

Green | Weather & Science

## American Dams Weren't Built for Today's Climate-Charged Rain and Floods

Hurricane Helene brought dams in North Carolina and Tennessee close to their breaking point. Many US dams are decades old and weren't designed for the impacts of climate change.



The Nolichucky Dam in Greene County, Tennessee, following Hurricane Helene on Sept. 28. *Photographer: George Walker IV/AP Photo*

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As flooding hammered Appalachia in the aftermath of [Hurricane Helene](#), residents became intimately familiar with a new norm in the US's post-storm script: dams at imminent risk of failing.

Officials last week said multiple dams were on the brink, including Tennessee's [Nolichucky Dam](#) and North Carolina's Walters and Lake Lure dams. People in nearby communities were ordered to evacuate.

Ultimately, the dams held. But the close calls highlighted the stress on the nation's dams, many of which are more than half a century old and none of which were designed for the higher levels of precipitation brought on by climate change.

## **Bloomberg Green**

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A lot of the dams “are absolutely performing a useful function for communities, whether helping to hold the water for irrigation or hydropower,” said Tom Kiernan, president and chief executive officer of American Rivers, an environmental nonprofit. But many others, he said, “are outdated, unsafe, abandoned.”

The average US dam is 60 years old, according to the American Society of Civil Engineers, even though dams typically “are designed and built for a 50-year period,” Kiernan said. There are more than 92,000 dams nationwide, according to a [US Army Corps of Engineers inventory](#). Of those, some 16,000, or close to 20%, are classified as having “high hazard potential.” That doesn't mean they are at increased risk of failure, but that their failure would entail a significant loss of life or property. This group includes the 98-year-old Lake Lure hydroelectric dam. The number of high-hazard-potential dams in the US has risen as development encroaches on once-rural areas.

Over the past decade, extreme precipitation has caused partial or complete dam failures in Connecticut, Minnesota and Michigan. In 2017, heavy rainfall brought California's Oroville dam to crisis stage and forced the evacuation of more than 180,000 people. Between 2015 and 2018, North and South

Carolina saw more than 100 dams breached due to record flooding, according to a Congressional Research Services report.

Only 3% of dams in the US are under federal control; some are managed by states, but the majority are under private ownership. In 2022, the Association of State Dam Safety Officials, a nonprofit, estimated that \$75.7 billion was needed to rehabilitate non-federal dams. The Inflation Reduction Act earmarked \$2 billion for dam decommissioning and upgrades.

“We need tens of billions more,” said Kiernan.



The Broad River in the aftermath of Hurricane Helene in Bat Cave, North Carolina, on Oct. 1. *Photographer: Sean Rayford/Getty Images*

As greenhouse gases in the atmosphere drive up temperatures, rainstorms are becoming more intense. That increases the danger to dams, especially the earthen dams that comprise the majority of those in the US. Excessive rainwater poses a risk in a least two ways. The first is overtopping – when water spills out over the edge of the dam, eroding it and leading to structural failure. The second is the sediment and debris that floodwaters carry, which can choke systems like spillways that are supposed to help dams compensate for too much rain.

*Read More: [Extreme Rain Is a Growing Climate Threat to the Northeastern US](#)*

For more than 75 years, infrastructure whose failure could cause loss of lives – including dams and nuclear power plants – has been built or upgraded to withstand floods using a standard called Probable Maximum Precipitation (PMP). PMP was developed by the federal government starting in the 1940s, a process led by what is now the National Oceanic and Atmospheric Administration.

The standard is based on the most extreme rainfall events of the past, with the idea that infrastructure built to endure those extremes will be future-proof. But the data used to maintain the standard hasn't been updated nationally since 1999, and in some regions not for 60 years.

Some states have acted on their own initiative. “There’s probably 20 states now that have updated their PMP in the absence of federal guidelines,” often turning to the private sector for help, said Bill McCormick, who serves as a subject-matter expert on extreme precipitation for the Association of State Dam Safety Officials. North Carolina began its own updating effort before Helene hit, he said.

*Read More: [Helene Turned Asheville From Climate Science Hub Into a Disaster Case Study](#)*



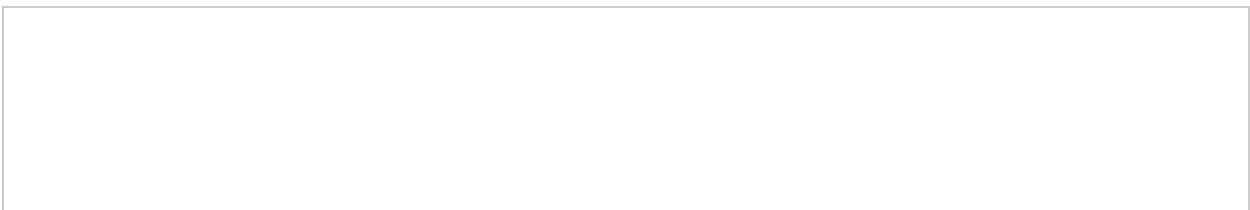


The heavily damaged spillway at Lake Oroville in Oroville, California, in 2017. *Photographer: Justin Sullivan/Getty Images*

But many states haven't started. And absent federal oversight, it's not clear if the state updates go far enough.

Not only is the historical data that informed the PMP based on yesterday's climate, it's not entirely reliable. "There are numerous flaws in how we've collected the data over 100 years," said James Smith, a Princeton University professor of civil and environmental engineering. "But the biggest and hardest one to deal with is climate change," he said.

Smith pointed to the catastrophic flooding in western North Carolina as a vivid example of the problem. There, the PMP is based in part on the great flood of 1916, when 22-plus inches of rain fell in 24 hours. Helene's rainfall – which by one estimate was 50% higher than it would have been without climate change – topped that in places by 7 inches.





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For a long time, NOAA “didn’t have any legislative mandate” to update the federal PMP, said McCormick. That changed in 2022 with the passage of the Providing Research and Estimates of Changes in Precipitation (PRECIP) Act. The law required the agency to conduct a study on estimating precipitation, including PMP, within two years. In June, the National Academies of Sciences, Engineering, and Medicine issued that [report](#), authored by a committee that Smith chaired. It urges the US to update the way it calculates the standard to take climate change into account.

PMP doesn’t just affect infrastructure as it is being designed and built but throughout its life. Dams and nuclear power plants are regulated and monitored by state and federal agencies, and maintained over time. “Even if it is 100 years old, if PMP changes, a dam needs to be able to pass the PMP without failing,” Smith said.

So far only two countries – Norway and Sweden – have rules requiring that dam owners incorporate future climate predictions into their operations, said Javier Fluixá-Sanmartín, a dam safety engineer with the Swiss firm [HYDRO Exploitation SA](#). But more such rules are likely coming to other countries.

In the US, the National Academies report is a key first step. But the bigger question will be funding. Many dam owners can’t necessarily afford to make upgrades.

“Not every dam is a hydroelectric dam. So not every dam generates revenue by producing power,” McCormick said.

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