Boston and Philadelphia have similar plans to build flood-resistant waterfronts. But not every city has such an option. Miami, further down the eastern seaboard, is built on porous limestone that allows water to move more freely, and is more vulnerable to flooding in the coming climate crisis. Despite the continuing development of high rises in these cities, places like Miami Beach and some parts of the Bay Area are losing ground, which may ultimately force residents to relocate.

"We kind of have a tendency that we think that the problem really starts when the water is at your feet," says Lohuizen. "I realized when I was in Panama, but moreover, in Bangladesh, that if the land frequently floods and the water doesn't recede anymore, and if the soil becomes saline, and people can't grow their crops anymore, and then the drinking water becomes brackish, that's enough of a reason for people to start relocating, because they're losing their livelihoods. I can't stress enough that there's a real urgency in that this is happening as we speak."

Julia Martins de Sa / Milwaukee Journal Sentinel The Lake Michigan shoreline at South Shore Park in Milwaukee. Data from the U.S. Army Corps of Engineers' Detroit office show that all of the lakes have lower levels, with Lake Michigan and Lake Huron showing a drop of 14 inches from the same time last year. However, Lake Michigan is still 22 inches above its average level.

Water levels drop in Great Lakes after record-breaking highs in 2020

By: Milwaukee Journal Sentinel

Water levels decreased in all of the Great Lakes this spring, thanks to a lack of snowmelt and few rain-storms: Water levels have been climbing steadily in the Great Lakes since 2013.

Before that, historic low levels going back to the 1990s caused issues, too, forcing some cities to dredge out harbors and ports so boats could gain access. Fluctuating water levels also affect beaches, and recreation is affected, too.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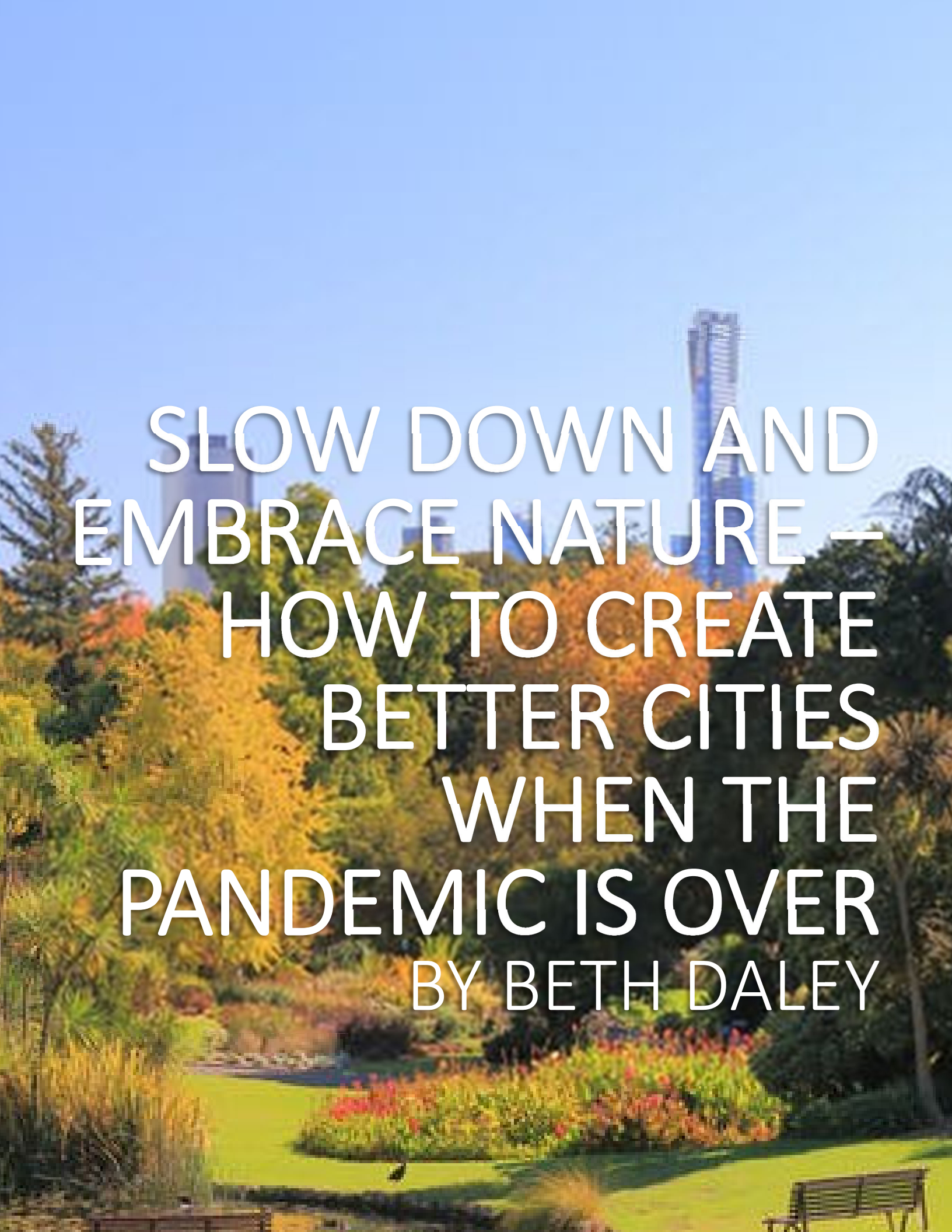


SLOW DOWN AND EMBRACE NATURE – HOW TO CREATE BETTER CITIES WHEN THE PANDEMIC IS OVER

BY BETH DALEY

Throughout the past year of working from home, I have gone for numerous morning, lunchtime and evening walks around my neighborhood in the Eastern parts of Lund in Sweden. My neighborhood has three dams for storing stormwater in the event of extreme rain. These help slow the water instead of overburdening the city's underground water sewage system, which would increase the risk of flooding.

It was at one of these stormwater dams where I first made friends with a beautiful and majestic heron. Like other birds, the heron seems to have found its home here – and it moves between the three dams depending on the time of the day.

I once saw the heron catching a fish, like a better version of one of these TV shows about nature. This vivid image of the heron with the fish has stuck with me – maybe because I observed it directly with my own eyes.

I find myself returning to the image of the fish-catching heron and pondering on the fact that this bird and I depend on the same ecosystem. The heron for habitat and food, I for recreational purposes (like my pandemic-induced walks) and being saved from flooding. We are so separate, and yet connected.

Multifunctional spaces

These dams aren't just a water management solution. When it's cold, they freeze over and provide ice-skating facilities. As well as looking visually striking, they also provide ecosystems and a habitat for animals and wildlife to thrive in.

This kind of multifunctional infrastructure is becoming increasingly popular, with many cities adopting so-called "nature-based solutions" to not just solve environmental problems and safeguard biodiversity, but to also provide local people with recreation space.

In the Naturvation project, which looks at the potential of nature-based solutions to transform cities, nearly 1,000 examples from 100 cities have been collected.

One of my favorite examples is Melbourne's Urban Forest Strategy, developed to adapt the city to climate change and to improve the wellbeing of people living there. The plan has seen the city increase the number of trees and green spaces.

It also involved setting up a database that maps all the trees in the city. Through this database, people have then been able to send e-mails to individual trees, as a way of connecting with and communicating their love for their favorite tree.

Human-nature links

Being aware of nature and its life-supporting functions, including how we as humans relate to it, is important. It helps our societies to function more sustainably and to recognize the symbiotic relationships we have with the plants and animals around us.

But as well as reflecting on and changing our relationships with the natural world we also need to rethink how we use space in a way that positions nature at the center of things.

This will not only help to ensure that we consider the natural world and people's wellbeing but it will also mean better access to green and blue spaces – such as parks, forests and meadows but also rivers, lakes, canals, waterfalls and even fountains. Inequality in terms of access to outdoor spaces has been highlighted during the COVID-19 lockdowns – with people having greater appreciation for the role nature can play in terms of mental and physical wellbeing.

A slow new world

In contrast with the highly efficient and accelerated

modern world, the pandemic has slowed things down. Many of us now spend less time rushing about, commuting and travelling long distances. Instead, we spend more time at home and in our local neighborhoods.

This shift has provided an opportunity for deep reflection about who we are and how we relate to nature. Indeed, many people have used this as an opportunity to escape the city and head to the countryside or the coast.

Against this backdrop, nature-based solutions offer promising options for the post-pandemic world. This is because, in terms of urban planning, it is an approach that, when implemented well, materializes nature-culture links, while also responding to some of the challenges around climate change adaptation in urban areas. Ultimately, we must work with nature – not against it – if we are to really move in the right direction.

Naturvation projects are nature-based solutions and adapting to climate changes.
Pictures provided by naturvation.eu

California Is Headed Toward Another Brutal Wildfire Season

Last year's blazes set state records. This year, the drought's even worse.

By: Dan Spinelli

A wildfire in Southern California grew to 1,325 acres on Sunday as roughly 1,000 Topanga Canyon residents had to be evacuated from their homes. Just like that, fire season has started again in California. As an extreme drought worsens across much of the state, 2021 is shaping up to be potentially another deadly year.

The state's warm climate and lack of rainfall makes it especially prone to wildfires, but nature is not the only reason large parts of California are regularly set ablaze every summer.

As Jeffrey Ball wrote for Mother Jones in 2019:

Today's monster fires result largely from three human forces: taxpayer-funded fire suppression that has made the forest a tinderbox; policies that encourage construction in places that are clearly prone to burning; and climate change, which has worsened everything.

That last point has become especially crucial as scientists have searched for ways to explain why the area covered by California's summer wildfires are eight times larger than they were in 1972. "This climate-change connection is straightforward," Park Williams, a bioclimatologist at Columbia University's Lamont-Doherty Earth Observatory, told the New York Times last year. "Warmer temperatures dry out fuels. In areas with abundant and very dry fuels, all you need is a spark."

The problem is only getting more dire. After a record year last year in which California fires burned an area "larger than the state of Connecticut," scientists are expecting an even worse season this summer, continuing a trend of earlier starts to fire season.

As Daniel Swain, a UCLA climate scientist, explained to CNN last week: "A combination of factors—including short-term severe to extreme drought and long-term climate change—are in alignment for yet another year of exceptionally high risk across much of California's potentially flammable landscapes."

Boat docks at the Browns Ravine Cove sit on dry earth at Folsom Lake on May 10 in El Dorado Hills.

The entire state of California is now in drought, just kindling waiting for an ignition

By Chad Myers and Monica Garrett, CNN Meteorologists

The title to the classic 1970s hit "It Never Rains in Southern California" has nothing to do with climate change or even precipitation for that matter, but it couldn't be more appropriate for the massive drought hitting the entire state this spring.

All of California is in drought, ranging from moderate (level D1) to exceptional (level D4). The last time this happened was in October 2014.

The drought has intensified, with the worst level now covering 14% of the state, up from 5% last week.

"Moving into dry season, California is expecting drought impacts to intensify during the summer months," this week's US Drought Monitor summary explains.

"There's no sugar coating it. It looks like fire season 2021 is going to be a rough one in California, and throughout much of the West, unfortunately," warns Daniel Swain, climate scientist for UCLA and The Nature Conservancy.

"A combination of factors -- including short-term severe to extreme drought and long-term climate change -- are in alignment for yet another year of exceptionally high risk across much of California's potentially flammable landscapes," Swain says.

Fire has now become a way of life in the Western states, just like severe weather is in the Plains. It is no longer if it occurs, but when, where and how bad.

The 2020 fire season was the worst in the state's history and 2021 could potentially be worse.

As of May 5, California has already seen seven times the amount of acres burned, compared to the same time frame last year.

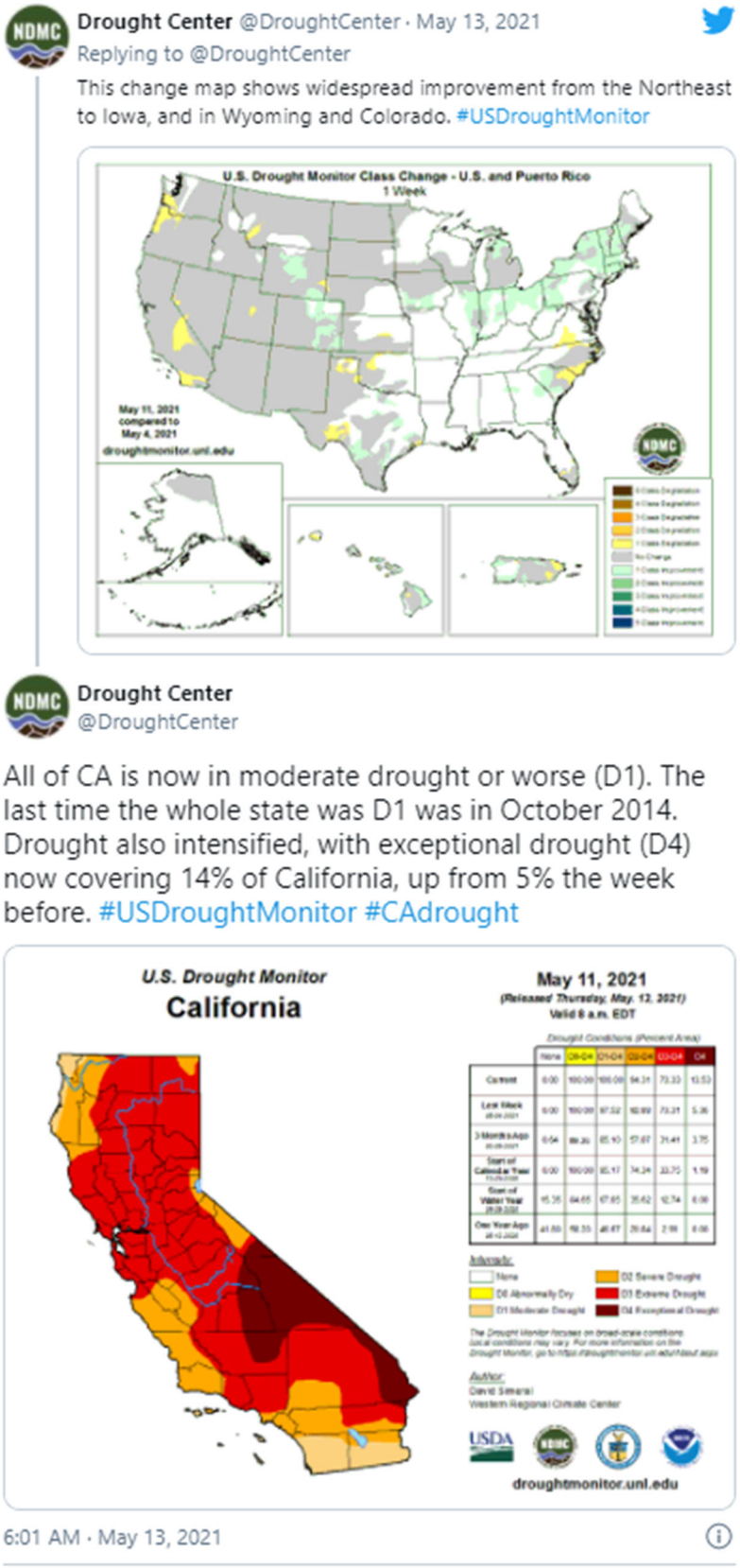
Gov. Gavin Newsom this week issued an emergency declaration for much of the state to deal with the drought crisis.

The declaration directs state agencies to take action to increase drought resilience, modify reservoir releases to conserve water, and allows for more flexible water transfers between rights holders.

Swain explains why this year's fire season is so concerning:

Some aspects of fire season are predictable, such as the state of the vegetation leading into it and temperature projections for the summer to come. Both of those point in the direction of an elevated risk.

Since vegetation conditions are currently



setting new records for dryness and flammability, and because the seasonal outlook continues to call for a warmer than average summer/autumn across most of California, it's easy to see why many folks are concerned.

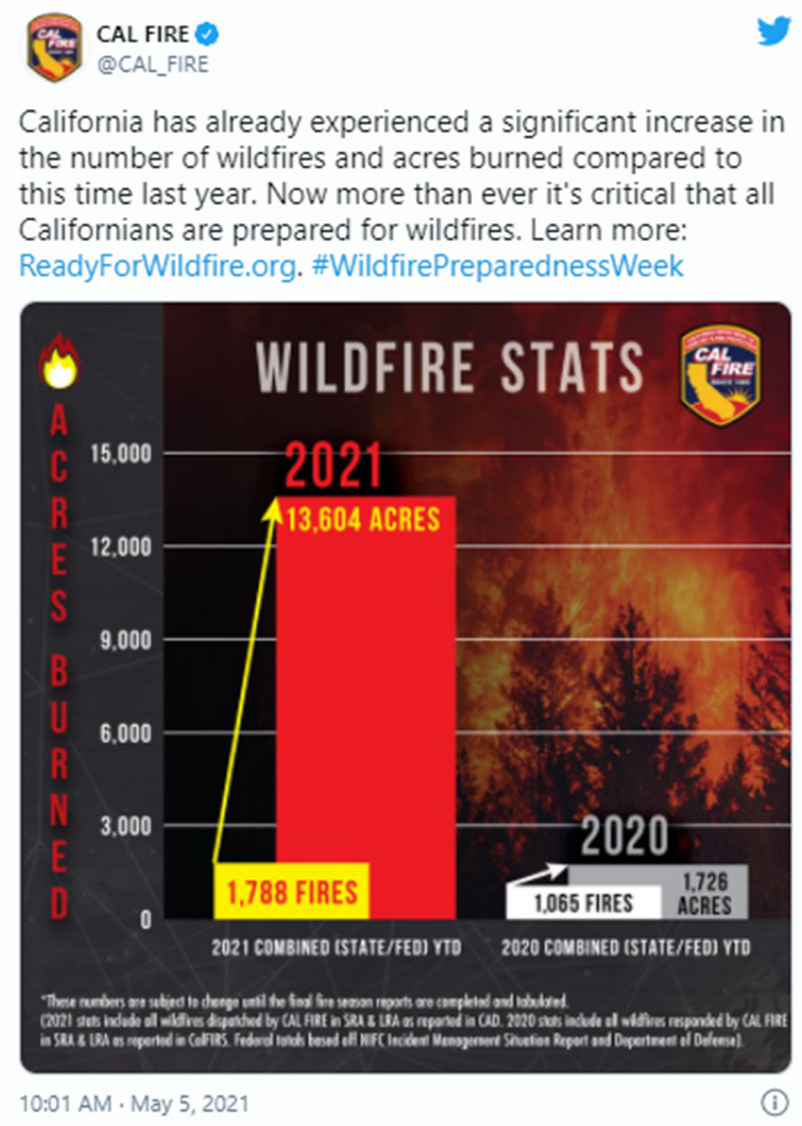
"Each year is unique. Drought helps set the stage," says Amanda Sheffield with the federal National Integrated Drought Information System.

Not enough snow to provide adequate water

"California and many parts of the West rely on snowpack for water resources. The poor snowpack, plus rapid spring snow melt has left areas of the West with not just low snow water equivalent (SWE) compared to normal for this date, but almost no SWE at all, including California at just 6% of normal and the Lower Colorado at just 4% of normal," says Sheffield, the California-Nevada regional drought information coordinator with the agency.

"There's essentially no snowpack left in the mountains," confirms Swain. "What's amazing to me as a climate scientist is to see the snow melt occur and then to see the rivers lakes and steams not responding. The soil under the snow is so dry that there is no runoff."

"This is one of the reasons why I think the highest increase in risk for wildfires will probably be in the forests. The risk of big true forest fires is going to be especially elevated in California," says Swain. He predicts the Sierra Nevada, the foothills ringing the Central Valley and the coastal forests including the redwoods are very much at risk.



Other states in the West also are dealing with extreme water shortages.

The snowpack in all of the states west of the Continental Divide is below normal and early-season warm weather is melting much of what's there.

"Severe and still-worsening drought, extremely dry vegetation, plus strong expectation of a hotter-than-average summer are deeply concerning," says Swain.

The record 2020 wildfire season was not all human-induced. Millions of acres burned due to lightning strikes alone.

"Pretty much everything that happened between August and September (2020) was lightning activity throughout the state," says Isaac Sanchez, Cal Fire battalion chief of communications. "It was an unprecedented event that lead to a thousand, if not more, fire ignitions."

Wildfires burning in the west El Dorado Hills.

The SCU Lightning Complex, LNU Lightning Complex and North Complex fires -- all ignited by lighting -- consumed over a million acres last year. Affected counties included Santa Clara, Alameda, Contra Costa, San Joaquin, Stanislaus, Napa, Sonoma, Lake, Yolo, Solano, Plumas , Butte and Yuba.

Lightning-induced fires typically start in remote and hard-to-fight areas in the Sierras, but often are blown by wind into cities and towns in the fire's path.

Firefighting assets may be stretched

With all of California in some level of drought, lightning again may contribute a significant percentage of burned acreage in 2021.

"I wish there was one item that we could point to and say, here it is, if we could just fix this one thing, everything would be better. But it's a combination of things," says Sanchez. "Primarily, what we are seeing is the increased window in which a destructive wildfire will burn. It's starting earlier in the year and lasting deeper into the year."

"The results are drier conditions sooner than we've ever had them before, which once a spark is introduced into the environment, it's just a hop, skip and a jump before it turns into a large destructive fire." Sanchez adds.

Firefighting efforts in the West often rely on mutual aid. Assets are moved from one area not experiencing fire to other areas that are. That concentrated effort may be in jeopardy this year with widespread fires occurring in many states.

"Everything from the Rocky Mountain continental divide westward, including Colorado, Utah, Nevada, Arizona and New Mexico have fire conditions that look really, potentially explosive. The drought is even worse in those places than in California," says Swain. "It looks pretty likely that it will be a severe fire season across most of the West."

Study exposes global ripple effects of regional water scarcity

By Syl Kacapyr

Water scarcity is often understood as a problem for regions experiencing drought, but a new study from Cornell and Tufts universities finds that not only can localized water shortages impact the global economy, but changes in global demand send positive and negative ripple effects to water basins across the globe.

"We are looking at water scarcity as a globally connected and multi-sector phenomenon," said Jonathan Lamontagne, M.S. '14, Ph.D. '15, assistant professor of civil and environmental engineering at Tufts University, who co-authored the study with Patrick Reed, the Joseph C. Ford Professor of Civil and Environmental Engineering at Cornell. Tufts graduate student Flannery Dolan is lead author of the study, which suggests water scarcity dynamics are more complicated than traditionally acknowledged.

The study, "Evaluating the economic impact of water scarcity in a changing world," was published March 26 in Nature Communications, and uniquely captures the interdependent effects of global trade consistently with differences in regional climate policies as well as river basin-specific capacity to address water scarcity risks.

The researchers coupled physical and economic models to simulate thousands of potential climate futures for 235 major river basins – a technique known as scenario discovery – to better understand how water scarcity is a globally-connected phenomenon, with local conditions having reverberations across the globe in industries such as agriculture, energy, transportation and manufacturing.

The research found that global trade dynamics and market adaptations to regional water scarcity result in positive and negative economic outcomes for every regional river basin considered in the study.

For instance, in the lower Colorado River basin, the worst economic outcomes arise from limited groundwater availability and high population growth, but that high population growth can also prove beneficial under some climatic scenarios. In contrast, the future economic outcomes in the Indus Basin depend largely on global land-use policies.

"What is happening elsewhere in the world through differences in regional choices related to energy transitions – how land is being managed as well as different regional water demands and adaptive choices – can shape relative advantages and disadvantages of water intensive economic activities," said Reed.

Restrictions in water availability usually lead to a negative regional economic impact, but the research revealed that some regions can experience a positive economic impact if they hold an advantage over other water basins and can become a virtual exporter of water. The Orinoco basin in Venezuela, for example, usually has a reliable supply of water and is often in a relative position that can benefit when other regions are under stress, according to the researchers.

The study also found that small differences in projections for future climate conditions can yield very large differences in the economic outcomes for water scarcity.

"Human activities and market responses can strongly amplify the economic effects of water scarcity, but the conditions that lead to this amplification vary widely from one basin to the next," said Lamontagne.

A river basin can be considered economically robust if it is able to adapt to drought with alternative sources of water or adjust economic activity to limit usage. If a basin is unable to adapt its supply options and if prolonged water scarcity leads to persistent economic decline, then the researchers describe the loss in water basin adaptive capacity as having reached an 'economic tipping point.'

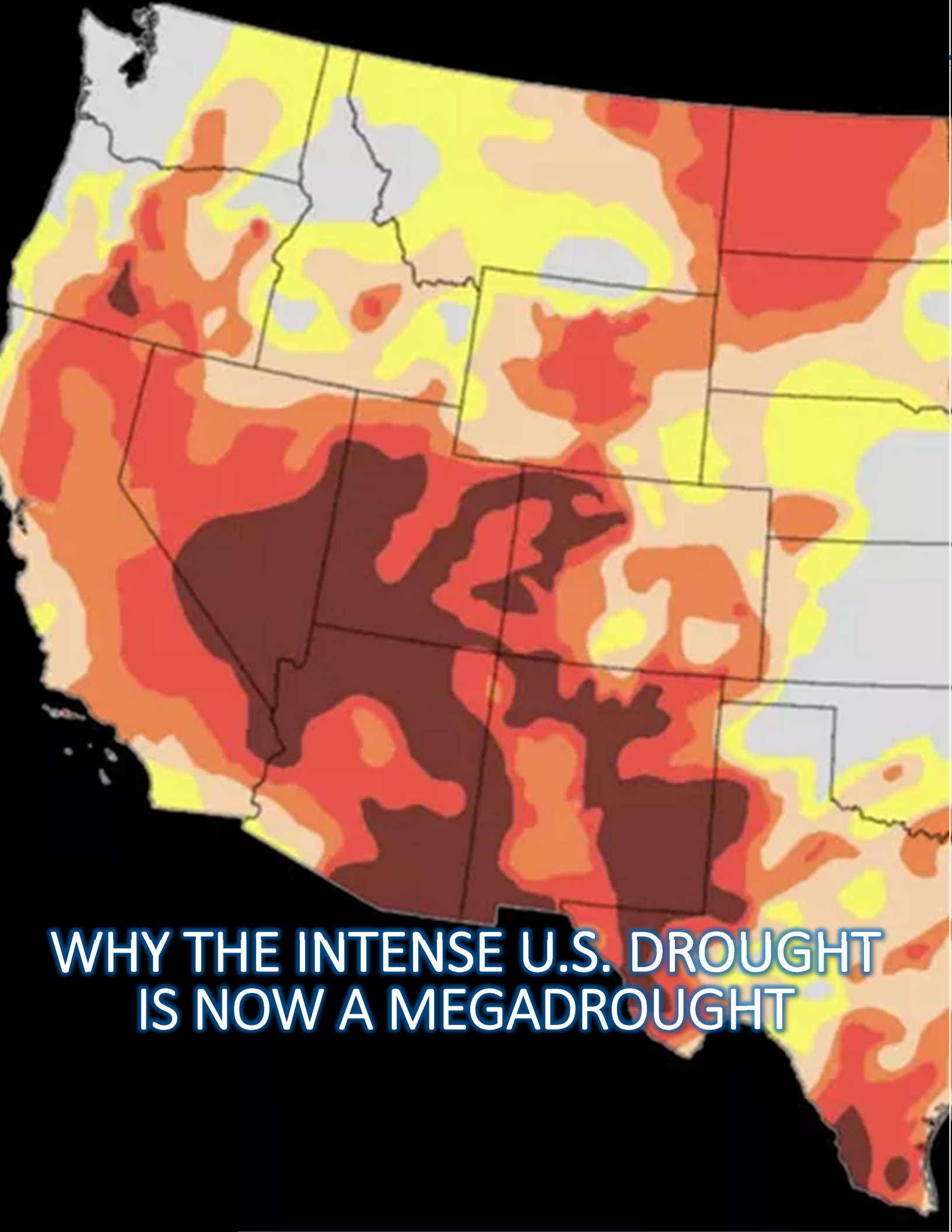
For example, in the Indus region in South Asia, the water supply is under stress due to heavy agricultural use and irrigation leading to unsustainable consumption of groundwater, which places it close to the tipping point.

The conditions that lead to these tipping points are highly variable from basin to basin, depending on a combination of local factors and global conditions. In the Arabian Peninsula, low groundwater availability and pricing of carbon emissions are key factors. In the lower Colorado River basin, a mixture of low groundwater availability, low agricultural productivity, and strong economic demands from the U.S. and Europe lead to tipping points.

"It is noteworthy that the lower Colorado River basin has some of the most uncertain and widely divergent economic outcomes of water scarcity of the basins analyzed in this study," said Reed. "This implies that assumed differences in regional, national and global human system conditions as well as the intensity of climate change can dramatically amplify the uncertainty in the basin's outcomes."

As climate change makes the physical and economic effects of water scarcity more challenging for policy makers to understand, the researchers hope their work will provide the basis for similar analyses and draw attention to the importance of expanded data collection to improve modeling and decision making.

The study was co-authored by researchers from the Joint Global Change Research Institute at the Pacific Northwest National Laboratory, and was supported by the U.S. Department of Energy's Office of Science.


WHY THE INTENSE U.S. DROUGHT
IS NOW A MEGADROUGHT

The water keeps going down.

Almost the entire Southwest is mired in various stages of drought as of April 21, 2021, resulting in falling water levels at the nation's two largest reservoirs, Lake Mead and Lake Powell. The consequences could be unprecedented. For the first time in Lake Mead's 85-year existence, water levels may drop below a point this summer that triggers water cuts in Arizona and Nevada. (This would largely mean cuts to farmers and agriculture.)

Geological and climate records show that sustained droughts, lasting decades, come and go in the Southwest. But the current prolonged drying trend, which started some 20 years ago, is exacerbated by a rapidly warming climate. This makes the current drought not just long, but especially intense.

"It's two decades long and probably the worst drought in at least 400 years," said Benjamin Cook, a research scientist at Columbia University's Lamont-Doherty Earth Observatory who studies drought.

The big picture is clear. In the last 50 years, precipitation trends in the Southwest haven't changed much and remained mostly flat, explained Jonathan Overpeck, a climate scientist at the University of Michigan who researches Southwestern drought. Yet, the amount of water flowing in the region's major artery, the Colorado River, has dropped significantly — by 16 percent — in the last century. The land is drying out, too. "The only thing that's changing in a big way is temperature," said Overpeck.

"[Droughts are] going to get worse and worse unless we stop global warming," he added.

Indeed, Earth's temperature will continue to rise in the coming decades, but just how much depends on the amount of heat-trapping greenhouse gases civilization emits. Currently, humanity is on course to warm Earth by over 5 degrees Fahrenheit (3 degrees Celsius) by the century's end. The last time it was that warm, sea levels were some 30 feet higher and giant camels roamed the high Arctic.

A warmer Southwest — some regions of which have warmed by well over 3.6 F (2 C) since the late 19th century — evaporates more water from rivers and the nation's sprawling reservoirs. On mountains, more snow directly evaporates into the air in a process called sublimation, meaning less water ultimately flows into rivers. And, crucially, the region's trees and plants are losing bounties of water to the warming, dry air. "They're losing a lot of moisture," explained Overpeck. These factors add up to a prolonged drying trend out West.

This certainly isn't a normal drought. "The reason this drought is so exceptional is likely because of climate change," emphasized Cook. "It makes it easier to get into a drought, and harder to get out. It makes droughts a bit more intense than they used to be."

But should today's drought be called a megadrought? Megadrought is a fuzzy term with no standard definition. Overpeck said "megadrought" is often used to describe a drought that's at least two decades long. Cook noted some researchers call it a megadrought, while others don't, but belaboring the nomenclature doesn't change what really matters: The drought is exceptionally dry and intense, and human-caused warming is likely playing an outsized role.

Droughts are cumulative, meaning it's unlikely one good year of rain will eliminate a long regional drought. In 2019, for example, we saw normal rainfall in parts of the Southwest and a pretty wet year in California. But 2020 dashed hopes for climbing out of a prolonged drought. On top of warmer temperatures, the region's typical summer rainfall failed, and California received just half of its normal precipitation this winter. An important rain-fed reservoir has dried up in Northern California. The drought continues.

It's always possible a surprise late-season rain or snow changes the trajectory of the current drought, like 2014's impressively wet "Miracle May." But that's unlikely. "That's a hope against hope," said Overpeck. "That's like buying a lottery ticket."

Overall, the evidence points to an increasingly drying Western world. This demands improved water conservation, especially in water-gulping agriculture. Lake Mead, the nation's largest reservoir, is now about 40 percent full. "It's pretty dire," said Overpeck.

BY MARK KAUFMAN

Vegas pushes to become first to ban ornamental grass

A desert city built on a reputation for excess wants to become a model for conservation with a first-in-the-nation policy banning grass that nobody walks on

By SAM METZ and KEN RITTER Associated Press

A desert city built on a reputation for excess and indulgence wants to become a model for restraint and conservation with a first-in-the-nation policy banning grass that nobody walks on.

Las Vegas-area water officials have spent two decades trying to get people to replace thirsty greenery with desert plants, and now they're asking the Nevada Legislature to outlaw roughly 40% of the turf that's left.

The Southern Nevada Water Authority estimates there are almost 8 square miles (21 square kilometers) of “nonfunctional turf" in the metro area — grass that no one ever walks on or otherwise uses in street medians, housing developments and office parks.

They say this ornamental grass requires four times as much water as drought-tolerant landscaping like cactus and other succulents. By ripping it out, they

cactus and other succulents. By ripping it out, they estimate the region can reduce annual water consumption by roughly 15% and save about 14 gallons (53 liters) per person per day.

Las Vegas might be known for splashy displays like the Bellagio fountains on the neon-lit Strip, but officials say residents of bedroom communities and sprawling suburbs embrace conservation measures, including aggressive monitoring of sprinklers and leaky irrigation systems.

“The public perception outside of Las Vegas is certainly much different — and has been for a long time — than the water conservation ethic within the community,” said Colby Pellegrino, Southern Nevada Water Authority water resources director.

California imposed a temporary ban on watering ornamental grass during last decade's drought, but no state or major city has tried to phase out certain categories of grass permanently.

“The scale of this is pretty unprecedented in terms of a full ban on this nonfunctional turf,” said John Berggren, a water policy analyst at Western Resource Advocates.

The proposal is part of a turf war waged since at least 2003, when the water authority banned developers from planting green front yards in new subdivisions. It also offers owners of older properties the region's most generous rebate policies to tear out sod — up to $3 per square foot.

Those efforts are slowing. The agency says the number of acres converted under its rebate program fell last year to six times less than what it was in 2008. Meanwhile, water consumption in southern Nevada has increased 9% since 2019.

Last year was among the driest in the region's history, when Las Vegas went a record 240 days without measurable rainfall. And the future flow of the Colorado River, which accounts for 90% of southern Nevada's water, is in question.

The waterway supplies Arizona, California, Colorado, Utah, Nevada, New Mexico, Wyoming and Mexico. As drought and climate change decrease what the river provides, the amount allocated to Arizona, California and Nevada is projected to be cut further.

Justin Jones, a Clark County commissioner who serves on the water authority's board, doesn't think ripping out ornamental turf will upend people's lives.

“To be clear, we are not coming after your average homeowner’s backyard,” he said. But grass in the middle of a parkway, where no one walks: “That's dumb."

"The only people that ever set foot on grass that’s in the middle of a roadway system are people cutting the grass,” Jones said.

The agency has different regulations for yards and public parks. Based on satellite imaging, it believes banning ornamental grass will primarily affect common areas maintained by homeowner associations and commercial property owners.

Jones said the proposal has drawn resistance in some master-planned communities, but water officials say years of drought-awareness campaigns and policies like the rebates have cultivated a cultural change.

Southern Nevada Homebuilders’ Association lobbyist Matt Walker said consumer preferences have reached the point that potential homebuyers from wetter regions aren't turned off from neighborhoods that have parks but no ornamental grass.

Conservation frees water, reduces per capita consumption and strengthens builders’ arguments that the desert can accommodate more growth, Walker

said. "And the benefits are the ability to keep doing what we do, which is building homes."

"We've really gotten a comfort level that buyers are very much willing to go along with responsible development practices when it comes to water use," he added.

Other desert cities aren't so sure. Salt Lake City has an ordinance that requires a certain amount of yard and median greenery. Phoenix, where some neighborhoods remain lush from flood irrigation, has never offered grass removal rebates.

Water officials elsewhere are loath to compare their policies to southern Nevada. Particularly in cities where water consumption per person is high, they say there's no one-size-fits-all approach for a drier future.

Las Vegas, for example, mostly ignores toilets, showers and dishwashers because the water authority is able to treat and recycle indoor wastewater and let it flow through a natural wash into Lake Mead — the Colorado River reservoir behind Hoover Dam. It is filtered again for reuse.

A draconian anti-grass policy might not work in downtown Phoenix, said Cynthia Campbell, water resources adviser for the nation's fifth-largest city. Trees and grass blunt public health dangers of " urban heat islands " — areas lacking green landscaping to offset heat through evaporative cooling.

Regional water officials understand future consumption will have to be reduced but fear the preparation and perception could backfire if the community doesn't buy in.

"There comes a point when people's demands start to harden," Campbell said. "They'll say, 'This is the point of no return for me.' For some people, it's a pool. For some people, it's grass."

The Southern Nevada Water Authority isn't sure the idea of banning grass will spread to other cities. But Pellegrino, the water resources chief, said other places will have to make changes.

"Particularly every community that relies on Colorado River water."

Weird potatoes, bad berries, hazardous human conditions: Heat takes its toll on Northwest farming

By Anna King

Record heat across the Northwest is taking a toll on agriculture — both the crops and the workers who harvest them.

Central Washington farmer Alan Schreiber is worried about his fields.

“Melon, watermelon, tomatoes, eggplant, okra. What you call hot crops,” Schreiber says. “But they need a lot of water.”

Schreiber just found out his irrigation pump is only running at 30 percent capacity. It hit 117 degrees in his field Tuesday.

His new water pump won’t arrive until Friday. So now he’s having to make some hard choices.

“We have stopped watering our perennial crops, so we’re not watering our tree fruit, grapes and berry crops,” he says.

Schreiber says those fruits can hold up with less water.

Agriculture is stressed across the region. Blueberries are ripening so fast, processors can’t keep up. Potatoes, a valuable Northwest crop, are growing in weird shapes, making them hard to cut into fries. Dairy cows produce less milk when overheated, so operators are misting them with water and turning giant fans on them.

Weird potatoes, over-ripe berries

Northwest potatoes like heat. Just not this much. And they start doing weird things when it gets this hot. Some tubers sprout knobs or grow into dumbbell shapes.

Mike Pink farms near Pasco, Washington. He says some farmers might not even be able to keep their crops going if they were struggling at all before the heat wave.

“This heat is going to take the life out of some of these potatoes that were a little more stressed,” Pink says. “Or maybe they’re not going to live as long. So their life cycle is going to end quicker, so they won’t produce the amount of potatoes at the end that they could produce.”

Across the region, apple growers are keeping fruit cool with overhead sprayers. Blueberries are ripening so fast, farmworkers and berry processors are having trouble keeping up, according to Schreiber, who also directs the Washington Blueberry Commission.

“Western Oregon is getting hit by this, especially in the south. and eastern Washington is getting hit by this. And so there is a lot that’s going to get diverted into processing is my concern,” he says.

That means loads of over-ripe fruit might be left in the field, made into juice or dumped.

Farmworker peril

Of course, most in peril are humans. Heat is known to kill more people than any other weather-related event. Some workers are picking cherries at night under floodlights.

Gonzalo Rodriguez is a farmworker supervisor. He says after early morning work his farmworkers hide in air-conditioned housing watching TV, napping or calling family.

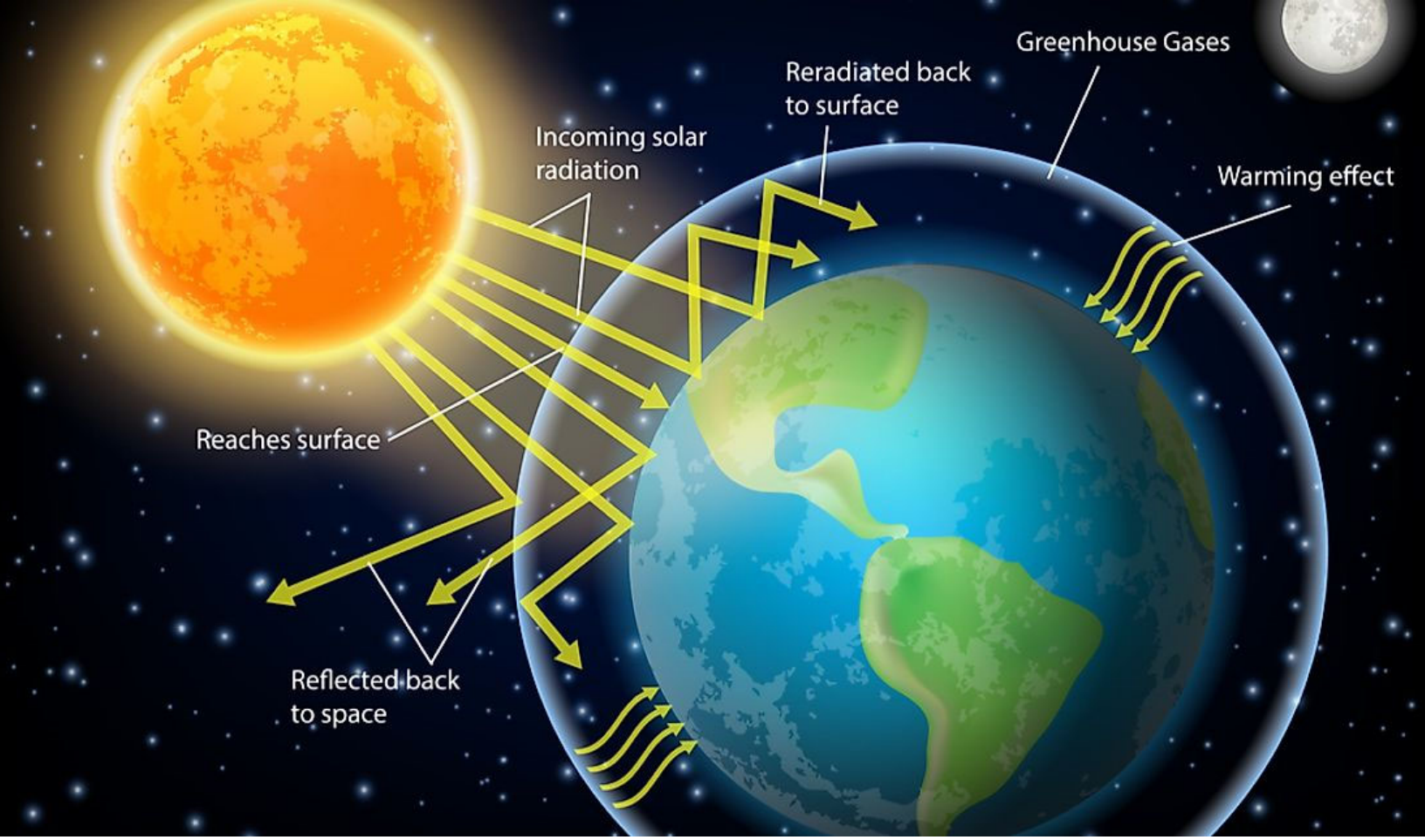
“You really get tired when you wake up at 4 (a.m.) you start to work at 5 and you finish at 10 or 11 or maybe noon. And then, what you really want and need is to eat and sleep,” Rodriguez says.

The death of a farmworker in Oregon over the weekend is being investigated as heat-related, according to the state’s worker safety agency.

The Associated Press reported Tuesday:

“The United Farm Workers urged Washington Gov. Jay Inslee to immediately issue emergency heat standards protecting all farm and other outdoor workers in the state with a strong agricultural sector. The state’s current heat standards fall short of safeguards the UFW first won in California in 2005 that have prevented deaths and illnesses from heatstroke, the union said in a statement.”

The National Weather Service forecasts the high temps above 100 to continue for large parts of the Inland Northwest into next week.

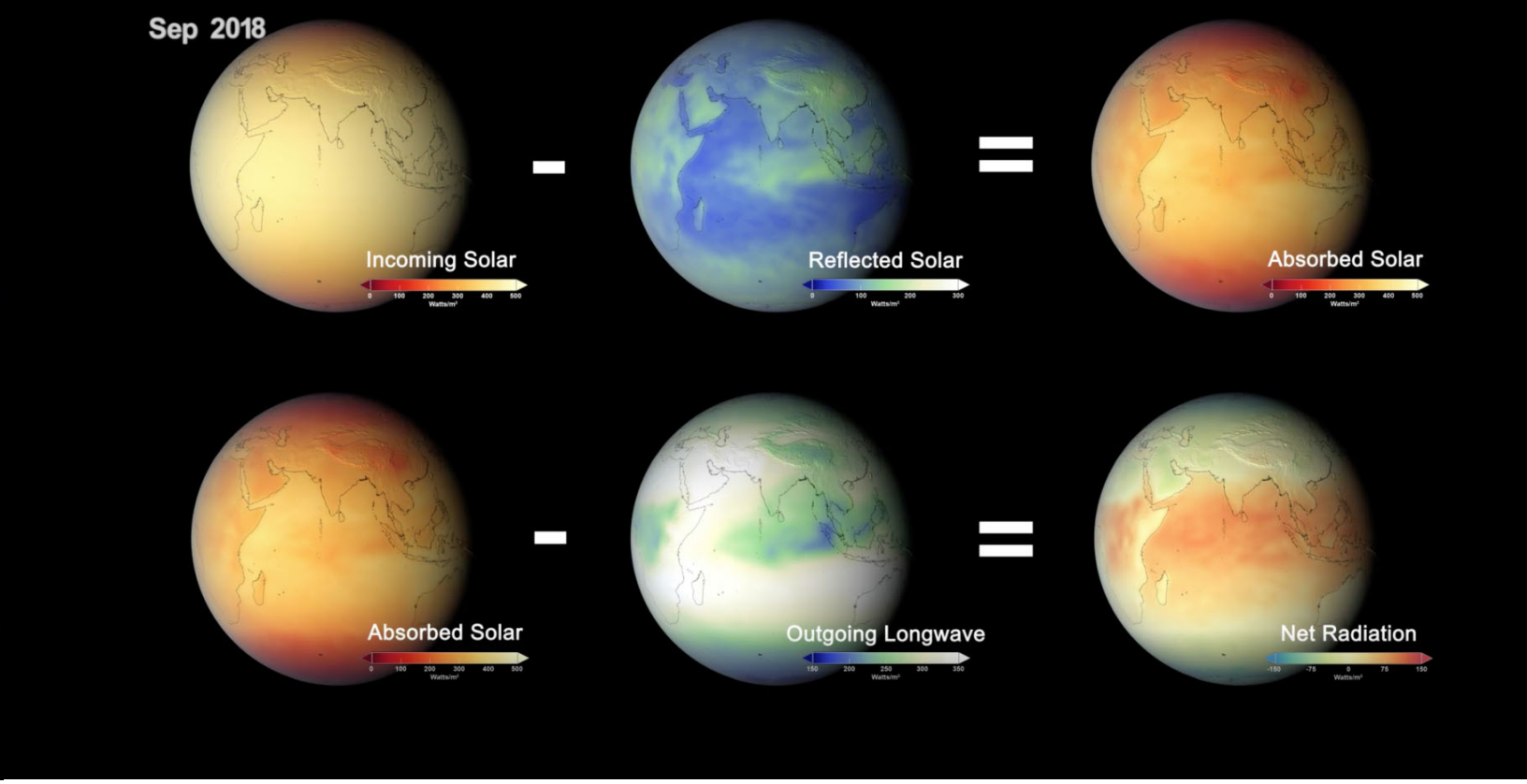


A NASA study says it's the first to directly measure humans' role in climate change

By Michael J. Coren

Every year, the sun sends radiation toward Earth equivalent to more than 7,000 times humans' annual energy consumption. Much of it (about 30%) ricochets off the atmosphere into space; the rest is absorbed or reflected back out after reaching Earth's surface. Global warming happens when the greenhouse gases dumped into the atmosphere act like a warm, insulating blanket, capturing this energy rather than letting it escape.

For decades, scientists have relied on models to predict exactly how fast the world is warming due to human activities. And they've gotten very good at them. But scientists publishing in the journal Geophysical Research Letters on March 25 reported the first direct global observations of how much aerosols and greenhouse gases released by humans are driving climate change. "It's direct evidence that human activities are causing changes to Earth's energy budget," said Ryan Kramer, co-author of the paper and a researcher at NASA's God-



dard Space Flight Center and the University of Maryland, Baltimore County.

Since 1977, NASA has been continuously studying Earth's energy budget by flying instruments aboard satellites with the Clouds and the Earth's Radiant Energy System (CERES) project. These have delivered detailed measurements of the planet's radiation: how much enters, how much escapes, and how much soaks into the oceans. The new study is the first to account for human activities—as well as natural factors such as water vapor, clouds, and surface reflectivity—to precisely pin down the Earth's energy imbalance, the "distinct fingerprints of anthropogenic activity in Earth's changing energy budget."

The study concluded human activities increased this imbalance, also known as "radiative forcing," by about 0.5 watts per square meter between 2003 to 2018, mostly due to rising greenhouse gas concentrations. For context, that's about the equivalent of keeping nearly 5 trillion 60-watt light bulbs lit across the Earth's surface all the time.

Zeke Hausfather, a climate scientist at the environmental research group Breakthrough Institute, said the study "largely validates what we already know but in a more straightforward observation-based way," pointing to a 2015 study in Nature that measured CO2 radiative forcing on the Earth's surface as another example.

That data lines up well with scientists' climate models, but it also offers a faster way to monitor how mitigation efforts are working and to test computationally-intensive models. It might also influence those who continue to doubt the overwhelming climate consensus among 97% of publishing climate scientists. "In my experience," said Hausfather, "skeptics tend to be more swayed by observations than models, so it's certainly helpful. It creates a pretty high bar to explain away."

The Dead Sea is dying. Drinking water is scarce. Jordan faces a climate crisis.

By Nabih Bulos,
Los Angeles Times

The first time people here saw a sinkhole, they thought a small asteroid had slammed into the Dead Sea's salt-encrusted shore.

Then others appeared.

One swallowed the edge of a state-owned building. Another opened near a house and forced the family to move. Worried farmers scanned their fields and abandoned their harvests. At one point, a chunk of highway collapsed, disappearing several stories deep and leaving a lone PVC pipe that ran like a high-wire over the crater.

Finally, the residents of Ghor Haditha realized, the problem was literally beneath their feet, a symptom of the Dead Sea's death and a disturbing measure of the parched land Jordan has become. This small kingdom has long ranked high on the list of water-poor countries. But a mix of a ballooning population, regional conflicts, chronic industrial and agricultural mismanagement and now climate change may soon bring it another distinction: the first nation to possibly lose viable sources of freshwater.

The sinkholes are a harbinger of a future in a Middle East precariously balanced on dwindling resources. With the Dead Sea—a lake, really—shrinking at a rate of 3 to 5 feet a year, its saltwater is replaced by freshwater, which rushes in and dissolves subterranean salt layers, some of them hundreds of feet below. Cavities form, and the soil collapses into subsurface voids, creating sinkholes.

In the last three decades, the Dead Sea's level has fallen almost 100 feet. The rate of loss is accelerating, and sinkholes now number in the thousands, like a rash spreading on the exposed seabed.

"When I was younger, the water used to reach all the way up to that field," said Hassan Kanazri, a 63-year-old tomato farmer, as he pointed to a spot some 300 yards away from the water's edge. He stepped onto a patch of dark brown earth speckled with holes; the soft dirt gave way underfoot.

"We can't use tractors here. The land is too weak, so we've had to plow manually," he said.

The sinkholes are a piece of a larger danger revealing how Jordan's perennial thirst is worsening. A virtually landlocked desert kingdom with few resources, the country's yearly decrease in rainfall could lead to a 30% reduction by 2100, according to Stanford University's Jordan Water Project. Jordan's aquifers, ancient groundwater reservoirs that take long to replenish, are being pumped at a furious pace, even as the pandemic has increased demand by 40%, the Water Ministry says. And precarious finances mean desalinization, which serves some of Jordan's richer neighbors, is—for now— too expensive an option.

"The situation here is bleak," says Water Ministry spokesman Omar Salameh. "Without a huge amount of support to execute development projects, Jordan doesn't have the resources to provide water."

To understand the crisis one need only take a drive on Highway 40, which stretches east from Amman toward the Iraqi border. With the capital in the rear view, you cross through to the Azraq wetlands—once a lush, water-filled stopover for migratory birds now decimated by over-reliance on an aquifer there— before you reach a vast expanse of desert. Some 92% of the country gets less than 200 millimeters—about 8 inches—of rainfall per year, with only nine countries in the world getting less annual precipitation than Jordan.

Though Jordan is uniquely challenged, it's a preview of what the region faces as a whole. Middle Eastern nations top the list of most water-stressed countries, the World Resources Institute says.

The region is also a "global hotspot of unsustainable water use," according to 2017 World Bank report, and whatever water is available is further degraded by brine discharge from desalination, pollution and untreated wastewater. Poor water quality costs governments as much 2.5% of their gross domestic product.

Making matters worse are broiling summers, with the Max Planck Institute for Chemistry projecting average daytime temperatures to exceed 116 degrees Fahrenheit and reaching almost 90 by night. (And it's not just estimates; the temperature in Mitribah, in northern Kuwait, reached 129 degrees in 2016.)

Much of Jordan's water problem is a simple matter of math: In the 1950s, its population numbered half a million people. Now there are more than 10 million, housed in a country whose water supply, researchers say, can't sustain a population exceeding 2 million. Residents make do with 135 cubic meters, or about 36,000 gallons, of water per person per year; the U.N. defines "absolute scarcity" at 500 cubic meters per year.

That population explosion is less a result of Jordanians' fertility than it is of the country's reputation as a so-called oasis of stability in a not-so-stable neighborhood.

Palestinians pushed out by the creation of Israel in 1948 and the subsequent 1967 conflict; Lebanese escaping civil war in the '80s; Iraqis fleeing U.S. bombardment and sanctions; more than a million Syrians after 2011, along with Yemenis and Libyans—if there's a regional conflict, Jordan is probably hosting its refugees.

A 2016 census estimated the number of refugees at

2.9 million, and that's including the approximately 1 million migrant workers in the country.

"The Syrian crisis alone raised demand for water an average of 20%," Salameh says. It's double that amount in northern areas of the kingdom, where most of the refugees reside, he adds.

It's little better on the supply side, where Jordan has to contend with the tyranny of geography.

Go north from Ghor Haditha, past the baptismal site of Jesus Christ on the Jordan River (now reduced to a sewage-contaminated trickle in some parts); continue east along its main tributary, the Yarmouk River, where Lawrence of Arabia once tried and failed to blow up an Ottoman railroad, and you encounter the Al Wehda Dam, a 360-foot concrete embankment on Jordan's border with Syria.

Its capacity of 110 million cubic meters makes it Jordan's largest dam, a reliable source of more than a third of the country's water supply. But it's never been more than half full. That's because Syria, which controls the Yarmouk River's flow into Jordan, has built upstream more than 40 dams and thousands of wells to irrigate its own crops, leaving Jordan with only a fifth of its share.

"We were supposed to expand the dam and build a hydroelectric plant. The plan was we would get water, and the Syrians would get power," said Munther Maayeh, one of the dam's managers. "But the water we receive from the Syrians isn't anywhere near enough for that."

Israel too has diverted some 600 million cubic meters of water in the Sea of Galilee—another lake—from the Jordan River. The result has been a 90% plunge in the river's flow to a paltry 200 million cubic meters per year. (Under the 1994 peace agreement, Israel regularly conducts transfers of water from the Jordan River to the kingdom.)

To make up the shortfall, Jordan increasingly turned to nonrenewable water sources such as aquifers. Jordan has 12 of them, but is already pumping 160% more than it should for them to be replenished; 10 are all but depleted.

The low supply coupled with burgeoning demand has forced the government to ration water delivery. In practical terms, that means most homes don't get municipal water more than once a week. Many residents turn to illegal drilling of wells, Salameh says.

On the outskirts of Amman, water tank trucks back up to a communal well equipped with 9-foot-high faucets. Raafat Awamleh, a driver with his 8-year-old son, Shahem, by his side, climbed up the side of his truck, slipped a rubber hose over one of the faucets and placed the other end into his tank.

"People call us from all over Amman to deliver water," Awamleh said, adding that the area had some six similarly equipped communal wells. The coronavirus cut a portion of his business, including water deliveries to farmers, but he expected work to pick up soon.

"In the summer we have to do this all the time," he said. "It just gets too hot and people need water."

Jordan's internal topography plays a role as well. More than half of Amman's water supply, for example, comes from the Al Disi aquifer, some 200 miles south. Another portion is taken from the Azraq aquifer, 50 miles east.

"That's a huge expense on the state treasury," Salameh says, estimating the cost at $4 per cubic meter from aquifer to tap. Power requirements for pumping water amount to more than a sixth of the country's total power production, the government says.

The failure of Jordan's water management is increasingly apparent, says Raed Dawood, founder and head of Eco Consult, a water-use consulting firm. Rickety infrastructure means more than half of the water leaks out of pipes or is stolen. State subsidies for agriculture, a sector that consumes slightly more than 50% of Jordan's water supply while contributing only 3% to 4% to its GDP, give farmers little incentive to use new—and expensive—irrigation

techniques or choose crops that are more profitable.

"Water productivity here is about $1.50 per cubic meter. It's $100 in the Netherlands," Dawood says, adding that Jordan's top crops are tomatoes and cucumbers, low-profit plants that consume a lot of water.

To make a point, he walks out of his office and returns with a plate of dates. They were plump, with a singed caramel-colored skin. The variety is known as Medjool and the kingdom is famous for them, Dawood says. This kind of crop, he adds, could more than quadruple the value farmers get out of their water.

"We have to be selective and careful in what we grow," he says.

"All these things are matters of policy, and yes, we're a scarce-water country, but we have to use it effectively."

Back in Ghor Haditha, increasing industrialization, much of it centered around the Arab Potash Co., is exacerbating the water problem. The company, along with its Israeli counterpart, pumps Dead Sea water to extract minerals, adding to the sea's retreat and compounding sinkhole formation, says William Ajalin, a resident and head of a local environmental association.

On the rooftop balcony of the association's building, he points to the main highway bisecting Ghor Haditha: On one side lies the Dead Sea, the foot of the Karak mountains on the other.

"People are already too afraid to do anything on the side by the Dead Sea," he says.

"Of course we're worried this is making it worse."

But a change of behavior, including better conservation, would have to go beyond villages like Ghor Haditha to cities, especially Amman, says Ammar Khammash, an architect who specializes in eco-friendly projects.

"We cannot continue like we did in the '70s and '80s. All the water of Azraq, we flushed it down the toilets of Amman," he says. The solution, he says, is to incorporate water storage capacity in every building.

"Governments like big projects, but the solution involves smaller pieces: A place like Amman needs to become a 'sponge city' where every house doesn't waste a single drop."

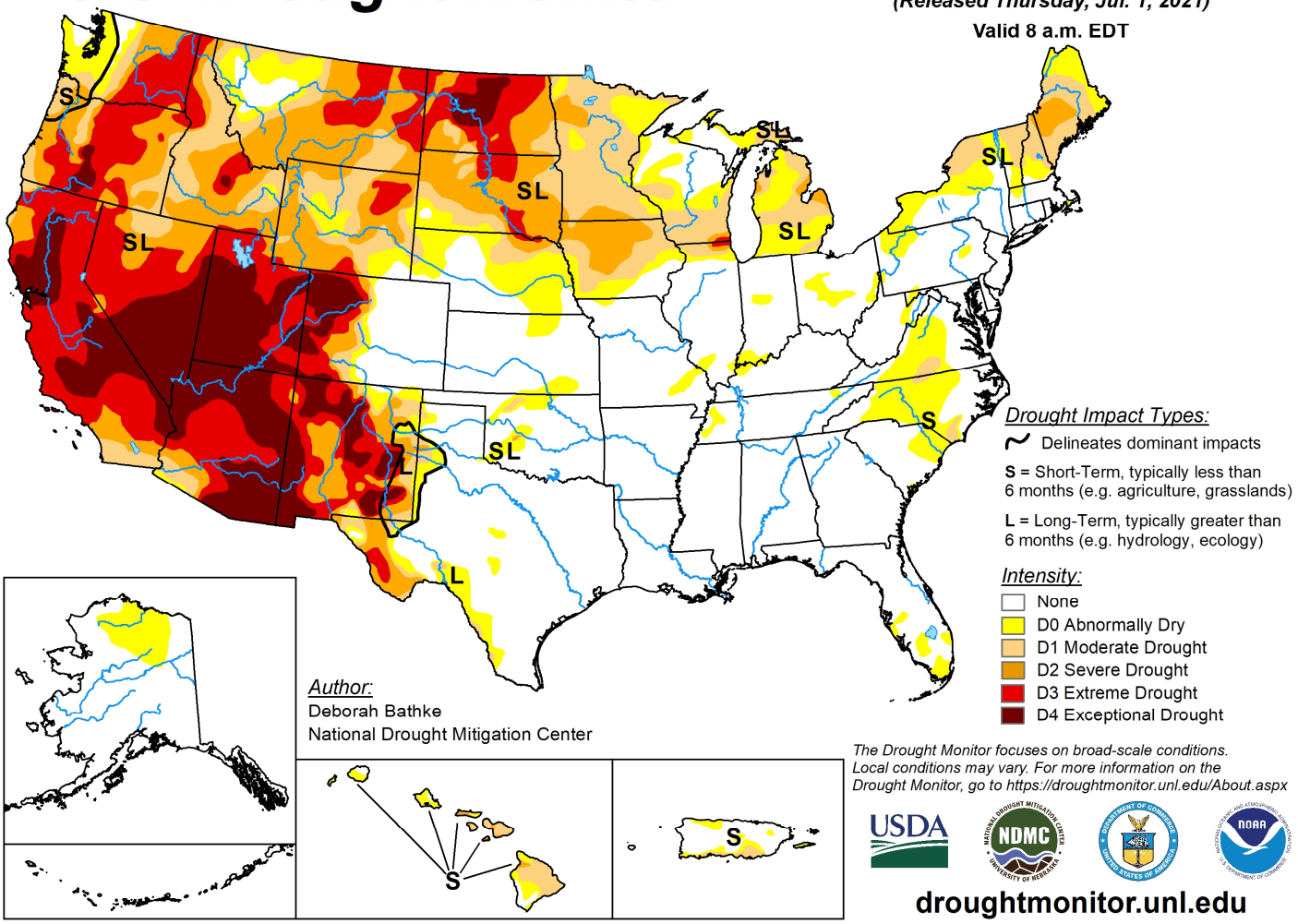
For now, the government is exploring other venues, such as Red to Dead, a joint project with Israel and the Palestinian Authority. It aims to build a desalination plant in Aqaba, Jordan's sole outlet on the Red Sea, and dump the briny water to replenish the Dead Sea. The project has been on the books since 2005 without much progress.

In any case, relations between Jordan and Israel have reached a nadir, with diplomatic spats flaring over the last year between Israeli Prime Minister Benjamin Netanyahu and King Abdullah II. The last such incident was resolved April 12 when Netanyahu approved Amman's request for extra water rations from the Jordan River, almost a month after the Jordanian government asked for it. (The peace agreement allows for Jordan to request additional water supplies.)

That has forced the kingdom to look inward, conducting deep-water exploration of desert areas and drilling wells more than a mile deep. Those efforts are expected to yield 70 million cubic meters of water by the project's end. It's expensive, but essential at a time when the kingdom's relations with its neighbors over water remain a challenge.

"You can't predict what the political situation is going to be," Salameh says.

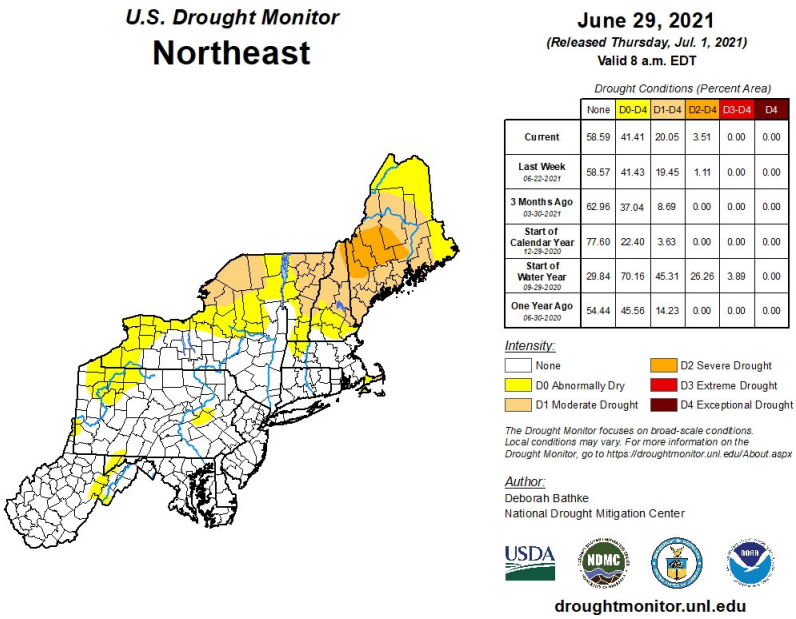
"As long as there is no horizon for peace in the area, Jordan will remain vulnerable to the challenges imposed on it by its situation with water."

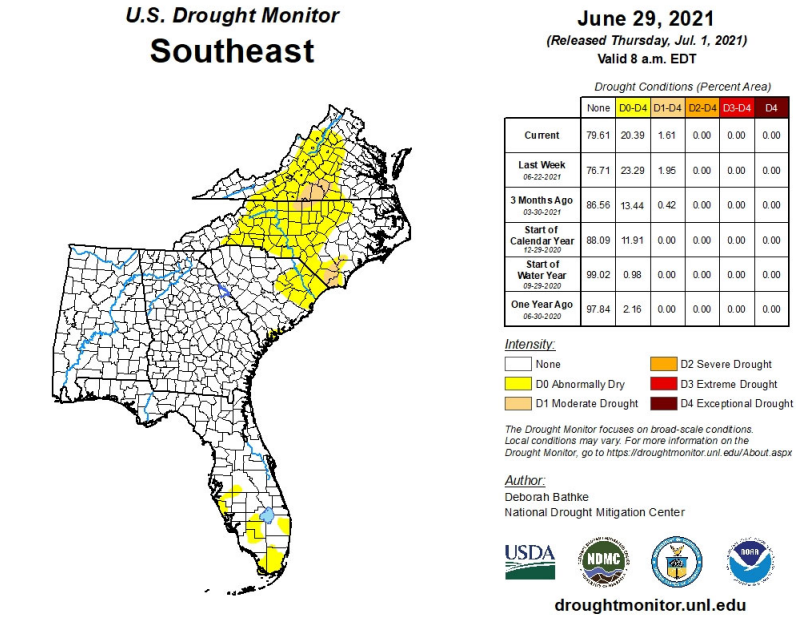


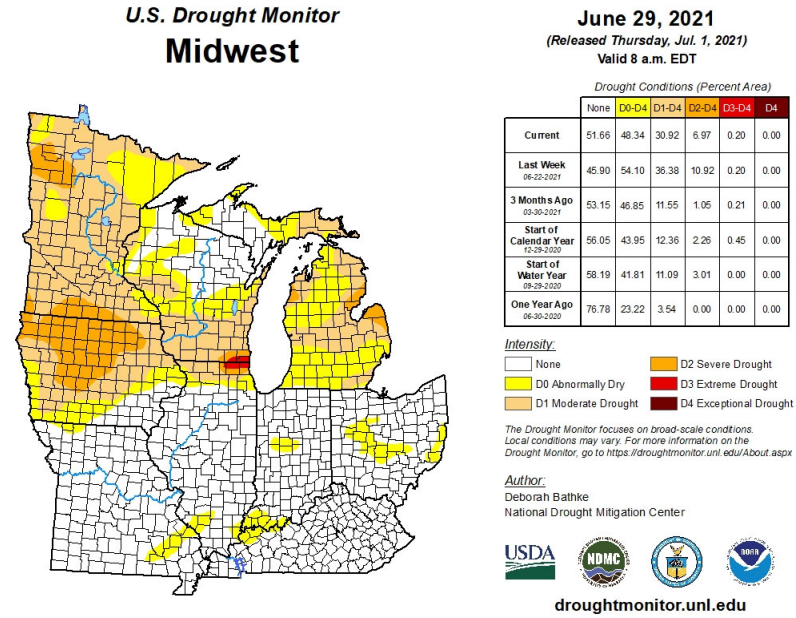
National Drought Summary

Author(s): *Deborah Bathke, National Drought Mitigation Center and Ahira Sanchez-Lugo, NOAA/NCEI*

This week's U.S. Drought Monitor saw changes to over 30 states this week. Record-breaking heat in the Northwest, Great Basin, and Northeast led to expansions of drought conditions. Meanwhile, multiple rounds of heavy rain across the Central U.S. led to large-scale improvements, and intense rainfall along the Gulf Coast led to the reduction or removal of lingering pockets of abnormal dryness.







Northeast

Warm, dry weather across New England led to the expansion of moderate (D1) and severe (D2) drought where year-to-date precipitation is down more than 6 inches below normal. Multiple high temperature records were broken over the last couple of days and values have consistently ranked in the top 10 warmest over the last 90 days. The lack of rainfall, combined with the excess heat, has dried soils and lowered streamflows. Water conservation measures are in effect in parts of Maine, New Hampshire, and Vermont.

Southeast

Intense rainfall this past week left much of the region virtually drought-free. In areas that missed out on the heaviest rainfall, such as Virginia and North Carolina, pockets of moderate drought (D1) remain and areas of abnormal dryness (D0) expanded. Rainfall deficits of 2 to 8 inches in areas of those two states still exist over the past 90 days. State drought monitoring teams commented that ag reports continue to note moderately dry fields, which is apparent on satellite-based indicators of vegetation health, and that lake levels remain low.

Midwest

A stalled frontal boundary brought widespread, heavy rain (3 to 10-plus inches) and flash flooding to parts of the lower Midwest. The excess moisture led to a general one-category improvement to drought conditions as short-term rainfall deficits decreased and streamflow and soil moisture improved. In the Upper Midwest, which mostly missed out on the heaviest rain, drought remains a concern. In Minnesota, the U.S. Department of Agriculture (USDA) reports as of June 27, that 75% of the state's topsoil moisture is short to very short, meaning that it's significantly less than what is required for normal plant development. While crops can still improve with additional rain, the damage has already been done to pastures. Abnormal dryness (D0) expanded in Minnesota and moderate drought (D1)

expanded in northern Illinois.

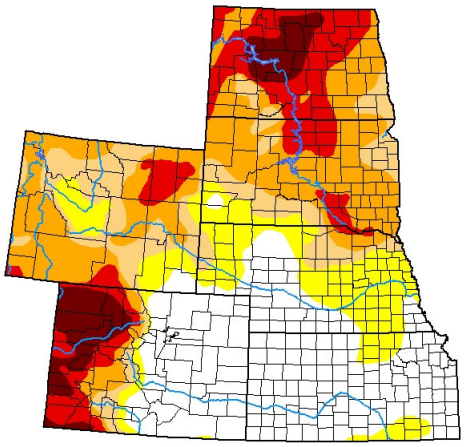
High Plains

The same stalled frontal boundary that affected the Lower Midwest this week also brought widespread rain to the region with the largest totals (2 to 8-plus inches) falling over eastern Kansas and eastern Nebraska. One-category improvements were made in southeast Kansas, eastern and north central Nebraska, and parts of North Dakota as short-term rainfall deficits decreased and streamflow and soil moisture improved. In Colorado, improvements were made to small areas of exceptional (D4) and extreme (D3) drought as recent rainfall has helped chip away at shorter term deficits. Hydrological and ecological drought, which generally occur on longer time scales, remain a concern. In areas which missed out on the heaviest rain, drought continues to impact the region with cattle producers feeling the brunt of the impacts. The USDA reports that 90% of South Dakota and 66% of North Dakota's topsoil moisture is short to very short, leading to forage shortages. Producers from Wyoming eastward across the Dakotas are having to make tough decisions as to what to do with cattle, with many selling entire herds. In response to the worsening conditions, extreme drought (D3) expanded in South Dakota and parts of Wyoming where supported by increasing rainfall deficits, declining soil moisture and streamflow, and vegetation stress.

South

A band of substantial rain (6 to 10-plus inches) fell from West Texas to northeast Oklahoma, leading to large areas of one-category improvements as well as some smaller areas of two-category improvements as short-term rainfall deficits, soil moisture, and streamflow improved. Drought and abnormal dryness remain in areas where indicators still show dryness at longer timescales. A re-evaluation next week will help determine the full effect of the rainfall.

U.S. Drought Monitor
High Plains



June 29, 2021
(Released Thursday, Jul. 1, 2021)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	31.79	68.21	54.47	41.44	18.39	6.04
Last Week 06-22-2021	29.66	70.34	53.90	38.82	18.44	6.08
3 Months Ago 03-30-2021	18.86	81.14	63.81	40.67	17.89	2.99
Start of Calendar Year 12-29-2020	3.82	96.18	82.46	50.36	27.09	5.71
Start of Water Year 09-29-2020	6.73	93.27	62.11	36.56	16.16	0.54
One Year Ago 06-30-2020	34.41	65.59	39.70	13.29	7.90	0.43

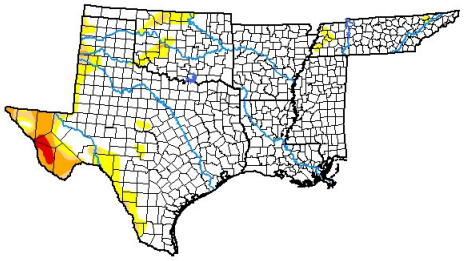
Intensity:
None · D0 Abnormally Dry · D1 Moderate Drought · D2 Severe Drought · D3 Extreme Drought · D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
Deborah Bathke
National Drought Mitigation Center

droughtmonitor.unl.edu

U.S. Drought Monitor
South



June 29, 2021
(Released Thursday, Jul. 1, 2021)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	88.10	11.90	4.78	2.90	0.59	0.00
Last Week 06-22-2021	84.32	15.68	7.14	3.96	2.26	0.59
3 Months Ago 03-30-2021	46.74	53.26	36.74	17.76	10.30	3.46
Start of Calendar Year 12-29-2020	31.94	68.06	45.97	26.45	15.39	6.58
Start of Water Year 09-29-2020	71.83	28.17	18.56	12.16	6.27	1.66
One Year Ago 06-30-2020	60.33	39.67	19.86	6.90	2.04	0.01

Intensity:
None · D0 Abnormally Dry · D1 Moderate Drought · D2 Severe Drought · D3 Extreme Drought · D4 Exceptional Drought

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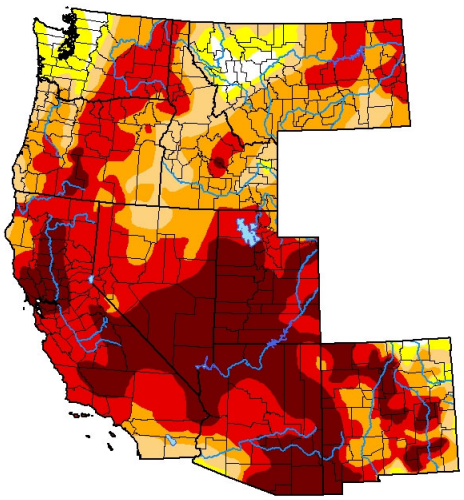
Deborah Bathke
National Drought Mitigation Center

droughtmonitor.unl.edu

U.S. Drought Monitor
West



June 29, 2021
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Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	1.82	98.18	93.16	81.88	59.56	26.54
Last Week 06-22-2021	2.11	97.89	90.92	78.14	55.83	26.71
3 Months Ago 03-30-2021	11.95	88.05	73.82	59.44	42.24	23.23
Start of Calendar Year 12-29-2020	13.52	86.48	75.49	63.25	45.40	23.76
Start of Water Year 09-29-2020	9.96	90.04	73.14	51.29	32.19	2.50
One Year Ago 06-30-2020	38.10	61.90	42.12	21.57	2.42	0.00

Intensity:
None · D0 Abnormally Dry · D1 Moderate Drought · D2 Severe Drought · D3 Extreme Drought · D4 Exceptional Drought

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Deborah Bathke
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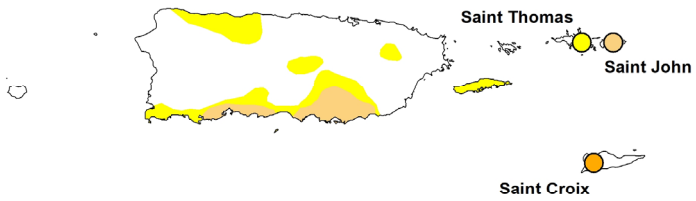
U.S. Drought Monitor

Caribbean



June 29, 2021

(Released Thursday, Jul. 1, 2021)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	72.83	27.17	8.33	0.00	0.00	0.00
Last Week 06-22-2021	44.83	55.17	11.37	0.00	0.00	0.00
3 Months Ago 03-30-2021	73.21	26.79	8.04	0.00	0.00	0.00
Start of Calendar Year 12-29-2020	77.70	22.30	3.31	0.00	0.00	0.00
Start of Water Year 09-29-2020	94.96	5.04	0.00	0.00	0.00	0.00
One Year Ago 06-30-2020	26.87	73.13	54.60	22.35	0.00	0.00

Note: Statistics do not include areas represented by points.

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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U.S. and Puerto Rico Author:
Deborah Bathke
National Drought Mitigation Center

Pacific Islands and Virgin Islands Author:
Deborah Bathke
National Drought Mitigation Center

droughtmonitor.unl.edu

West

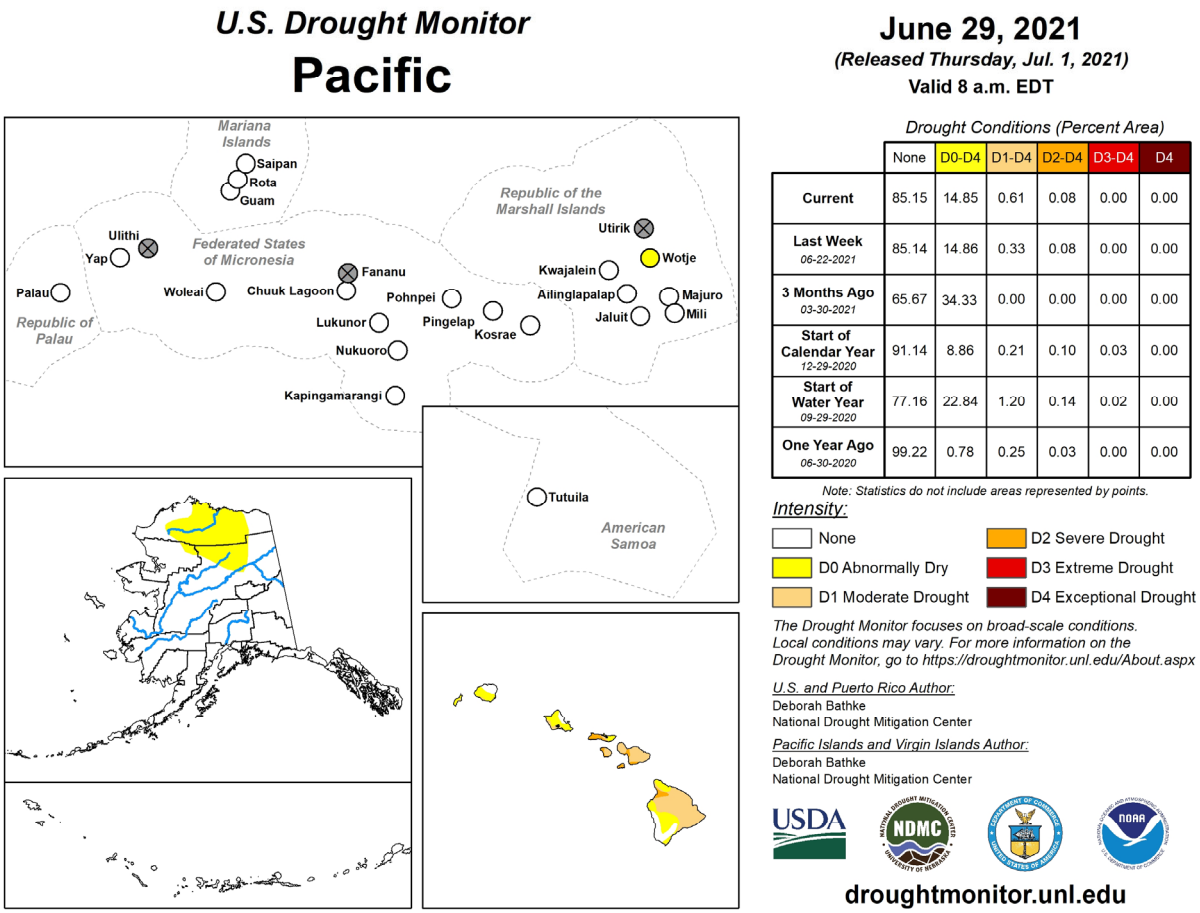
Unprecedented heat in the Northwest, combined with another week of dry weather, led to worsening drought conditions across the region. This week, high temperatures ranged from 20 to 30 degrees above normal, breaking multiple records. The excess heat greatly increased evaporative demand, further drying out soils and vegetation, and worsening conditions. Many areas in the Northwest saw one-category degradations, including expansions of severe (D2) and extreme (D3) drought. Conditions in the Southwest remained unchanged, except for the expansion of D3 in central Arizona. Much of the West is classified as severe drought or worse. Notable impacts include increased wildlife encounters in California, Nevada, and Utah, as drought has driven snakes and/or bears in search of food and water into urban areas in those states. In Montana, fishing restrictions have been put in place on many rivers due to low flows and warm waters. Drought-stricken ranchers are selling cattle due to poor forage conditions and a lack of feed. On top of this, grasshoppers have been denuding trees and competing with cattle for food. So far, at least eight national forests in the West now have fire restrictions.

Caribbean

In Puerto Rico, beneficial rains decreased deficits and improved drought conditions across the central and eastern parts of the Island. Meanwhile, rainfall deficits continued to build along the southern coast, leading to increases in abnormal dryness (D0) and moderate drought (D1).

The Cyril E. King airport in St. Thomas had 1.71 inches of rain and a month-to-date total that was 195.1% of normal. CoCoRaHS stations had a weekly rainfall total between 1.0-2.50 inches, with month-to-date totals between 4.0-6.0 inches. Year-to-date rainfall total at the airport was 88.2% of normal. SPI values for all timescales indicate drought free conditions. This week, a one-category drought improvement was made to St. Thomas.

Weekly rainfall totals for St. John were between 1.0-1.40 inches, depending on the CoCoRaHS station. Month-to-date rainfall totals were a little over 4 inches. Year-to-date rainfall total at the Windswept Beach was 70% of normal. SPI values for 6 (-0.89), 9 (-0.69) and 12-month (-0.64) were indicative of abnormally dry to moderate drought conditions. All



other timescales were indicative of drought free conditions. Moderate drought continued across St. John.

Severe drought persisted across St. Croix as it received meager rain this week. The Henry Rohlsen airport had 0.48 inch of rain and a month-to-date rainfall total that was 91.9%. Year-to-date rainfall at the airport was 62.3% of normal. The CoCoRaHS weekly rainfall totals were between 0.09-0.17 inch, with a month-to-date between 0.96-1.94 inches. SPI values at the 3 (-0.65), 6 (-1.16), 9 (-1.44), and 12-months (-1.13) were indicative of abnormally dry to severe drought.

Pacific

In Alaska, no changes were made to the map this week.

In Hawaii, lighter than normal winds and lower than normal rainfall occurred over the past weeks. Rainfall totals along the windward slopes are below 50% of the June average and streamflows are declining. As a result, abnormal dryness (D0) expanded on Molokai and moderate drought (D1) expanded on the Big Island. Above normal rainfall on the southeast side of the Big Island led to the reduction of D0.

The weather features across the U.S.-Affiliated Pacific Islands (USAPI) during this USDM week (06/23/21-06/29/21) included a series of surface troughs that moved from east to west across Micronesia, accompanied at times by a couple weak circulations. An ITCZ (Inter-Tropical Convergence Zone) meandered at times across parts of central to eastern Micronesia. Upper-level lows and troughs (Tropical Upper Tropospheric Troughs, or TUTT cells) migrated east to west across northern parts of the region, mostly north of 10 degrees North latitude. Early in the week, Tropical Storm Champi (06W) spread rain across the Marianas as it exited the region, then later in the week surface troughs coupled with upper-level divergence to bring additional rain to the Marianas. South of the equator, a surface trough spread moisture across the Samoan Islands.

Satellite-based estimates of 7-day precipitation

(QPE) are available from two products: one using mainly infrared (IR) sensors (NESDIS GOES-R AHI) and the other incorporating microwave sensors (GPM IMERG). These QPE products showed a band of precipitation stretching from Indonesia southeastward to the Samoan Islands and beyond (South Pacific Convergence Zone, or SPCZ) and areas of precipitation over Micronesia. The QPE indicated areas of 2+ inches of rain across American Samoa; southern Portions of Chuuk, Pohnpei, and Kosrae States in the Federated States of Micronesia (FSM) and southern portions of the Marshall Islands (RMI); Palau and western Yap State; and much of the central and northern portions of the Marianas.

Palau IAP had 2.98 inches of rain this week and 9.46 inches for the month-to-date, surpassing the weekly (2 inches) and monthly (8 inches) thresholds to meet most water needs. Drought free conditions continued across Palau.

Across the Marianas, Guam had the least rain this week at 0.63 inches. However, Guam's month-to-date rainfall total was 4.80 inches, surpassing the monthly threshold of 4 inches to meet most water needs. Meanwhile, Saipan had the most rain with rainfall totals surpassing 2 inches and a month-to-date total that was over 5 inches. Both Guam and Saipan continued in drought free conditions. Rota had its fourth consecutive week with rainfall totals below the weekly threshold of 1 inch at 0.69 inch. Rota's month-to-date is only 1.98 inches of rain, which is less than the threshold of 4 inches to meet most water needs. For this week, drought free conditions continued for Rota since no notable drought impacts were reported.

For the FSM, Yap, Kosrae, Chuuk Lagoon, Kapingamarangi, Nukuoro, and Pingelap had over 2 inches of rain this week, securing another week of drought free conditions. Meanwhile, Pohnpei, Lukunor, and Woleai had less than 2 inches of rain for the week. Most of these locations had a month-to-date rainfall total that surpassed the threshold of 8 inches or were close to the threshold. For this reason, drought free conditions continued as drought is not a concern at the moment for these locations.

Fananu and Ulithi had no data, so they were set to be missing.

Across the Marshall Islands, Ailinglaplap and Mili had the most rain this week, with rainfall totals over 2 inches. Majuro had a little less than 2 inches of rain this week. However, all three locations continued to be drought free. Kwajalein and Jaluit had the least rain at 0.46 and 0.42 inch, respectively. Jaluit's month-to-date was over 11 inches, so drought free conditions persisted. Kwajalein's month-to-date was a little less than 5 inches. However, since there were no notable drought impacts reported, drought free conditions will remain. Wotje continued to be abnormally dry this week as it only had 1.03 inches of rain and a month-to-date rainfall total of 2.49 inches. As of last week, no notable drought impacts were reported and it was stated that vegetation was green.

This was a wet week for American Samoa and drought is not a concern as the three locations had over 3 inches of rain this week.

Looking Ahead

The National Weather Service Weather Prediction Center forecast for the next five days (July 1 -4) shows that the prolonged heat wave is expected to continue across the interior sections of the Northwest and Northern Rockies and move into the Northern High Plains. In the East, a cold front is forecast to bring relief from the hot, muggy weather in the Northeast, Mid-Atlantic, and Southeast. As the front moves through the region, these areas can expect moderate to heavy rainfall and an increased chance of severe weather.

Moving into next week, the Climate Prediction Center six-to-10 day outlook (valid July 6-10) favors above normal temperatures across the West, Northern and Central Plains, Midwest, and Northeast. Below normal temperatures are most likely across the South, Southeast, and Alaska. Below normal precipitation is expected to continue across much of the west and Northern Plains, while above normal precipitation is favored across most of the rest of the Lower 48 and Alaska.

A town's water is contaminated with 'forever chemicals' – how did it get this bad?

Testing by the Guardian and Consumer Reports found high levels of potentially harmful PFAS in Pittsboro, North Carolina, and regulators have struggled to keep pace

On a bitterly cold afternoon earlier this year, the Haw River was running high – its water a bright ochre thanks to heavy rainfall and snow melt.

Most of the water flowed south, where it would eventually connect with Jordan Lake and the rest of the Cape Fear River basin, home to the cities of Greensboro, Durham, Fayetteville and Wilmington and a major source of drinking water for the eastern half of the state.

But some of it took a sharp turn, pumped up to the local water treatment plant where it was cleaned and filtered before continuing its journey, piped down the road and into a church in downtown Pittsboro where Jim Vaughn had just finished helping hand out free lunches.

Vaughn, a retired electrical equipment salesman and longtime Pittsboro resident, had found a problem with the water coming out of the church's tap – contamination with a group of chemicals that are linked to health concerns.

The 76-year-old is part of a collaborative project between the Guardian and Consumer Reports that tested 120 tap water samples from locations across the US for dozens of per- and polyfluoroalkyl substances, or PFAS. Known as "forever chemicals", PFAS are a group of roughly 5,000 manmade compounds found in everything from food packaging to nonstick cookware to firefighting foam. The health risks associated with long-term PFAS exposure include cancer, liver damage, decreased fertility, increased risk of asthma and thyroid disease.

The chemicals have been around for more than 80 years, but it wasn't until 2016 that the EPA set an advisory limit for PFAS in drinking water – 70 parts per trillion (ppt).

The Consumer Reports test measured PFAS levels of 80ppt in the water coming from the Pittsboro church's tap.

The EPA is under pressure to lower its limits on PFAS. For instance the non-profit Environmental Working Group has proposed a total PFAS limit of 1ppt in drinking water and groundwater.

CR's scientists say the maximum allowed amount should be 5 ppt for a single PFAS chemical and 10 ppt for two or more. That is in line with standards for bottled water that an industry group, the International Bottled Water Association, has its members adhere to.

Vaughn, who wears a black cowboy hat with a multicolored feather stuck in the band, wasn't particularly surprised at the high PFAS result from the Consumer Reports/Guardian testing, likely due to North Carolina's long history with PFAS. In the early 1970s, the chemical company DuPont began operating a manufacturing facility that discharged PFAS into the Cape Fear River.

"There's a feeling of helplessness," Vaughn said. "Is there something we can do about it? Is there something that the town will do about it? Or will we let it ride and try to ignore it?"

Knowingly or unknowingly, he said, communities like Pittsboro are used to getting "dumped on". For more than 90 years Duke Energy operated a large coal-fired power plant in the nearby community of Moncure (population 709), right where the Haw and Deep rivers converge to become the Cape Fear. The area is now the site of a coal ash disposal pit, which is being filled with as much as 12m tons of slag, powder and other residual byproducts of burning coal. Multiple tests have revealed elevated levels of metals and other contaminants in groundwater near the site.

The PFAS contamination of Cape Fear River has been a source of controversy for years.

A 2007 EPA study found evidence of PFAS contamination downstream of the plant and throughout the Cape Fear River basin, including high concentrations near the Ft Bragg and Pope Field military bases. In 2016, researchers discovered contamination farther downstream, as well as in local drinking water, a revelation that spawned a spate of news coverage.

Since then the state has engaged in a back-and-forth with the offending companies over the issue. In 2017 the North Carolina department of environmental quality blocked the DuPont plant (now operated by a DuPont offshoot The Chemours Company) from discharging into the Cape Fear, and later entered into a consent order requiring Chemours pay a $12m fine.

Late last year the state filed a lawsuit against the companies, alleging they "knowingly discharged vast quantities of PFAS into the air, water, sediments, and soils of … southeastern North Carolina."

Asked to comment about the CR test finding in Pittsboro, Chemours spokesman Thom Sueta said it had taken "numerous actions to reduce the emissions of fluorinated organic compounds (FOC), that includes

PFAS" and its goal was to reduce them "by at least 99%" at its sites worldwide compared to a 2018 baseline.

The spokesman said there were "many sources that impact the water quality of the Cape Fear River". At its Fayetteville NC site Chemours has installed "a thermal oxidizer that is destroying more than 99.99% of FOC emissions from the processes directed to it" and there was "remediation work underway to address groundwater, including our seep treatment units," Sueta said.

Concerns

The highest concentrations of PFAS from the 2007 EPA study were found upstream of the Chemours plant, near Pittsboro. That was one of the first indications, said Emily Sutton, the riverkeeper for the Haw, that the problem might be more widespread than first thought.

For Sutton, who spends most of her time these days studying, thinking and talking PFAS, the issue is threefold.

The first and often most pressing problem for locals like those in Pittsboro is the contamination in municipal drinking water. But solving this requires hugely expensive upgrades to wastewater treatment facilities (recently floated price tags for Pittsboro, a town of 4,200, range upwards of $20m) or costly individual, in-home filtration systems.

"We know that the drinking water in the town of Pittsboro is contaminated. People who are concerned are left to pay for a reverse osmosis system in their own home," Sutton said. "That means that only people who can afford that luxury have safe drinking water."

The second problem is identifying and stopping contamination at its source. According to Sutton, ongoing testing has revealed that much of the PFAS floating down the Haw and into Pittsboro originates from the nearby city of Burlington. Late last year, the non-profit Haw River Assembly helped forge an agreement with the city, compelling it to identify the local facilities or companies responsible for discharging PFAS.

More broadly, Sutton said, regulatory agencies in the US need to reconsider their priorities. The current system favors the introduction of new chemicals, products or processes, only later limiting or removing them after they have been proven harmful. Sutton would rather bodies like the EPA and NC DEQ operate under the precautionary principle – the idea that the onus lies with companies and producers to prove something harmless before it is introduced into the environment.

PFAS is a perfect example, she added, noting that of the some 5,000 compounds in its category, scientists can only test for roughly 30.

"We can't regulate these compounds one at a time," Sutton said. "The science exists to demonstrate that [they] should be regulated as a class because they're equally harmful. It's such an obvious step that we could take as a country to prioritize the health of our communities rather than the profit of industries."

Officials in the town insist that they are doing everything they can to improve the water quality. Chris Kennedy, the town manager for Pittsboro, told the Guardian that that while the town was not a contributor to PFAS, it was "still diligently working towards removing PFAS from our potable water supply". Kennedy said the town was in the process of installing infrastructure that will remove at least 90% of PFAS by the end of the year and that it was taking steps where it could "to reduce contamination into the Haw River, which will provide the best results long-term".

The Guardian

Fickle weather takes crops on roller coaster

By Rod Boshart, Special to the Globe Gazette

Iowa's notoriously volatile and fickle weather patterns caused some roller-coaster effects for developing crops over the past week, state officials reported Monday.

Farmers reported many crops benefited from much-needed rain but more moisture is needed, especially in the northern two-thirds of the state, according to the latest crop report issued by the by the U. S. Department of Agriculture National Agricultural Statistics Service. But there also were scattered reports of damaging hail and high winds throughout Iowa.

"An active weather pattern shifted into the Midwest last week bringing several days of widespread and beneficial rainfalls," said Iowa Secretary of Agriculture Mike Naig. "The rain came just when moisture-stressed corn and soybeans needed it.

"Unfortunately, severe thunderstorms caused crop damage in parts of western and central Iowa, as well as flash flooding across southeastern Iowa," said Naig, head of the Iowa Department of Agriculture and Land Stewardship. "The forecast shows additional chances of rain and milder temperatures are expected over the next week."

Weekly precipitation totals ranged from slightly more than one-quarter of an inch in Sheldon to 8.1 inches in Cedar Rapids over the past week. The statewide weekly average precipitation was 2.13 inches, almost double the weekly normal of 1.09 inches.

While precipitation fell across Iowa the past week, amounts received varied widely with northwest Iowa still reporting over two-thirds of topsoil moisture short to very short. In contrast, districts in the southern one-third of Iowa rated 60 percent or more of subsoil moisture adequate to surplus.

Even with the beneficial rains, topsoil moisture levels were rated 12 percent very short, with 82 percent short to adequate and 6 percent surplus, while half of Iowa was rated short or very short of subsoil moisture.

State climatologist Justin Glisan said several waves of showers and thunderstorms brought measurable rainfall statewide along with multiple days of severe weather. Parts of southern and northeastern Iowa received heavy rain, which led to localized flash flooding while portions of northwestern Iowa continued to miss out on higher totals.

On a related development, Gov. Kim Reynolds issued a disaster proclamation Monday for Linn, Monroe and Wapello counties in response to severe weather beginning June 24 and continuing.

The governor's proclamation allows state resources to be utilized to respond to and recover from the effects of this severe weather and activates the Iowa Individual Assistance Grant Program for qualifying residents, along with the Disaster Case Management Program, for those three counties.

The Iowa Individual Assistance Grant Program provides grants of up to $5,000 for households with incomes up to 200 percent of the federal poverty level for a family of three. Grants are available for home or car repairs, replacement of clothing or food, and temporary housing expenses. Original receipts are required for those seeking reimbursement for actual expenses related to storm recovery. Potential applicants have 45 days from the date of the proclamation to submit a claim.

FROM DUST BOWL TO CALIFORNIA DROUGHT: A CLIMATE SCIENTIST ON THE LESSONS WE STILL HAVEN'T LEARNED

BY: MAANVI SINGH

California is once again in a drought, just four years after the last dry spell decimated ecosystems, fueled megafires and left many rural communities without well water.

Droughts are a natural part of the landscape in the American west, and the region has in many ways been shaped by its history of drought. But the climate scientist Peter Gleick argues that the droughts California is facing now are different than the ones that have historically cycled through the Golden State.

"These are not accidental, strange dry periods," said Gleick, the co-founder of the Pacific Institute, a global thinktank that has become a leading voice on water issues in California and around the world. "They're increasingly the norm."

Gleick this week spoke with the Guardian about the history of drought in the west, and the urgency of reshaping our relationship to water. The interview has been edited for length and clarity.

The California governor has declared a drought emergency in two counties, a few years after the state faced its last major drought from 2011-2017. Are more frequent dry periods part of a new normal?

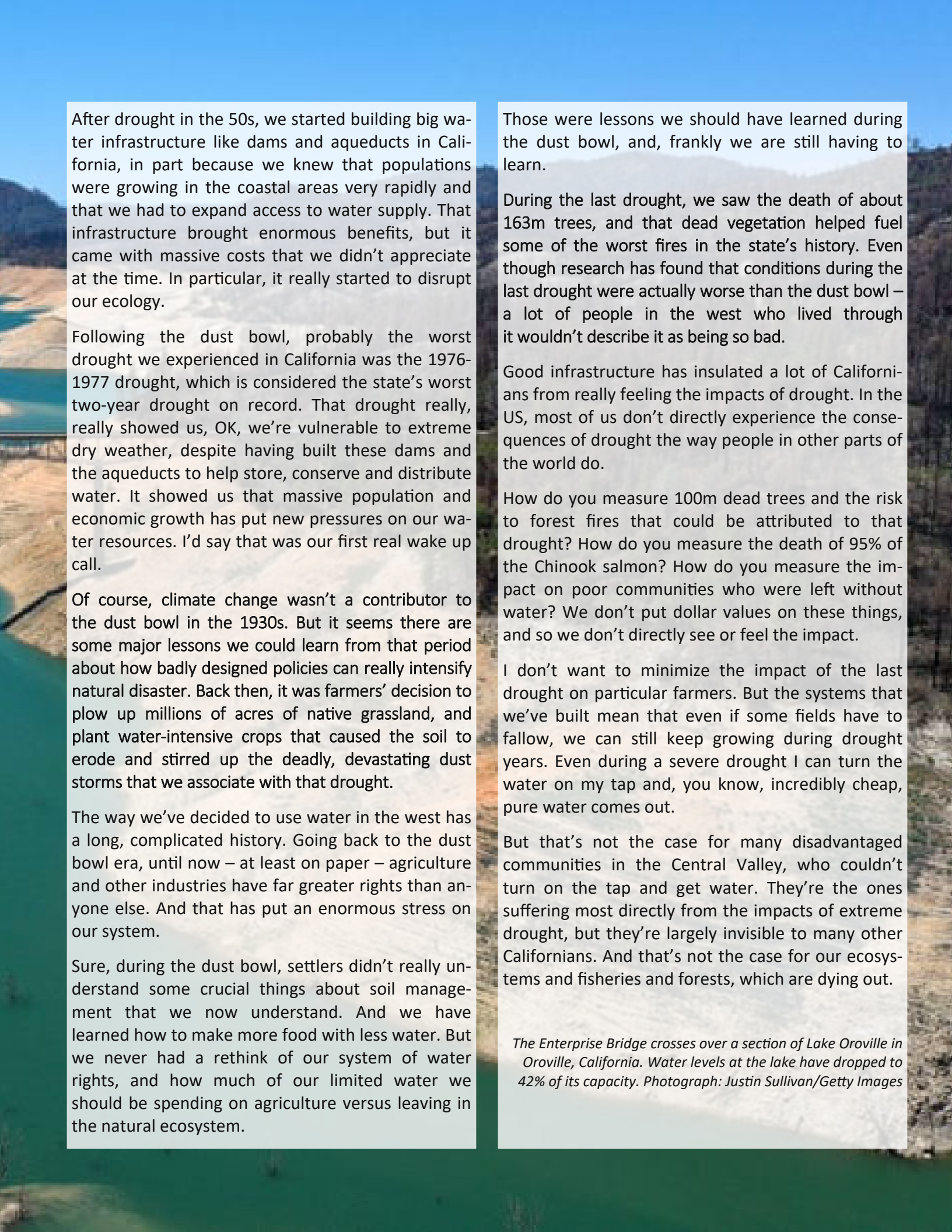
The last drought was a wake up call to the effects of climate change. For the first time, the public began to make the connection that humans were impacting the climate and the water cycle – affecting the intensity and severity of our droughts.

Since that drought, we have learned some lessons about improving water efficiency, and reducing waste. We had serious conversations about things like getting rid of grass lawns for example. But we still haven't learned the fundamental message: that these are not accidental, strange dry periods. They're increasingly the norm.

We better start to assume that the sooner we put in place policies to save water, the better off we are. We don't seem to have learned that there still is enormous untapped potential for conservation and efficiency despite our past improvements.

If the last drought helped people wake up to a worsening climate crisis, how did other defining droughts reshape our understanding of water in the region?

There were the dust bowl years of the 1930s, when thousands and thousands of people were dislocated from their homes in the western US because of severe drought that decimated agriculture and triggered deadly dust storms.



After drought in the 50s, we started building big water infrastructure like dams and aqueducts in California, in part because we knew that populations were growing in the coastal areas very rapidly and that we had to expand access to water supply. That infrastructure brought enormous benefits, but it came with massive costs that we didn't appreciate at the time. In particular, it really started to disrupt our ecology.

Following the dust bowl, probably the worst drought we experienced in California was the 1976-1977 drought, which is considered the state's worst two-year drought on record. That drought really, really showed us, OK, we're vulnerable to extreme dry weather, despite having built these dams and the aqueducts to help store, conserve and distribute water. It showed us that massive population and economic growth has put new pressures on our water resources. I'd say that was our first real wake up call.

Of course, climate change wasn't a contributor to the dust bowl in the 1930s. But it seems there are some major lessons we could learn from that period about how badly designed policies can really intensify natural disaster. Back then, it was farmers' decision to plow up millions of acres of native grassland, and plant water-intensive crops that caused the soil to erode and stirred up the deadly, devastating dust storms that we associate with that drought.

The way we've decided to use water in the west has a long, complicated history. Going back to the dust bowl era, until now – at least on paper – agriculture and other industries have far greater rights than anyone else. And that has put an enormous stress on our system.

Sure, during the dust bowl, settlers didn't really understand some crucial things about soil management that we now understand. And we have learned how to make more food with less water. But we never had a rethink of our system of water rights, and how much of our limited water we should be spending on agriculture versus leaving in the natural ecosystem.

Those were lessons we should have learned during the dust bowl, and, frankly we are still having to learn.

During the last drought, we saw the death of about 163m trees, and that dead vegetation helped fuel some of the worst fires in the state's history. Even though research has found that conditions during the last drought were actually worse than the dust bowl – a lot of people in the west who lived through it wouldn't describe it as being so bad.

Good infrastructure has insulated a lot of Californians from really feeling the impacts of drought. In the US, most of us don't directly experience the consequences of drought the way people in other parts of the world do.

How do you measure 100m dead trees and the risk to forest fires that could be attributed to that drought? How do you measure the death of 95% of the Chinook salmon? How do you measure the impact on poor communities who were left without water? We don't put dollar values on these things, and so we don't directly see or feel the impact.

I don't want to minimize the impact of the last drought on particular farmers. But the systems that we've built mean that even if some fields have to fallow, we can still keep growing during drought years. Even during a severe drought I can turn the water on my tap and, you know, incredibly cheap, pure water comes out.

But that's not the case for many disadvantaged communities in the Central Valley, who couldn't turn on the tap and get water. They're the ones suffering most directly from the impacts of extreme drought, but they're largely invisible to many other Californians. And that's not the case for our ecosystems and fisheries and forests, which are dying out.

The Enterprise Bridge crosses over a section of Lake Oroville in Oroville, California. Water levels at the lake have dropped to 42% of its capacity. Photograph: Justin Sullivan/Getty Images

Crews Drain Florida Wastewater Pond As Leak Threatens To Unleash 'Catastrophic Flood'

By Rachel Treisman

Emergency crews in Manatee County, Fla., are using pumps and vacuum trucks to drain a leaking wastewater reservoir in an effort to prevent a full-fledged breach that officials said could unleash a "20-foot wall of water."

The leak at Piney Point — a long-abandoned phosphate plant in the Tampa Bay area — was first discovered last month, and workers are removing millions of gallons of water from the reservoir each day to reduce pressure on its liner. Concerns over a potential breach prompted Florida Gov. Ron DeSantis to declare a state of emergency Saturday for Manatee County, where more than 300 homes and businesses have been ordered to evacuate.

"What we're looking at now is trying to prevent and

respond to, if need be, a real catastrophic flood situation," DeSantis said at a Sunday press briefing. Officials said Monday that a drone may have identified a second breach overnight; engineers evacuated the site but have since returned to continue their assessment.

The leak at the former fertilizer manufacturing facility and threat of an uncontrolled breach have prompted a multi-agency response at the state and federal level. The U.S. Environmental Protection Agency deployed an on-scene coordinator on Sunday, for example, and an Army Corps of Engineers team arrived at the site Monday.

Piney Point closed 20 years ago when its owners declared bankruptcy, Steve Newborn of member station WUSF told NPR. It is now owned by a company called HRK Holdings and still stores industrial byproducts including polluted water and stacks of phosphogypsum — a waste product that emits radioactive gas, according to the EPA.

HRK reported on March 26 that process water was bypassing the wastewater management system at Piney Point, according to Protecting Florida Together, a state-run website focused on water quality issues. Officials identified a leak in a containment wall that put the structure at risk of collapsing.

DeSantis said a "controlled release" began on March 30 at the urging of engineers, and efforts have averaged about 35 million gallons per day.

Water is being drawn by pumps from the top of the 79-acre pond to Tampa Bay, according to the county. Officials said on Sunday that the Florida National Guard was dropping off extra pumps to increase the volume of water being pumped out in addition to the 10 vacuum trucks and 20 pumps already deployed.

Acting County Administrator Scott Hopes said Monday that the additional pumps are expected to come online by the end of the day and more than double the volume of water being pumped out to between 75 million and 100 million gallons per day.

There were about 480 million gallons in the impacted area of the reservoir on March 26, according to Protecting Florida Together. By Monday, Hopes said that number was "probably just shy of 300 million."

DeSantis said the water being discharged is not radioactive, describing it as saltwater from a dredging project "mixed with legacy process water and stormwater runoff." It meets water quality standards for marine waters, officials said, "with the exception of pH, total phosphorus, total nitrogen and total ammonia nitrogen."

Matt Pasek, a geoscience professor at the University of South Florida, told NPR's Here and Now the water that is a waste product of phosphate is "mildly radioactive" but said "radioactive" has a wide range of values.

"To put it in perspective, this one's more radioactive than bananas, but not that many bananas. It's about 20 bananas' worth of radioactivity," Pasek said, adding that it likely does not pose digestive danger, at least in the short term.

While the state Department of Environmental Protection is monitoring the water to capture any environmental impacts, DeSantis stressed on Sunday that officials are most immediately concerned with the risk to local residents.

"Public health and safety is the priority," DeSantis said. "Obviously we want to protect that in a way that minimizes any of the environmental impacts, but the goal is to ensure the integrity of the stack system as quickly as possible in order to minimize impacts to local residents and to prevent an uncontrolled discharge."

Local water supplies are not in danger, state and local officials said Sunday, reassuring utilities customers that their drinking water remains safe and residents who rely on drinking wells have no cause for concern.

Ongoing evacuation order

On Saturday, the county expanded the mandatory

evacuation area around the breached reservoir by a half-mile to the west and one mile southwest. Emergency alerts urged residents to evacuate immediately, warning "Collapse of Piney Point Stack Imminent."

Much of the area under the evacuation order is agricultural and industrial, WUSF's Newborn said. Officials said Monday that about 30 people and their pets remain in noncongregate shelters at local hotels.

Concerns have also been raised over the safety of residents at the Manatee County Jail. Hopes initially said on Sunday that all personnel and residents had been moved to the top floor of the two-story facility, putting them "well over 10 feet above base level." On Monday, he said inmates had been safely transported to a nearby undisclosed location.

The Miami Herald reported that 267 inmates were transferred to a correctional facility in Polk County after testing negative for the coronavirus and that the remaining 721 were sheltering on the second floor. Another 200 individuals can still be transferred to another location if the need arises, Manatee County Sheriff's Office spokesman Randy Warren told the newspaper.

History of problems and hopes for accountability

While crews continue working to mitigate the most pressing risks, public officials said they will soon start looking ahead to addressing the environmental impact of the breach, holding HRK accountable and implementing a permanent solution.

Some noted that Piney Point has long posed an issue. Nikki Fried, Florida's commissioner of agriculture and consumer services, said in a tweet that the situation is a "result of decades of ignoring science and scientists."

In a Saturday letter requesting that DeSantis convene an emergency meeting of the Florida Cabinet for a briefing by the state's Department of Environmental Protection, Fried described "numerous, well-documented failures ... of the property's reservoir liner, including leaks, poor welds, holes, cracks and weaknesses" that existed under previous ownership and have worsened since.

"For more than fifty years, this Central Florida mining operation has caused numerous human health and environmental disasters and incidents, including evacuations from sulfuric acid leaks, deaths of multiple employees, the release of more than 1 billion gallons of contaminated wastewater, and ongoing, regular gypsum stack and reservoir leaks from poor construction and maintenance that released heavy metals and pollutants into the region's water and soil," Fried wrote.

This issue, Hopes said Sunday, "could have been resolved over two decades ago."

U.S. Rep. Vern Buchanan, R-Fla., said at a Monday press conference that he was concerned about the environmental impact of the breach, noting he had seen the area by helicopter and thought the water "spewing out ... looked pretty contaminated to me." He also said he believes the situation is affecting not just Manatee County but the entire region, noting the movement of the currents.

Pasek, the geoscience professor, said that an influx of phosphorus can cause phenomenon such as algal blooms and red tide, which damage the ecosystem, kill off fish and render seafood creatures toxic.

Buchanan is one of several officials calling for HRK eventually to be held accountable for what he described as "failing over the years to properly protect the public."

Department of Environmental Protection Secretary Noah Valenstein said in a statement that "it is clear that this facility must be closed," and said that the department would hold the company accountable through "enforcement action."

DeSantis said he had asked Valenstein to work with the county and use all available resources to create a permanent solution.

How Technology Can Help Restore Food And Agriculture Production

By Peter Pluim

A recent Cornell University study found that farming productivity has fallen 21 percent since the 1960s due to climate change. Farmland impacts biodiversity and the earth's ability to absorb carbon dioxide which is why it must become smarter, to produce enough food for our planet's population, and more resilient, to support the restoration of our eco-system.

Enter digital, cloud and intelligent technologies which can optimize farming, capture carbon, and facilitate regenerative agriculture. More importantly, we can shift the entire agricultural supply chain to a circular business model by connecting linear, fragmented supply chains into unified, collaborative, and intelligent business networks.

A circular model can combine already existing approaches to make food production more sustainable and resistant to environmental changes. Ag tech companies like Syngenta and Indigo Ag have developed different types of seed technologies that make crops more resilient. Crops, such as wheat, corn, and soy, can grow in tougher conditions with less water. As a result, farming becomes less dependent on irrigation and may be even restored on barren lands. At some point in the future, growing food may even become possible on Mars.

For now, here on earth, farmers started using satellites and drones to monitor crop health and soil conditions. They use sensor technology to measure moisture and temperature, and aerial images give updates on crop growth. It also has become more common to see robots in the field weeding and harvesting.

More invisible to the eye of the consumer, but highly impactful is the use of cloud platforms and services to aggregate and analyze data from the entire production process, such as the data from soil sensors, the crop growth captured by drones, and weather updates. Farmers and distributors can build a more intelligent agricultural supply chain using cloud-based technologies that enables them to adapt more quickly to a changing growing environment and consumer demand.

Let's not forget, agricultural products are highly perishable. They have a short shelf until they get consumed or preserved. Matching agricultural production with consumer demand is important for product quality and to reduce food waste and carbon emissions. The UN estimates that 8-10 percent of global greenhouse gas emissions are associated with food that is not consumed.

Zespri International, the world's largest marketer of kiwifruit is an example of an intelligent enterprise that is using technology to optimize production and distribution. The New Zealand based company is using the cloud to plan their global supply chain more accurately and make decisions on shipments and market allocations.

Zespri could already reduce the loading time of kiwi pallets onto the ship at ports from 20 minutes to 30 seconds to get the fresh produce faster to destinations worldwide. In partnership with SAP, the grower-owned marketer of kiwi fruits is now transforming its entire global supply chain by standardizing and automating processes across the organization, creating efficiencies, and providing a platform for growth and innovation.

The possibilities of technology innovation are endless, but our time is limited to reverse the effects of climate change. By working together and using new technology approaches for responsible design, sourcing, production, consumption, recovery, and reuse across industries we can pave the way for a circular, more sustainable economy and restore our earth. The next generation is counting on us.

'Extreme drought' is threatening parts of the Prairies, says Agriculture Canada

Farmers fear for their crops and cattle in severely dry conditions

By: Cameron MacIntosh and Karen Pauls · CBC

Manitoba farmer Chuck Fossay has never seen his fields this dry. As he scoops up a handful of black top soil, it runs through his fingers like sand.

"It's just bone dry. And there's nothing there to support the seed and the crop to grow," he said.

Farming near Starbuck, Man., about 20 minutes west of Winnipeg, Fossay is trying to get his canola into the ground.

He's planting a little deeper this year, hoping to find moisture so the seeds can germinate and start growing.

He hopes that with some well-timed rain, he can still salvage a near-average crop but with conditions this dry, he said it's likely compromised before it's even planted.

"Dry is dry and nothing grows without water. That's just a fact of life. You need water to live. And if you don't have enough water, nothing grows," Fossay said.

"If we don't get a rain, a nice, general soaking rain probably the next two weeks, we're probably talking a crop failure out here in Manitoba."

'Extreme drought'

It will take more than just one day of rain. An abnormally dry fall is being followed by one the driest springs in recent memory.

Agriculture and Agri-Food Canada considers southwestern Manitoba and southeastern Saskatchewan to be under "extreme drought" conditions, while most of the rest of Prairies are also considered to be experiencing moderate drought.

"Parts of it are close to record dry conditions when you look at soil moisture, that's less than 40 per cent of normal," said John Pomeroy, a Canada Research Chair in Water Resources and Climate Change. He works out of the University of Saskatchewan's lab in Canmore, Alta.

While droughts are part of the agricultural cycle, Pomeroy said what is unusual this year is the scope of the dryness, extending "from Vancouver Island to southern Quebec, down into the United States, into California, right into Mexico ... it's enormous."

Economic impacts

Also enormous is the potential impact on Canada's economy. If these conditions persist, it won't just be farmers hit hard. For consumers, it can mean higher grocery prices.

Water is also a critical resource in the resource and energy sectors; potash mining, oil production and hydroelectricity rely on it.

"Back about 20 years ago, there were four years where there was a $10-billion hit to the western Canadian econ-

omy from drought and 41,000 jobs lost in Saskatchewan alone. So there's an impact," Pomeroy said

"It's like losing the automotive industry out of southern Ontario."

Drought and dry conditions can also threaten the water supply as rivers dry up and lake levels drop.

"There's a lot of small communities, rural communities that have a less than reliable water supply. So they might get their water, for example, from a shallow well, they might get their water from a reservoir and those water supplies are being depleted," said Dave Sauchyn, a professor and researcher with the University of Regina's Prairie Adaptation Research Collaborative.

He helped write a report on climate change impacts and approaches to adaptation.

Already, one community in southern Manitoba has started restricting water use, asking residents to cut their consumption by 25 per cent.

The province has also put a ban on campfires and access to back country trails in drought-affected areas, activities that have been extremely popular during the pandemic.

Near the Ontario border, a forest fire has already cause damage in Manitoba's Whiteshell Provincial Park.

But for those who rely on Mother Nature for their livelihoods, the stakes are high.

'Cattle cannot survive without water'

Close to the Manitoba-Saskatchewan border, Bill Campbell is worried about his own farm, but he's also hearing concerns from farmers across the province as president of Keystone Agricultural Producers, an advocacy group based in Winnipeg.

"We always say that April showers bring May flowers. Well, it also brings me grass," Campbell said as he watched his cattle graze on grass that is brittle and dry.

"It becomes a major concern when we have limited forage reserves like bales in the yard or silage left over. And once you run out of that reserves, what do you do? You send them to pasture for a limited amount of time and they eat all that's there."

Looking at the Souris River on his land, Campbell points out rocks that should be covered with a metre of water that are now exposed.

"We rely on retention ponds, dugouts, springs, creeks, various water streams and a lot of them are dry and cattle will not survive without water," he said.

Curled heads of wheat show the drought damage on Nicole Berg's ranch in southeast Washington state.

Farmers Are Feeling The Pain As Drought Spreads In The Northwest

By: Anna King

Nicole Berg's stunted wheat field is so short and sparse she doesn't think the combine can even reach the wheat without, as she puts it, eating rocks.

"Combines don't like dirt and rocks," Berg says, standing amid the damaged rows. "They get indigestion."

Berg is a dryland wheat farmer in the sweeping Horse Heaven Hills of southeastern Washington state. She shows off one head of half-turned golden wheat amid a sea of them. Besides being too short, the plant's kernels didn't fill out properly.

"See how the wheat head is curled like that?" Berg points out. "And then you break into it, you might have some berries down here, but this will be empty. There is no wheat inside the wheat head."

Northwest farmers like Berg, and ranchers who de-

Northwest farmers like Berg, and ranchers who depend on rain, are expecting what one farmer called a "somber harvest" this year.

Little moisture since February in wide swaths of the region is to blame. And drought is deepening across the West, with federal drought maps showing massive and growing areas of red.

On her ranch, Berg says she's also worried about 1,000 acres of native grass seeds she has to plant this year into dry soil for a government conservation program. She says with all the Western wildfires in recent years, the wild grass and forage seeds have become expensive. She hates to plant them in shallow, bone-dry soil only to lose the crop if there's not sufficient rain.

As dry as it's been in a century

The Berg's aren't the only ones suffering. The region is parched from near the Canadian border clear to the edge of Nevada, with triple digit temps on the way making it worse.

Earlier this year, Oregon declared drought zones for eight counties, and six more have requested it since. Now the drought is rapidly expanding into usually cooler and wetter western Oregon, according to Ryan Andrews, a hydrologist for the state's Water Resources Department. He says the thirsty ground will absorb whatever rain comes, meaning streams and rivers will get little water.

Jeff Marti, a drought expert for Washington's Department of Ecology, says it hasn't been this dry since the 1920s.

"For anybody farming right now, they haven't seen it this dry out there," Marti says.

He explains that the impact will vary.

"It's the story of the irrigation haves and the have nots," he says. "Meaning those folks who get their water from rivers or storage, are probably going to be fine for their irrigation needs. But the dryland users and the folks that have cattle that depend on forage on the rangelands may be more challenged."

Looking ahead, Marti says the warming climate may mean more rain for the Northwest, but also much less snowpack that melts sooner. That could stress water supplies even more.

"We're not going to give up"

A bit west of Alderdale, Washington, cattle rancher Gary Hess is also having a hard time with the drought. His grass-fattened mother cows bawl at their calves, wanting them to stay close and away from the cattle dog. But he only has enough irrigated pasture for a small part of his herd, the rest are on dryland range.

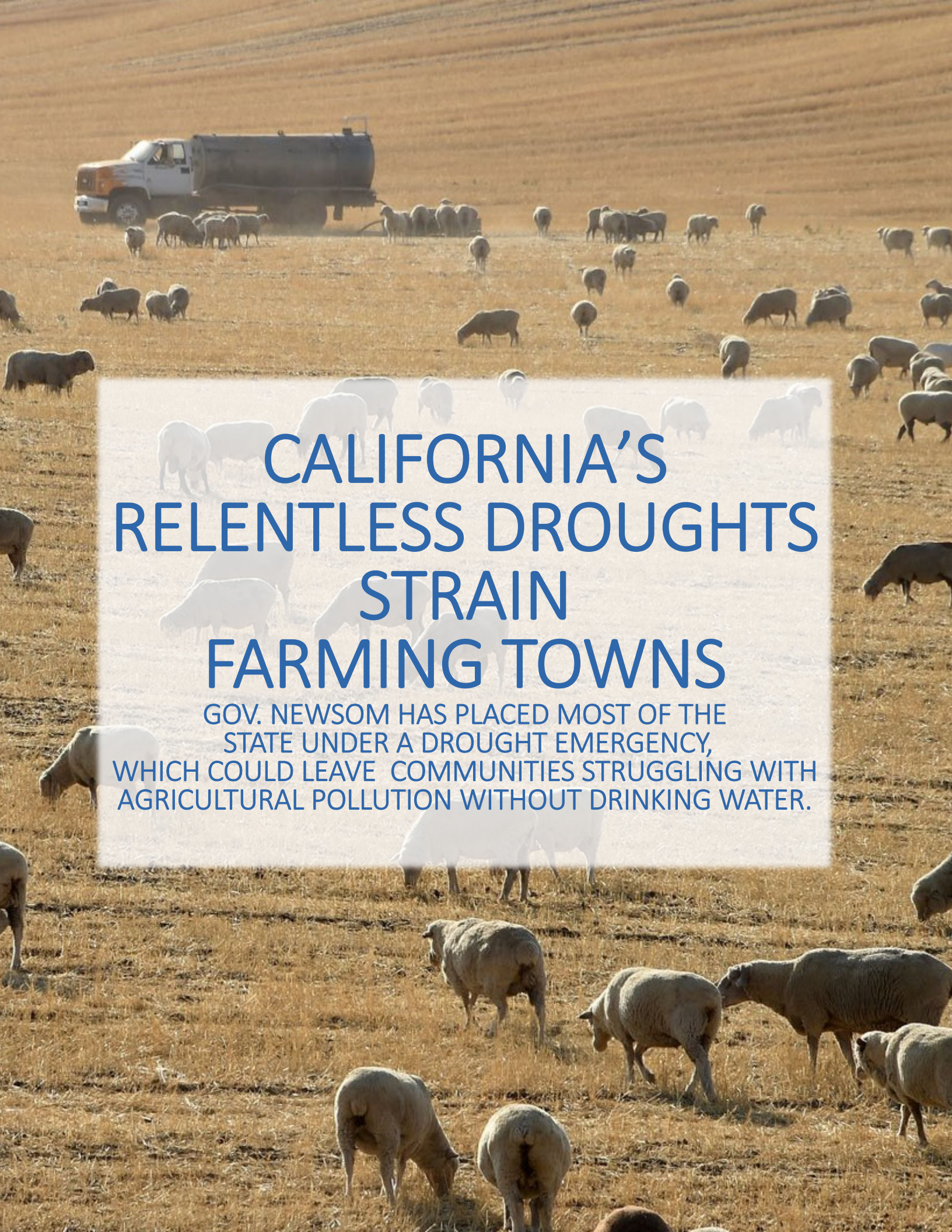
So Hess recently sold 70 mother cows with calves at their sides to another operator in Wyoming. They had many more good calves in them, and he hated to see them go. But he has no dryland grass to keep them.

"When you have to sell younger cows, that's a disappointment," Hess says as he tears up a bit. "With the kind of weather we've had the last couple of years, and the drought and the lack of feed and lack of water, we just finally had to cut back."

This spring it's also been windy here, further drying out the landscape like a blow dryer. Hess is thinking he'll have to sell more cows soon just to survive. He says it's hard to lose animals and bloodlines that he's worked so hard to build up. He figures it could take him up to a decade to build his herd back up without going into debt.

"Our family has been here over 100 years, and they've been through this before," he says. "We're not going to give up."

Most ranchers say they don't have time to dwell on the trucked-off cattle or lost crops. They're busy applying for federal disaster aid. And they're also keeping an eye out for wildfires that are always top-of-mind in the dry, hot summer, but expected to be worse because of this year's terrible drought.



CALIFORNIA'S RELENTLESS DROUGHTS STRAIN FARMING TOWNS

GOV. NEWSOM HAS PLACED MOST OF THE STATE UNDER A DROUGHT EMERGENCY, WHICH COULD LEAVE COMMUNITIES STRUGGLING WITH AGRICULTURAL POLLUTION WITHOUT DRINKING WATER.

Sandra Chavez was 13 years old when her family's well went dry in 2014, two years into California's last major drought. Their tap had stopped running a few times before, but the water always returned the same day, so they didn't think it was a big deal. This time was different.

"We didn't have water in our house for eight months," said Chavez, now 20 and a college student. "We had to get tanks of water, fill them up, haul them over in my dad's truck and fill up buckets of water that we'd have to heat up if we wanted to use it to bathe."

Chavez's family lives on a small ranch on the outskirts of Porterville in the San Joaquin Valley's Tulare County, the nation's top dairy producer. When they tried to get someone to service their well, they learned that there was a waiting list of one to two years, because so many had the same problem. Luckily, her dad found a friend of a friend who digs wells and could help them sooner. But the family had to take out a loan to pay for the work.

There is no guarantee that the same thing won't happen again—to the Chavez family and to tens of thousands of others—as California's latest drought emergency drags on.

On May 10, after two dry winters in a row, Gov. Gavin Newsom declared the second drought emergency in less than a month. The declaration now covers 41 counties, from the Oregon border to the southern Central Valley, which produces more than 250 crops, worth $17 billion a year, and accounts for roughly three-quarters of the state's irrigated land.

Exceptionally warm temperatures in April and early May distinguished "this critically dry year" from all others on California record, the governor's office said. High temperatures accelerated snowmelt in watersheds that feed California's major reservoirs, while the bone-dry ground sucked up meltwater that normally rejuvenates rivers and streams.

To mitigate severe drought impacts, the governor authorized state officials to direct water flows where they're needed most. But some observers worry that the drought will aggravate long standing inequities in access to the state's dwindling water supplies.

"The drought is absolutely going to exacerbate existing disparities in a number of ways," said Jonathan London, associate professor of human ecology and faculty director of the Center for Regional Change at the University of California, Davis.

During the last drought, California farmers lost about 30 percent of their surface water allocations, which they replaced largely by pumping groundwater. They are likely to do the same thing this time around.

"That's going to lead potentially to dry wells for low-income people who can't afford to dig deeper wells," London said. "It will also potentially lead to toxic groundwater plumes spreading through the valley that could affect people with shallow wells and don't have a community water system to provide safe drinking water."

Millions of Central Valley residents get their drinking water from wells fed by the same underground aquifers that supply the region's farms. Aquifers in the Tulare Basin, where Chavez and her family live, have sunk to precariously low levels. That's because farmers extracted water with little oversight from the early 1900s through 2014, when the state passed a sustainable groundwater management law. By then, however, they had pumped, on average, hundreds of billions of gallons a year more than could be replaced by rainfall and other sources.

As a result, more than 2,000 wells went dry in the San Joaquin Valley during the historic drought that lingered from 2012 to 2016. But as many as 65,000 people in the region could lose their access to drinking water because their wells are too shallow to

reach the dropping groundwater levels, according to a 2020 report from London's Center for Regional Change.

The valley is one of the poorest regions in the country, "poorer than Appalachia," London said. And many of those at-risk wells serve mostly people of color, living in unincorporated communities that lie beyond city limits and lack access to essential municipal services, including adequate sewers and safe drinking water.

Exposing Historical Inequities

In 2012, California became the first state in the country to recognize access to safe, affordable drinking water as a human right. Yet the historic 2012-2016 drought, which one study concluded was the worst California drought in more than a millennium, revealed disparities not only in who gets the state's increasingly precious water supplies but in who receives water that's fit to drink.

During the summer of 2014—soon after the Chavez family lost their water in Porterville—some 300 wells went dry in the adjacent town of East Porterville, one of the largest unincorporated disadvantaged communities in the San Joaquin Valley.

By the time the drought ended in 2016, about 1,600 domestic wells experienced shortages in Tulare County, according to a 2018 report from the Center for Regional Change. Close to a third of those wells supplied people in East Porterville, where 79 percent of residents are Latino and the poverty rate is more than three times the national rate—in one of the richest agricultural regions in the nation.

Other wells were contaminated with nitrates from widespread use of commercial fertilizers and manure, which Tulare County growers applied to nearly 600,000 acres in 2017, according to the latest statistics available.

A year after the Chavez family got their well working again, they learned that the water had four times the level of nitrates considered safe. "I had been drinking that water since I was three," Sandra Chavez said.

Now, with the help of the Community Water Center, a nonprofit based in the valley, the Chavez family gets five-to-six five-gallon jugs of water delivered to their home through a combination of state programs and nonprofit organizations. Chavez said she's grateful for the support, but that it's not enough for the household, which includes seven foster children her parents care for.

California officials have long recognized that nitrate groundwater contamination is widespread. The state Legislature first addressed the issue in 2008, when it asked researchers at the University of California, Davis, to investigate the causes, to "ensure the provision of safe drinking water to all communities."

The researchers determined that 96 percent of nitrate groundwater pollution came from fertilizers and manure applied to crops, and that it contaminated the drinking water of more than a quarter of a million people in the Tulare Lake Basin and the Salinas Valley, where most of the nation's lettuce is grown. And a 2011 study showed that low-income, predominantly Latino communities in the San Joaquin Valley faced the highest risks of receiving that water.

Nitrates cause a life-threatening condition called methemoglobinemia, better known as blue baby syndrome, which blocks oxygen flow in blood. Mounting evidence also links high nitrate exposure to colorectal cancer, thyroid disease and birth defects of the brain and spinal cord.

Two years ago, the state created the Safe and Affordable Funding for Equity and Resilience (SAFER) program, which has provided bottled water to the Chavez family and others throughout the valley. But it will take years to build the infrastructure needed to connect isolated farming communities to municipal water supplies in cities.

Until then, people who rely on wells, or who live in unincorporated towns that lack the customer base

to afford effective water treatment, must still resort to bottled water. And if they don't know the water's contaminated, as Chavez didn't for years, they must also bear the health costs of drinking unsafe water.

Conflicting Narratives

Climate change is already making droughts worse and the state's winter rainy season shorter and more erratic.

Understanding how different people experience vulnerability to drought is critical to ensuring that water policies address historical and current social and environmental inequities. Toward that end, researcher Christina Greene interviewed farmers, farmworkers and other rural residents in the San Joaquin Valley about their perceptions of the 2012-2016 drought.

Most people viewed the drought as a result of human actions, said Greene, assistant research scientist at the University of Arizona's Climate Assessment for the Southwest. But they weren't referring to human-caused climate change.

"By far the dominant discourse is that the drought is because of water regulation," she said, especially regulations aimed at reducing agricultural diversions to help the state's threatened smelt and salmon. Several people blamed the drought on environmentalists and the Endangered Species Act. "Drought started in 2008, when the courts ruled in favor of the fish," a social worker told Greene.

Greene heard the same perspective during random conversations in stores. "There's also a lot of money going into propagating that narrative," she said, referring to billboards throughout the valley blaming Congress for the "dust bowl" and "flawed laws" like the ESA.

Such attitudes are understandable, Greene said. "Their livelihood is completely intertwined with the success of these farms."

But, in contrast to what many people told Greene, recent research puts the lie to the notion that either the state's native fish or water regulations created the drought.

Last year researchers at Santa Clara University in Silicon Valley, where the nation's billionaire tech titans live an hour south of San Francisco, published an analysis of the relative impacts of extreme drought on water allocations from the Tuolumne River, which originates in the Sierra Nevada. They tracked allocations during periods of normal water supply and moderate and severe drought to the San Francisco Bay Area (which is fed by the Hetch Hetchy Reservoir that dams the river) and to agricultural regions in the southern Central Valley, which includes prime habitat for Chinook salmon, listed as a species of concern under the ESA.

The study results, published in the Journal of Hydrology X, revealed profound differences in how supplies were allocated from 2008 to 2018.

Severe drought had no effect on water flows to affluent Bay Area users. By contrast, supplies to less well-off agricultural and urban users in the valley were curtailed by about 30 percent, while flows to the San Joaquin River, which are critical for salmon survival, were reduced by 85 to 90 percent.

"We were transporting some of the best water in the world, from the Sierras and Hetch Hetchy, right through the farming communities," said Iris Stewart-Frey, an associate professor of environmental studies and sciences at Santa Clara University who led the study. Many of those communities have disproportionate rates of poverty and lack access to safe, clean water, she said.

Liza Gross / Inside Climate News

California is on the brink of drought – again. Is it ready?

It's been just four years since the state's last drought emergency and battles are beginning over how scarce supplies are rationed

The Guardian

California is at the edge of another protracted drought, just a few years after one of the worst dry spells in state history left poor and rural communities without well water, triggered major water restrictions in cities, forced farmers to idle their fields, killed millions of trees, and fueled devastating megafires.

On Thursday, the unofficial end of California's wet season, officials announced that the accumulation of snow in the Sierra Nevada mountains and the Cascades was about 40% below average levels. The state doesn't have enough snow and rain banked to replenish its groundwater supplies, feed its rivers and streams or fill depleted reservoirs.

"It's not just that we're anticipating a dry year, it's that this is our second extremely dry year, in a row," said Daniel Swain, a climate scientist at the University of California Los Angeles and the Nature Conserv-

ancy. California – along with much of the US west – is parched, Swain added, and should brace for water cuts and arid conditions that could trigger more destructive wildfires.

Just four years since the state's last drought emergency, experts and advocates say the state isn't ready to cope with what could be months and possibly years of drought to come. Heading into the summer, battles are heating up between cities, farms and environmentalists over how scarce supplies are rationed.

'We're simply not prepared'

In the San Joaquin Valley – California's farming heartland – the last drought never really ended for some. There are still communities in rural Tulare county that are getting their water delivered by trucks, homes with massive tanks parked out front. Reserves of groundwater that millions of households rely on for drinking, cooking and bathing, in some cases, never fully recovered.

But at the height of the state's last major drought, which ran from 2012 through 2016, things were even worse. When residential wells ran dry, "high schools opened up early so students could shower before class", said Erick Orellana, a policy advocate at the non-profit Community Water Center. Households lucky enough to dredge up some water ran hoses over to neighbors whose supplies had run dry, "so they could flush their toilets", he said. Underserved communities, Latino and Native communities were the worst affected.

Looking ahead, "we're simply not prepared to prevent that from happening again", Orellana said.

Already, the California department of water resources has announced major cuts to the reservoirs and aqueducts that supply farms and cities. The Federal Bureau of Reclamation, which delivers water to farms up and down the state's Central Valley, said agricultural customers south of California's delta, which feeds into the San Francisco Bay, will not be getting any water this year. And some localities, including Marin county, north of the San Francisco Bay, have asked residents to voluntarily cut back on their water use.

"But our water system is already strained" said Nicola Ulibarri, who researches water management at the University of California, Irvine. The state's massive agriculture industry, which supplies what amounts to a quarter of the US food supply, sucks up 80% of the state's water resources. Much of the rest is pumped to cities and towns across the region. California is already drawing so much water from the state's bay delta that endangered, native fish species are in decline.

There just isn't enough water to go around, she added, "and that to me signals we're going to need the whole system to change".

When rivers and reservoirs run dry, farmers turn to pumping more and more water from the ground. During the last drought, they sucked up so much water that many farm workers and other residents in the San Joaquin Valley were left without any.

Since then, California passed its first-ever law regulating the use of groundwater. As part of the new legislation, over the past two years, communities have been developing proposals to conserve reserves. But these plans haven't been implemented yet, said Ulibarri – and especially on the heels of the coronavirus crisis, which drained state coffers, state politicians may not have the will or resources to fund much-needed changes.

And even as officials review proposals for making changes, big farmers have been able to lobby for more water rights. "Meanwhile, there's no real lobby for households that also need water," said Camille Pannu, who directs the Water Justice Clinic at the UC Davis School of Law. "And that's how we end up with really stark racial inequalities when it comes to access to water"

Wildfire and a changing climate

Political clashes over where the limited water sup-

plies should be allocated have already flared up across the state. Environmentalists have warned that they may sue the federal government to prevent it from redirecting delta water to farms at the expense of endangered smelt and salmon. Agricultural lobbies have been pushing the state's governor, Gavin Newsom, who is facing a recall campaign, to provide assurances. And groups such as the Community Water Center have been pushing legislators to pass bills to protect underserved, rural communities' access.

But as officials face fraught decisions about how to allocate water, scientists are warning that the drought will also bring fiercer, more destructive fires across the west. Over the past decade, drought in California contributed to the death of about 163m trees – and dead vegetation has helped fuel some of the most destructive fires in the state's history over the past few years.

The current drought, and the previous one, are characterized by not just low precipitation – but also hotter weather, said Swain of UCLA. Not only drier, but also hotter conditions have primed the landscape to kindle more destructive blazes. "Extreme, intense fires are the exclamation points at the end of long-term droughts," he said.

Last year, which saw the state's worst wildfire season on record, left 31 people dead, and burned up more than 10,000 buildings. In regions devastated by recent megafires, toxic fallout from the flames has also tainted limited drinking water supplies.

"This year is likely to bring more big burns," Swain said. "There isn't really any sign of relief on the horizon."

Deepening Drought Holds 'Ominous' Signs For Wildfire Threat In The West

By: Eric Westervelt

After one of the most destructive and extreme wildfire seasons in modern history last year, a widening drought across California and much of the West has many residents bracing for the possibility this season could be worse.

Anemic winter rain and snowfall has left reservoirs and river flows down significantly, even as the state experiences its driest water year in more than four decades. Today, wildfire fuels in some parts of California are at or near record levels of dryness.

Fuel moisture — the amount of water inside a living plant — "is the lowest that we've recorded at these sites since 2013," says Craig Clements, director of the Wildfire Interdisciplinary Research Center at San Jose State University. "It's indicative of very dangerous conditions coming into this summer."

Those hazardous conditions are the result of drier, hotter weather and accelerated vegetation drying due to a warming climate, combined with more than a century of fire suppression, that has left many forests with treacherous amounts of built-up fuel. Those two factors are now amplifying each other, says Daniel Swain, a leading climate scientist at UCLA and the Nature Conservancy.

"I think, unfortunately, as bad as things have been recently, this year looks like another year that has some really ugly potential," Swain says.

Climate scientists point out that a menacing wildfire potential this year doesn't necessarily mean that anything will happen.

"Really, that's just going to be a matter of luck," Swain says. But "of all the aspects that are predictable, they all look pretty ominous."

As dire drought conditions spread, all could get exacerbated again by warmer than normal temperatures.

"Summer temperatures are forecasted by the National Weather Service to be above normal again all across the West, including California," says Amanda Sheffield, a regional drought information coordinator with the National Oceanic and Atmospheric Administration's National Integrated Drought Information System.

California has already had a pretty rapid snowmelt for this time of year, she notes, so upper elevations "could be particularly vulnerable earlier than usual as we move into midsummer."

But it's a forecast some in wildfire and pandemic-battered California may not want to hear.

On a recent day in Napa County's picturesque Calistoga, tourists are returning in droves more than ready for a post-lockdown generous pour, and to take in the beautiful, if fire-scarred, landscape.

But Calistoga — like a handful of other cities — has already imposed emergency water restrictions because of the drought. So the city's energetic mayor, Chris Canning, has to balance boosterism with realism.

Canning notes that since the city's founding in 1862, residents have only been evacuated twice, both times in the last four years because of wildfire.

"Not a good resume for a mayor," he says with a smile. "But absolutely necessary for the safety and protection of our residents. And we'll do it again if we have to."

To get a jump on any fires this season, Canning is pleased that the California Department of Forestry and Fire Protection, or Cal Fire, has dedicated a new firefighting helicopter and a 24/7 firefighting crew of nearly 50 men and women for Napa County. Cal Fire has beefed up its wildfire fighting capacity statewide, adding several specially modified S-70i Firehawk helicopters to its fleet. These are more agile and versatile than its old UH-1H, or Huey, helicopters.

And the mayor says most of the region's residents get it: Climate-fueled wildfires are an ongoing

threat. So people are building bigger fire breaks, making an evacuation plan and clearing brush — creating what firefighters call defensible space on their properties.

But Canning admits that's not everyone.

"The other school of thought is let's pretend, you know, what happened in the past is the past, it'll never happen again," the mayor says. "The amnesia response is problematic, especially if you're not taking the precautions you need to as a business or a resident to be prepared. That's where it's dangerous."

In late September, the fast-moving Glass Fire badly damaged nearly 30 Napa wineries, including family-owned Hourglass wines. It swept through as the region was still recovering from 2017's record-setting fires.

"That was all remnants of the old farmhouse," says Jeff Smith, Hourglass' founder and president, as he walks near a pile of charred stones — all that remain of the winery's guesthouse, built in 1852.

But Smith says the hardest loss was the grove of old growth redwood, Douglas fir, oak and olive trees, even older than the house, most which now lie burnt and stacked for salvage.

"To me that was the soul of the property, those trees," he says. "The buildings can be rebuilt, but the couple hundred-year-old trees, you know, you can't just magically bring those right back."

Hourglass' winemaking building is a total loss. Steel fermentation and storage tanks sit like sad, damaged sculptures: Most of the 2020 vintage is still inside, cooked and useless.

The devastating Glass Fire was just one of nearly 10,000 California wildfires last year that burned more than 4 million acres — a modern record. Across the West, more than 14,000 structures were destroyed, causing billions in damages. At least 46 people were killed as California, Oregon and Colorado — all saw record-breaking "megafires."

Smith, who was born and raised in Napa, is rebuilding. But he says the more frequent, more destructive wildfires have him rethinking everything about how he manages his land, business and life.

"You know, I grew up here. All of my roots are here, and it's my intention to stay and rebuild," he says. "But I think that there's a lot of game-changing thought processes that we need to be going through."

Past vintages, stored in wooden barrels in stone and cement caves built into the hillside, survived the fire. Smith is looking to rebuild stronger and smarter.

"We're taking a much harder look at materials, defensible space, at fire suppression systems, access. You know, all of these kinds of things to try to mitigate this into the future."

And Smith is hopeful. He aims to rebuild enough this summer to crush and process this year's grape harvest in a new facility here, along Napa's famed Silverado Trail in September.

At least, that's the plan.

"I tell my winemaking team: Have a backup plan!" Smith says with a laugh. In a world-class wine region turned wine and wildfire zone, he concedes, "It's always good to have a Plan B."

Pictures by Eric Westervelt:
The entrance to Hourglass winery, with an evacuation tag from the Napa County Sheriff's Office from last year's Glass Fire blowing in the wind. Residents place these tags on their properties before evacuating, easing the job of first responders.

Wildfire-scarred hills are visible behind the famous sign welcoming visitors to Napa Valley.


TWCA CALENDAR
upcoming events
WSI
October 5-6, 2021
GIE + EXPO
October 20-22,
2021

TWCA TURF TIPS:

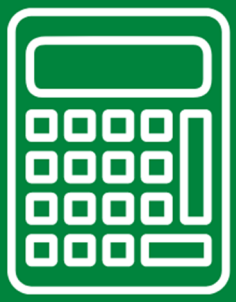
make every drop count

DONT MOW! TOO SHORT

Only mow 1/3 of the total grass blade off with a sharp blade. Cutting off more 1/3 increases water use and disease pressures

HEALTHY SOIL HEALTHY LANDSCAPE

Drought tolerance is directly tied to soil health. Performing a soil test is a key first step to knowing what your landscape needs



CALCULATORS HELP KNOW YOUR NEED

Every landscape has different needs. TWCA Irrigation calculator helps set run-times for all levels of management ant turf types. Access this through the link below:

turfgrasswaterconservationalliance.org

SET IT DON'T FORGET IT

Regularly inspect the irrigation system to make sure the spray heads and bodies are intact and operational.

NGBS

Earn points for using TWCA Qualified turf in the 2020 NGBS standard

MANUAL

Managing Landscapes for Water Conservation provides science based methods

CSI Standards

TWCA is developing CSI standard specifications in partnership with Turf Producers International

TWCA 10 YEARS

INDUSTRY STANDARD

TWCA defines water use in the turfgrass industry. Learn more at tgwca.org

TURFGRASS WATER CONSERVATION ALLIANCE / ADDRESS SERVICE REQUESTED