

2021

U.S. Drought & Impact Report

Growing up in Arizona's Sonoran Desert, I was taught to treat every sip of water as a precious. Here, our average annual rainfall is just 13 inches, temperatures regularly top 120 degrees Fahrenheit and climate change is quickly making this hot, dry area even hotter and even drier. We are now in our 26th year of drought.

We are not alone.

Climate change has accelerated the cycles of drought and flooding. From extreme weather patterns to warmer-than-average-winters, large swaths of the U.S. now face water scarcity. Collectively, we are experiencing the visceral precarity of our relationship with water.

We need to take a clear-eyed look at the drought currently plaguing 61.8 million people in our country. Unlike hurricanes and wildfires, the other markers of climate change, drought does not provide dramatic footage or alter lives in an instant. It's a slow-moving disaster. It creeps up, making each season with less rainfall a neglected crisis, until all our drinking water comes from a plastic bottle and we realize what's happened. For the 61.8 million Americans currently plagued by drought, it's a scenario that's all too real.

That is why a comprehensive report like this one is so vital. In producing it, we hope to raise awareness of this national crisis, and encourage partnership and innovation that can help us collectively address it. To that end, this report includes:

- Real-world impact to show pervasiveness and persistence of drought across America
- Regional impacts of drought, which illustrate a few of the ways scarcity impacts drinking water
- Scientists' forecast
- What you can do, and where to learn more

"While we work to eradicate the pollutants and practices that have led us to where we are today, we must also accept that our climate has changed. We cannot go back, but we can find creative ways to adapt and go forward."

—Cody Friesen, CEO and founder of SOURCE Global, PBC, Fulton Professor of Innovation in the Ira A. Fulton Schools of Engineering at Arizona State University, a Senior Sustainability Scientist at the ASU Global Institute of Sustainability, and winner of the 2019 Lemelson-MIT Prize for invention



Real World Impact

Globally, the World Health Organization estimates:

- 55 million people are affected by droughts annually
- 40% of the world's population is feeling the impact of water scarcity
- By 2050, 6 billion people will suffer from clean water scarcity as a result of climate change

While many think of water scarcity as a problem plaguing nations with less developed infrastructure, it's impacting people and wallets right here in America. And, even more than contamination and aging infrastructure, drought – brought on by climate change – is the defining factor. ([U.N. National Climate Assessment report](#))

Between 1980 and 2020, the U.S. registered:

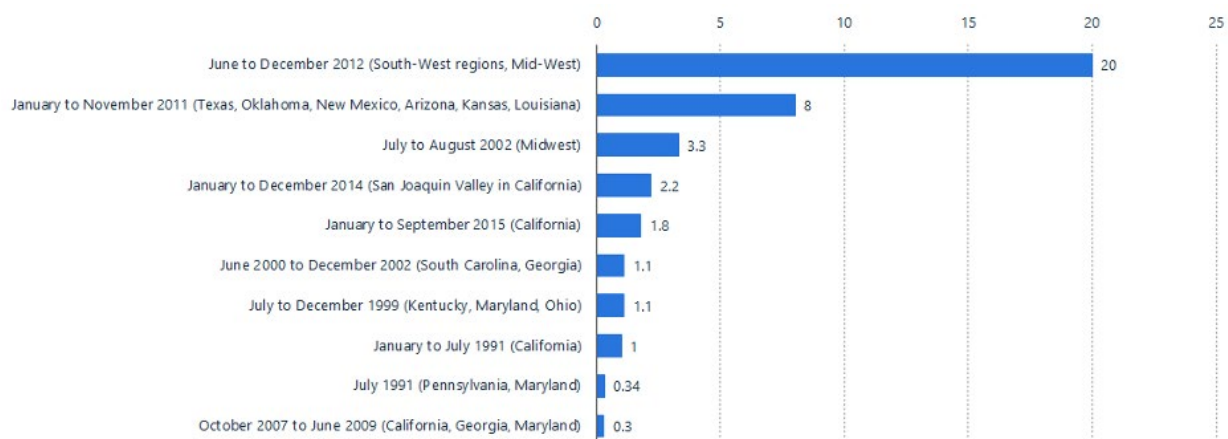
- 28 droughts
- \$258.9 billion in direct losses
- \$20 billion in losses from the 2012 drought alone ([Statista](#))

Drought ranks third among the most disastrous environmental phenomena, following tropical cyclones (hurricanes) and severe storms ([National Centers for Environmental Information](#)), and drier conditions have lengthened wildfire seasons in the Western states. ([NOAA National Centers for Environmental Information \(NCEI\)](#))



Economic loss caused by major droughts in the U.S. from 1900 to 2016 (in billion USD)

This graph shows the estimated economic losses or costs that resulted from droughts in the United States between 1900 and 2016. ([Statista](#))



Drought and water shortages have far-reaching, potentially devastating implications for human health. Reduced stream and river flows can increase the concentration of pollutants in water, while a lack of water for farming contributes to hunger, higher prices and food deserts. Dust from dry conditions and smoke from increasingly frequent wildfires impact air quality. ([CDC](#))

According to the [USGS](#), groundwater is the source of drinking water for:

- ~50% of the total population
- Almost 100% of the rural population

However, America's groundwater is being pumped faster than it can be naturally replaced.

- In as little as 50 years, the U.S. freshwater supply could be reduced by as much as a third
- Nearly half of those freshwater basins may be unable to meet consumers' monthly demands. ([Earth's Future](#))

The Latest Data

Water scarcity isn't a "future" problem. It's happening now. In fact, most Americans (62%) say climate change is affecting their community, and 64% point to droughts and water shortages as its major effects. ([Pew Research](#))

2020 was exceedingly difficult in terms of drought. The year began with drought and abnormal dryness covering 11.2% of the contiguous United States. ([U.S. Drought Monitor, Feb. 18, 2021](#)) However by December, almost 57% of the country was experiencing drought or abnormal dryness ([DroughtScape, Winter 2021](#)), which resulted in more than \$4.5 billion in economic losses. ([Aon plc, 2020 Annual Report](#))

Further aggravating this, climatologists confirmed the 2020-2021 winter would be impacted by La Niña, a weather pattern over the Pacific Ocean that leads to warmer conditions across the Southern United States, and severely reduces precipitation across the western half of the country.

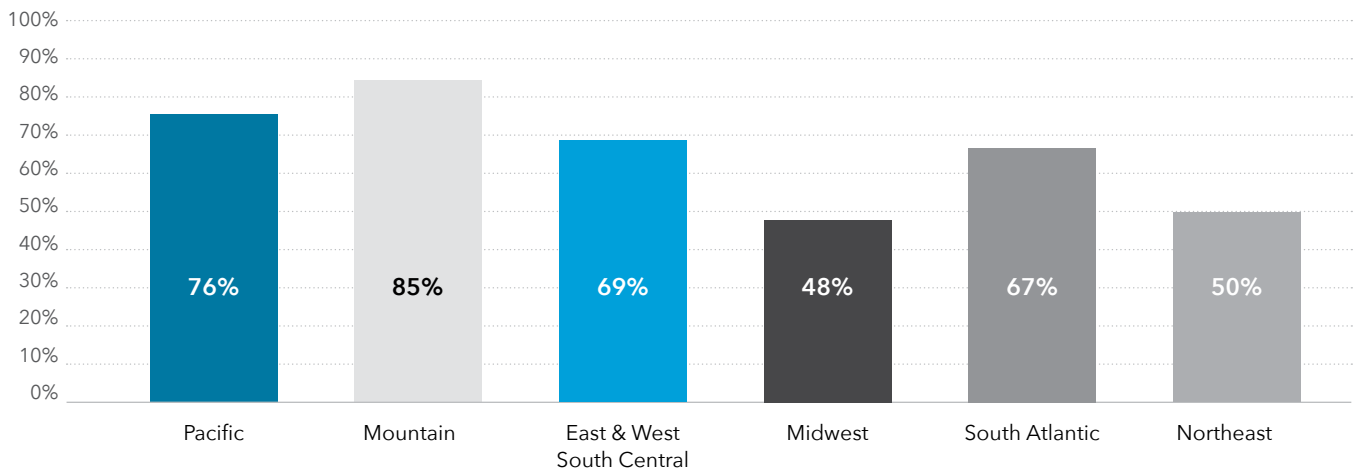


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at the end of 2020.

- The National Drought Mitigation Center

Percentage of U.S. adults who say drought/water shortage is a major way climate change is affecting their local community



(Pew Research: U.S. Public Views on Climate and Energy)

The impact of drought on the nation's water supply manifests in many ways. Across the U.S., water supplies are compromised – from aging pipes leaking lead in New Jersey and uranium mines seeping radioactive waste into Arizona and New Mexico's groundwater, to hookworm disease (Alabama); mining spills (Kentucky) and per- and polyfluoroalkyl substances (PFAS) (South Carolina). Add drought to the mix, and many, many Americans will soon find themselves on the frontline of the water crisis.

During the next 50 years, the nation could see its freshwater supply reduced by one-third. This is not a problem for the next generation, this problem is right now. In 2021, experts predict 40% – as many as 83 out of 204 – U.S. water basins could begin to feel the brunt of these shortages. It's not a matter of if, but when. (T.C. Brown, T.C. 2019, Feb. 28. *Adaptation to Future Water Shortages in the United States Caused by Population Growth and Climate Change*)

As a report in [The Washington Post](#) noted, "... drought is an insidious climate threat – by the time it has a hold of a region, impacts on ecosystems and water supplies can be locked in. It may not grab extreme weather headlines like the disrupted polar vortex or record hurricane season, but drought during 2020 and heading into 2021 is a looming story likely to grow in importance."

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– The Washington Post

Regional Impacts

Pacific

Numerous studies have shown that as land temperatures continue to rise, drought conditions are expanding and intensifying, and fire seasons are becoming longer.

This reality registers with most people. Seventy-six percent of those living in Western states cite droughts and increased wildfire frequency and as major local impacts of climate change. ([Pew Research](#))

California has been particularly hard hit, and experts believe the chances are strong that the state will experience a multi-year drought. ([Capital Public Radio](#)) California reservoirs sit below historical averages due to a lack of winter storms and less snowpack in the Sierra Nevada. And some 35 million Americans rely on these water sources either for drinking or farming.


In early February 2021, [Mercury News](#) reported the Bay Area registered:

- Its third driest period since record-keeping began in 1849.
- 46% of average total rainfall, just over 17 inches in the past 19 months average.
- 129.9 degrees - the hottest temperature ever reliably measured by instrumentation on earth in Death Valley, California, August 16, 2020 ([The Guardian](#))

The combination of hotter summer months and less precipitation have led to large-scale wildfires across California. Analysis by [The Los Angeles Times](#) confirmed the largest fires burned in areas experiencing moderate to severe drought. The direct costs stemming from these wildfires - money associated with fighting fires and property damage - could be as high as \$20 billion. ([Stanford Institute for Economic Policy Research](#)) It's impossible to get an accurate tally of these disasters' hidden costs on individuals and their communities, including disrupted businesses, lost tax revenue, health care bills and decreased property values.

And while state agencies are encouraging municipal drinking water systems that are vulnerable to drought-driven shortages to apply for emergency relief funding, California has begun trading water futures, which speaks to the severity of the situation and the precious nature of the nation's water resources. ([Bloomberg](#))

Considering that rainfall also supports California's agriculture industry's ability to produce important crops. If the predictions for drought are accurate, surface water will be less available, meaning cities and towns will have to compete for groundwater with agriculture - the biggest water user - to give their citizens water to drink.



"California has begun trading water futures, which speaks to the severity of the situation and the precious nature of the nation's water resources."

- Bloomberg

Southwest

Climate projections for the 21st century predict “unprecedented” drought risk for the U.S. Southwest and Great Plains. ([Science Advances](#))

The Colorado River, which brings water to some 74 million Americans across seven U.S. states – Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming – is below-normal water levels now, and no longer regularly flows to the ocean. Scientists from the U.S. Geological Survey estimated that warmer temperatures were behind about half the decline in the river’s flow from 2000-2017. ([Science Advances](#)) Now, the region is getting less water under a set of agreements to increase water levels in Lake Mead, a Colorado River reservoir, which is now at 40% capacity. U.S. Bureau of Reclamation projects show the lake falling another 30 feet by 2022, well under the lowest level on record.

In Texas, there was little to no rain in the fall of 2020, typically the area’s wettest season, leaving more than three quarters of the state in a drought. ([Texas A&M Today](#)) Projections for the Lone Star State indicate drier conditions during the latter half of the 21st century than even the most arid centuries of the last 1,000 years, which included megadroughts. ([Earth’s Future](#))



Mountain States

Eighty-five percent of people in the Mountain States region are very concerned about both drought and long periods of hot weather, and 78% worry about the wildfires that result. ([Pew Research](#))

In January 2021, Denver Water raised alarms as reservoir levels fell 4%, and about 91% of Colorado was considered to be in a severe (D3) to exceptional (D4) drought range, based on the U.S. Drought Monitor drought intensity categories from D0 to D4. These determinations are the most critical categories of drought, and lead to widespread water shortages in reservoirs, extreme fire danger and risk, and widespread crop and pasture losses. ([Denver Post](#))

More than 80% of the state of Utah experienced extreme drought in the fall of 2020– and 2021 is already worse. ([KSL.com](#)) Snow accumulation was well below normal levels, a far cry from what would be needed to offset its extended drought conditions. ([Salt Lake Union Tribune](#)) As of April 1, the entire state is in a moderate drought category, with more than 90% of the state deemed “extreme.”

Midwest - Central States

Home of the Dust Bowl, the Midwest has its own complex water struggles.

In 2017, [researchers from the University of Kansas](#) predicted that extreme weather – cycles of extended drought and intense rains – will ultimately drive up the cost of drinking water across the region. According to their observations, farmers apply “normal” amounts of fertilizer, however in a drought cycle, the smaller plants absorb less nitrogen. Then, when heavy rains hit, the build-up of nitrogen is washed into tributaries and rivers that supply communities with drinking water. As a result, communities and tax-paying residents bear the heavy burden: To address nitrate spikes in Iowa, Des Moines Water Works had to build a \$4.1 million nitrate removal plant, which costs \$7,000 per day to operate.

In addition to agriculture, dairy farming can also impact drinking water resources. Cow manure tends to be rich in nitrogen and phosphorus, but it also contains bacteria, nitrates, viruses and other pollutants. During heavy rains, these contaminants can seep into groundwater, and run off from fields flows into lakes and rivers. Compounding things, drier cycles mean there’s less water to dilute these problems. ([U.S. Department of Agriculture](#))



This brown water came from a home’s tap in Kewaunee County, Wisc. Researchers pointed to manure on a nearby field as the culprit, because the field’s soil and the tap water shared the same signatures for fecal contaminants. ([Courtesy of Kewaunee County Land and Water Conservation Department](#))

In fact, at the time of this writing, the Wisconsin State Supreme Court is weighing its Department of Natural Resources’ power to protect water from farm pollutants. ([WisPolitics.com](#))



Northeast

In 2000, 2016, and 2020, the Northeastern U.S. experienced historic drought conditions. ([Northeast Drought Early Warning System](#)) As a result, half the people in the region report concerns about droughts or water shortages. ([Pew Research](#))

The Northeast also frequently experiences “flash” droughts – short-term, intense dry periods that can follow a period of normal to above-normal precipitation. While these flash droughts may last only 2-6 months, they can

have profound impacts on a local region, resulting in shortages in public water supplies and very low stream flows.

A drought disaster was declared for 10 counties in Vermont in November 2020. When June’s abnormally dry season advanced to more severe levels of drought as the summer progressed, causing creeks to dry up, residential wells to run dry, and the water level in Lake Champlain to drop. Vermont farmers estimated at least \$27 million in crop losses due to the drought. ([Seven Days](#))

The Forecast

In February 2021, the [NOAA Climate Prediction Center's Seasonal Drought Outlook](#) reported that the large area of drought spanning a majority of the western half of the country is expected to persist and expand eastward into the south-central Plains.

If dry conditions continue throughout the spring months across the Sierra Nevada range and much of the Southwest and central Rockies, insufficient water resources may occur through the summer, increasing the potential for drought intensification and wildfires in the fall of 2021. ([NOAA](#))

37.2-43.2 M

Americans at increased risk of unsafe arsenic levels from their home's well water.

- U.S. Geological Survey

Meanwhile, new research continues to connect the dots between drought and health dangers. For example, the [U.S. Geological Survey](#) recently found:

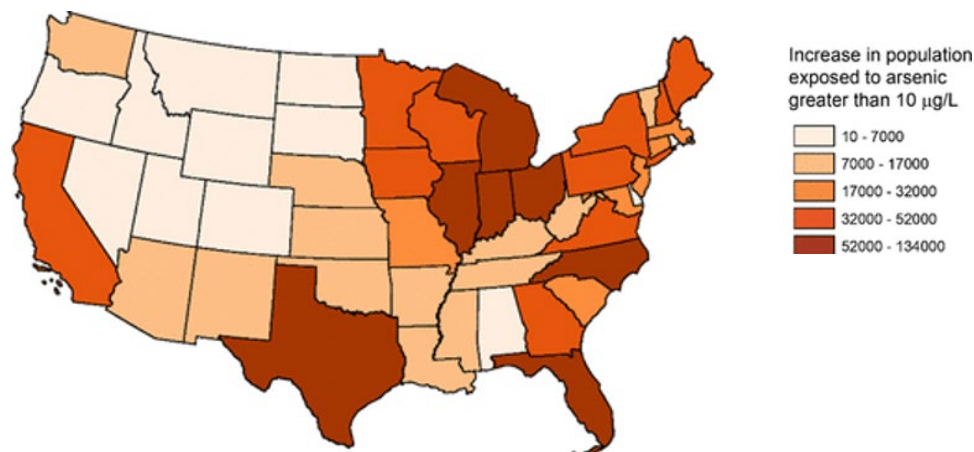
- 37.2-43.2 million Americans who use domestic wells for household water supply are at increases risk of unsafe arsenic levels.
- Especially vulnerable areas where arsenic in wells is already a problem include homes across the Southwest, Midwest and northern New England.

- Higher arsenic concentrations are attributed to decreases in deep groundwater flow and over-pumping of aquifers.

Chronic exposure to arsenic from drinking water is associated with an increased risk of several types of cancers including bladder, lung, and prostate, as well as developmental impairments and impacts on the immune and endocrine systems.

Increase in the population of domestic well users exposed to arsenic greater than 10 µg/L under drought simulation

(*Environ. Sci. Technol.* 2021, 55, 3, 1822-1831, *Assessing the Impact of Drought on Arsenic Exposure from Private Domestic Wells in the Conterminous United States* Jan. 13, 2021)



Where we go from here

The good news: There are ways to address America's water crisis.

1. Be responsible about water use in our homes.

We already have relatively simple and readily available technology that can recycle up to 70% of a home's "gray water" to irrigate grass, plants, shrubs, and trees. To clear toilets – which are among the biggest water gluttons in American homes – alternatives include using salt water, air pressure, and even electrical currents.

2. Advance our water technology

Just as solar and wind have given us clean, renewable energy alternatives to fossil fuels, technology can give us renewable answers for water too. For example, scientists have created a system that uses the sun to remove contaminants from ocean water, leaving clean, drinkable water behind. This technology is estimated to be 3.5 times more efficient than similar systems, and a viable alternative to expensive and energy-intensive desalination. Another research team developed a technique to quickly transform brackish water and seawater into safe, clean drinking water using metal-organic frameworks and sunlight. Industry leaders including some of the world's largest companies, are beginning to leverage technology to offset the water they use, and some set a goal of being net-water-positive.

3. Replace aging, broken infrastructure with new technologies that create safe, reliable drinking water at a far lower cost.

Using the principles of renewables, innovative problem solving and American ingenuity, scientists have developed entirely new resources of drinking water, independent of geography or infrastructure and produced and delivered where people live.

Hydropanel technology developed within our team at SOURCE Global, PBC is currently deployed in 48 countries. It uses the power of the sun to pull clean water out of the air, even in dry climates, and convert it to high-quality drinking water that's delivered directly to taps and faucets. The system works off the grid with no electricity. Plus, it's on-site, so there's no need to build or fix miles of pipes, truck in water, or package it in single-use plastics.,

We need to start treating our drinking water as the precious and finite resource it is. We need to conserve water, recycle it, and most importantly, embrace and invest in innovation.

The time to act is now.

To learn more, reliable resources from the U.S. EPA (Environmental Protection Agency) include:

[Basic Information About Your Drinking Water](#)

[Ground Water and Drinking Water](#)

[Sustainable Water Infrastructure](#)

[Consuming water In your home: the EPA's WaterSense program](#)