



THE

**Why Floods Can Follow Wildfires,
and How Communities Can Prepare**

SECOND



WAVE

By Amanda Monthei

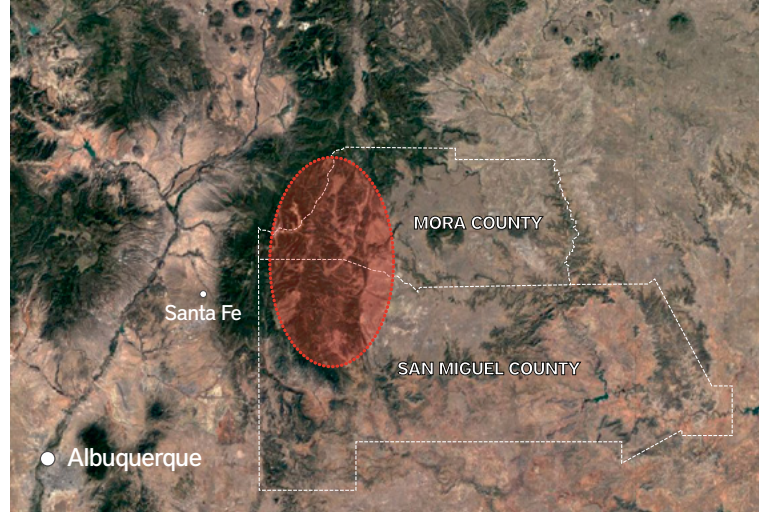
MOST PEOPLE in the mountainous northeastern corner of New Mexico were looking forward to the arrival of the annual monsoon season last summer. The Hermits Peak–Calf Canyon wildfire had started in April, ultimately burning 340,000 acres and destroying hundreds of properties, and residents were hoping for a reprieve from the smoke and evacuations that had begun to define their lives. But then the monsoon arrived, both unseasonably early and with more intensity than normal.

As the rains pelted soil that had been rendered water-repellent by the fire, mud and water cascaded down the slopes of the Sangre de Cristo Mountains into the waterways, fields, roads, and homes below. Still reeling from the fire, residents were forced to deal with a fresh disaster—in many cases, needing to leave their homes once again.

“Their homes were flooded, their corrals were taken out, their burnt barns were taken out,” said Veronica Serna, county commissioner in Mora County, one of the areas hardest hit by the fire and the floods. “One family had a boulder come down and block their whole driveway. They didn’t have any water and no way to go out and get water—just imagine not being able to shower in your own home or wash your hands or use a toilet. It was devastating.”

Serna recalls another family “whose home kept getting flooded over and over and over. One day we stopped by to check on them, and they were scraping the mud out of their shoes, shoveling mud out of their bedroom. It’s just so hard to see that.”

The flooding also affected San Miguel County just to the south, damaging homes and infrastructure, polluting wells, and threatening water supplies. “Most people are back within



Map of the general location of the Hermits Peak–Calf Canyon fire, which burned 340,000 acres in northern New Mexico in 2022. Credit: Google Earth/Landsat Copernicus.

the community, but they’re still stressed out about the future, because the flooding is not going to stop,” said Ralph Vigil II, a farmer and water commissioner who grew up in San Miguel County and runs a farmers’ cooperative there. “I’m afraid that we’re going to be dealing with this for years.” According to the Federal Emergency Management Agency, flood risk remains elevated for up to five years after a wildfire, until vegetation is restored (FEMA 2020).

Vigil had the opportunity to take a helicopter flight over the burn scar in the fall, after the fire was fully contained and the worst of the flooding had subsided. “You don’t really understand the vastness of the damage until you’re up there,” he said. He was alarmed, and not just by the decimation of landscapes and communities that he’s long loved: “I also saw the risk for more fires, and really the signs of what’s to come.”

As climate change contributes to longer, more intense wildfire seasons, fires are leaving burn scars across the U.S. West, putting nearby communities at risk of flooding. That flooding, which can be catastrophic, can occur long after the fire is over. In the face of these threats, communities can make land use decisions that help build their resilience.

The Hermits Peak–Calf Canyon fire above Las Vegas, New Mexico, in May 2022 (top); state vehicles navigate a flooded road in nearby Rociada three months later (bottom). Credits (top, bottom): Robert Browman/*Albuquerque Journal* via AP; Eddie Moore/*Albuquerque Journal*.

After the Fire, the Deluge

It's apt that the name of the Sangre de Cristo Mountains, which extend from Colorado to their terminus near Santa Fe, translates as "Blood of Christ." The ridges, valleys, and bowls that would have been dwarfed from Vigil's viewpoint in the helicopter make up the bulk of two watersheds that are the lifeblood of downstream communities and farmlands. Some 23,000 people in San Miguel and Mora counties rely on these watersheds for drinking water and agriculture.

Under the right conditions, naturally occurring and prescribed fires support ecosystem health. But the Hermits Peak-Calf Canyon fire, the largest in New Mexico's history, got out of control and caused chaos. Twenty-four percent of the burn area was classified as high-severity fire,

causing extensive tree mortality and profound impacts to soil. When trees and vegetation burn in high heat, they release gases that harden the soil into a water-repellent, concrete-like material. That allows rain to run over the forest floor like it would a sloped parking lot, picking up speed and sediment before flooding into the communities below.

"Pre-fire, these forested ecosystems and slopes work like a sponge, but post-fire, nothing is going to stop that rain," says Micah Kiesow, a soil scientist for the Santa Fe National Forest and team lead for the fire's Burned Area Emergency Response (BAER) team. BAER teams assess wildfire damage on federally owned lands.

"We saw a tremendous amount of erosion, sedimentation, and debris flows in the most severely burned areas, which eventually makes its way to the drainages and streams below."

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Credit: Federal Emergency Management Agency, National Flood Insurance Program.

Flood After Fire



Did you know wildfires dramatically alter the terrain and increase the risk of floods? Excessive amounts of rainfall can happen throughout the year. And properties directly affected by fires and those located below or downstream of burn areas are most at risk for flooding.

- 1 During normal conditions, vegetation helps absorb rainwater.
- 2 But after an intense wildfire, burned vegetation and charred soil form a water repellent layer, blocking water absorption.
- 3 During the next rainfall, water bounces off of the soil.
- 4 As a result, properties located below or downstream of the burn areas are at an increased risk for flooding.

Degree of Land Slope

Higher degrees of land slope speed up water flow and increase flood risk.

Flash Floods

Intense rainfall can flood low-lying areas in less than six hours. Flash floods roll boulders, tear out trees and destroy buildings and bridges.

Mudflows

Rivers of liquid and flowing mud are caused by a combination of brush loss and subsequent heavy rains. Rapid snowmelt can also trigger mudflows.



A soil scientist from the federal Burned Area Emergency Response (BAER) team inspects a culvert in the Hermits Peak–Calf Canyon burn scar in June 2022. Credit: U.S. Forest Service.

While post-fire flooding affected many communities around the burn area, some of the worst damage occurred in Mora County. The county, one of the poorest in the nation, has about 2,130 homes scattered across nearly 2,000 square miles. Serna estimates that 200 of those homes were burnt over and countless others impacted when ash, water, and sediment flowed into the communities of Mora, Holman, Chacon, and Guadalupita. “It’s sad, because our communities had a lot of adobe homes,” she said. “Our people have lived here for generations, they have inherited these adobes from their great-, great-, great-grandparents.”

Many of those affected were rural farmers. According to Serna, numerous residents had freezers full of high-quality cattle and game meat that had to be thrown away following power outages in the aftermath of the flooding. Meanwhile, the *acequias*—small ditches or canals that divert water from creeks and rivers to provide water to farms and form the foundation of water access in this part of New Mexico—were clogged with wood, rocks, and mud. Over 40 acequias were destroyed in the aftermath of the fire, according to the New Mexico Acequia Association and reporting by *Source New Mexico* (Lohmann 2022). The infrastructure that these remote communities rely on for everything from growing food to accessing critical services suffered profound damage.

In the immediate aftermath of the fire, it was difficult to access federal emergency funding. In later months, however, significant funding opened up for those affected by the fires—some \$3.9 billion total, including \$2.5 billion from the federal Hermits Peak–Calf Canyon Fire Assistance Act passed in September and \$1.4 billion allocated in the 2023 Omnibus Appropriations bill. Total damages for the fire have not been confirmed, but some estimates put it as high as \$5 billion.

Despite the influx of funding, “I really don’t think [\$3.9 billion] is going to be enough,” Serna said. “How do you replace trees that were over 100 years old? How do you get all that back? I mean, is there a dollar amount that could do that? How do you buy back time?”

While the recovery effort continues, the risk for more flood damage persists, hinging precipitously on the intensity of future rain and snowmelt events. Mora County officials have begun developing a hazard mitigation plan for potential impacts from fires and flooding in the future. This kind of planning is one of many steps communities need to take to become more resilient in the face of increasingly frequent and severe disasters.

With the wildfire largely contained and heavy rain in the forecast, a rancher worked to protect his property along the Gallinas River. Credit: Nadav Soroker/Searchlight New Mexico.



From Reactive to Proactive

In many cases, communities address the risk of flooding after a fire, but time isn't always on their side. "The challenge in New Mexico is we have a fire season from April to June, immediately followed by a monsoon season," said Brian Williams, director of emergency management in Santa Fe. "That window of time between when the fire season ends and the flooding season begins is weeks, not months. Often it overlaps, and then it's a mad scramble to mitigate those potential impacts as best you can. And the kinds of things that you can do are to some degree limited."

When BAER teams assess the extent of damages in federally owned areas, part of their charge is to determine priorities for immediate mitigation measures—ideally before extreme precipitation arrives. These often-forested ecosystems are prime candidates for aerial seeding and mulching, which can help burned areas begin to recover; restoration of stream channels can also help address flood risk. To prepare for the New Mexico monsoons, the BAER

team also recommended and oversaw a number of emergency interventions including installing obstructions in stream channels to redirect debris and sediment and making fixes to bridges and culverts to facilitate vehicle access. These measures likely helped minimize some of the most extreme impacts of the rains, but it's difficult to quantify their effect—and the hard truth is that only so much can be done in the timeline between fire suppression and extreme rain events. Harder still is the fact that that timeline seems to be shrinking in many regions.

A lot of the conversation around post-fire flooding focuses, understandably, on ecosystem recovery measures like those that BAER teams recommend and facilitate. But effectively preparing for the unique challenges of recovery and potential post-fire erosion events also requires significant forethought on the part of communities and homeowners.

Planning and land use decisions can minimize risk before fires occur. On the ground, communities can install infrastructure to help contain or redirect debris flows; retrofit homes with more ignition-resistant materials; and



CLIMATE CHANGE AND WILDFIRE

Climate change is affecting the way fire moves through landscapes—and is also affecting how resilient those landscapes are. Extreme droughts, heat waves, and aridification can dry out forest vegetation, making it burn more easily and faster. Meanwhile, unseasonably hot and dry weather can increase the likelihood of accidental ignitions and drive increasingly destructive rates of fire spread. The combination of dry fuels and shifting weather patterns puts forests and the communities abutting them at increasing risk for both wildfire and devastating post-fire flooding and debris flows; over the past 40 years, the western United States has seen a fourfold increase in large wildfires and the fire season has expanded by two and a half months.

Burned Area Emergency Response (BAER) team members inspect newly planted vegetation in the Calf Canyon burn scar in August 2022. Credit: U.S. Forest Service.



Flood control in the areas affected by the Hermits Peak–Calf Canyon fire included the installation of temporary dams (left) and floating barriers to slow or stop large pieces of debris (right). Credits (left to right): U.S. Army Corps of Engineers, U.S. Forest Service.

identify and improve evacuation routes. They can also reduce hazardous fuels in forests and create defensible space around structures by thinning trees and other vegetation. Some fuel-reduction work, which is an essential forest management tool, comes with risks; the Hermits Peak–Calf Canyon fire was the result of two U.S. Forest Service fires that went awry: a prescribed burn and a pile burning project. The fires combined and spread due to high winds. But under the right conditions, prescribed burns can reduce the risk of wildfire and help maintain ecosystem health.

On a policy level, communities can take steps including prohibiting or limiting development in areas vulnerable to fire and flooding. Where development is allowed, they can mandate the use of certain building materials, such as fire-resistant siding. Local and regional officials can also map wildfire and debris flow risks to help determine when and where to build; develop pre-disaster plans, which allow communities to consider how they will handle recovery challenges such as restoring electricity, providing temporary housing, or managing long-term rebuilding; and proactively budget for projects such as stormwater treatment infrastructure upgrades, which can help communities better cope with flooding. Communities can also engage in scenario planning, a process that can help them identify and plan for various possible futures (see sidebar page 39).

According to a report from the National Institute of Building Sciences, every \$1 of public

funding spent on hazard mitigation since 1995 is expected to save \$6 in future disaster costs (NIBS 2019). After decades of focus on disaster recovery funding, the federal government has begun a shift toward funding pre-disaster planning and mitigation. FEMA has released a pre-disaster planning guide and has made limited funds available for disaster mitigation projects (FEMA 2017). Unfortunately, this kind of advance planning often hinges on the kind of political will and funding that are still much easier to come by after disaster has struck.

“I think the fundamental challenge with all of this, as with most natural hazards, is it’s very hard for us to plan ahead for things,” said Dr. Kimiko Barrett of Headwaters Economics, a Montana-based nonprofit research group that works to improve community development and land management decisions across the country. “We are by nature reactive and responsive, in contrast to being anticipatory. Even after a wildfire occurs, we have a small window to actually mobilize and enact the transformative change needed before amnesia kicks in, or bias kicks in, where you feel that [because the fire] happened, it will never happen again.”

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A view of the Calf Canyon fire from Mora, New Mexico. The fire and subsequent flooding destroyed many of the area's traditional adobe structures. Credit: REUTERS/Andrew Hay.



A Holistic Approach

As more areas are affected by increasingly destructive wildfires, the threat of erosion and flooding in these landscapes will also increase—and should be factored into planning and land use decisions, Barrett says.

She explains that the principles of holistic land use policy for wildfire resilience are inherently connected to planning for potential post-fire impacts like flooding. The measures typically used to build community resilience to wildfire—things like reducing hazardous fuels near critical infrastructure, planning evacuation routes, considering home density and development patterns in new developments, and mapping risk—also provide intrinsic benefits in the post-fire period.

“[Taking these actions] means communities have a greater chance of surviving a wildfire—therefore, that rebuilding and recovery piece is inherently better situated, because you’ve put that thought and that deliberate strategic planning in on the front end,” Barrett says. “So [planning for wildfire and its impacts] have to be wedded together. The challenge is that federal funding and policy does not often address it in that nature, or within that holistic framing.”

Quantifying and addressing the highly localized hazard planning needs of individual communities—from mapping risk to implementing mitigation at a meaningful scale—is also challenging when an area hasn’t yet felt the impacts of a wildfire or post-fire disaster. Risk mapping, for example, makes it less challenging to predict where and how a wildfire might impact a landscape; yet it remains challenging to create comprehensive and accurate maps, not only because of the robust data needed to make such predictions, but also because of community resistance.

“There’s a lot of pushback—much like you see on sea-level rise and other things in Florida and elsewhere—where politicians, developers, and community leaders are like, ‘We don’t really want to know—or we might want to know, but we really don’t want it publicized,’” said Molly McCabe, CEO of HaydenTanner, an investor advisory firm that focuses on social impact and sustainability in the built environment. “So you have this tension between, ‘We want to keep our people safe,’ and ‘It’s also an economic risk.’”

In 2022, the state of Oregon created a statewide wildfire risk map, distributing it to 150,000 residents who lived in areas facing high or extreme risk. Controversy arose quickly:

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homeowners suspected that the map might affect property values and insurance rates, and some worried that it could lead to new building codes or mandates for home hardening—a retrofitting approach that involves steps ranging from replacing windows to trimming nearby trees and shrubs. The Oregon Department of Forestry withdrew the map for further development, but the response was a clear reflection of the challenges related to getting out ahead of risk.

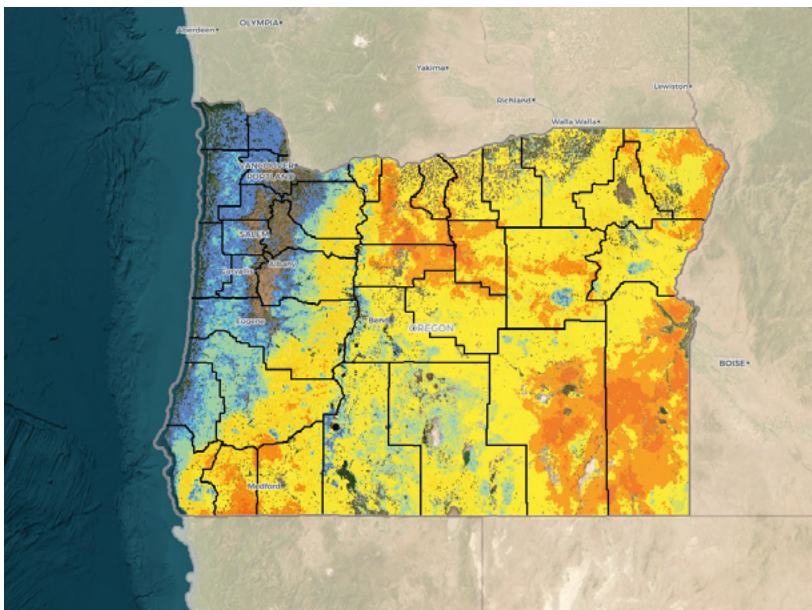
This problem grows even muddier when it comes to planning for erosion and flooding events after wildfires—how can you meaningfully quantify the potential impacts of a disaster that is the result of another disaster, which is also relatively difficult to predict? And how can you garner the essential buy-in of residents who could be financially affected by a better understanding of the risk in certain areas?

Despite these challenges, some communities are making progress, Barrett said: “I can tell you that there are communities that recognize their level of risk, and are addressing it in aggressive ways that go beyond what we’re seeing from federal mandates or state regulations.”

SCENARIO PLANNING FOR WILDFIRE RESILIENCE

Scenario planning can help communities plan for an uncertain future. The practice guides planners, community members, and other stakeholders through considerations of various futures and how to effectively respond to and plan for them. In the case of wildfires, communities can consider the impacts of a changing climate on factors including public health, housing, equity, the economy, water availability, and quality of life. How could more frequent and intense drought affect wildfire suppression efforts? How can coordinated regional climate policies reduce wildfire risk and improve quality of life? By asking questions like this and exploring multiple possible outcomes, communities can better prepare for the challenges ahead.

To learn more about this planning practice or to get assistance running a scenario planning process, visit the Lincoln Institute’s Consortium for Scenario Planning site at scenarioplanning.io.



Risk mapping can help communities and property owners better prepare for wildfire. Oregon’s Wildfire Risk Explorer tool allows users to filter results based on factors ranging from average flame length to susceptibility. Credit: Oregon Department of Forestry, Oregon State University.

- **Very High** (1-in-50 to 1-in-25)
- **High - Very High** (1-in-100 to 1-in-50)
- **High** (1-in-500 to 1-in-100)
- **Moderate - High** (1-in-1,000 to 1-in-500)
- **Moderate** (1-in-5,000 to 1-in-1,000)
- **Low - Moderate** (1-in-10,000 to 1-in-5,000)
- **Low** (\leq 1-in-10,000)
- Nonburnable/Urban/Barren/Ag/Water**

Communities Taking Action

Barrett said some communities in California have implemented mandates beyond existing state requirements for ignition resistance standards. Portola Valley, for example, adopted a home-hardening ordinance to supplement the state building code, which requires ignition-resistant building materials for new developments in high-risk areas. In 2020, residents in Marin County approved a measure that applies a property tax of 10 cents per square foot to support wildfire prevention efforts. The measure, which includes exemptions for low-income senior citizens, is expected to generate nearly \$20 million per year over a 10-year period.

Both Barrett and McCabe mentioned that bond proposals have been a successful—though not yet widely utilized—means for motivated communities to set aside funding for wildfire and post-fire resilience. One particularly notable example is the Flagstaff Watershed Protection Project (FWPP), initiated after the Schultz Fire burned 15,000 acres in the mountains north of the city in 2010. The fire itself had little impact on homes and private property in Flagstaff, but a month later heavy rains triggered debris flows and floods that swept into the valley, causing the death of a young girl and the loss of 85 homes. Two years later, residents approved a \$10 million bond that would help protect the watershed and adjacent homes and properties against similar impacts.

FWPP is a partnership between the state, city, and Coconino National Forest intended to help reduce the risk of both wildfire and post-fire flooding. “This has become one of the best examples I’ve seen out there of a partnership that has really resulted from a pretty devastating event that was post-fire related,” Barrett said.

Flagstaff residents contend with flooding a month after the Schultz Fire in 2010. Voters have since funded collaborative watershed protection efforts by the city, state, and U.S. Forest Service. Credit: Josh Biggs/*Arizona Daily Sun* via AP.

“It’s just a really good example of what can happen when the right players are there, and of communities and local partners recognizing a risk and acting on it.” Last year, voters in Flagstaff showed sustained support for continuing the city’s wildfire suppression and stormwater management efforts, with 76 percent approving a proposal to issue \$57 million in bonds to invest in water- and fire-related infrastructure.





In 2019, workers installed steel mesh netting in San Ysidro Canyon above Montecito, California, to reduce the impact of post-wildfire debris flows. Two years earlier, mudslides had killed 23 residents of the community and destroyed 130 homes. Credit: Christy Gutzeit.

McCabe mentioned Montecito, California, as another notable example of community resilience arising from tragedy. The 2017 Thomas Fire destabilized slopes above Montecito. When these slopes were subjected to a deluge of rain just a few weeks later, 23 people lost their lives and 130 homes were destroyed. Since then, Santa Barbara County officials have developed debris flow risk maps for the area, while a community-led nonprofit called the Project for Resilient Communities facilitated the installation of steel mesh netting to catch debris in drainages above the community.

In Montecito and other communities, McCabe says, “people are voluntarily using grants and other monies to build their homes up on 10-foot elevated pads, so that if they’re in a path, the mud flows around them. But I haven’t seen any policies that are requiring that for new construction, much less existing construction.”

Still, local or regional policy can support such individual actions. Grants or insurance incentives can be offered to homeowners who create defensible space around their home, or to those who retrofit their homes with ignition-resistant materials. Programs like FireWise USA, an initiative of the National Fire Protection Association, can help neighborhoods organize collective fire mitigation projects and hold residents accountable for maintaining properties over time.

Getting buy-in at the local level also hinges on communicating strategically. In Central Washington’s Chelan County, public information campaigns around wildfire risk reduction included translators who could engage Spanish-speaking communities. Engaging with non-English speaking and migrant communities, in addition to other communities that are at disproportionate risk of wildfire and post-fire flooding, is an important component of public information campaigns throughout the process—from preparing for wildfire to navigating the recovery stage.



To help residents and officials prepare for future flood events, Santa Barbara County officials have developed debris flow risk maps. Credit: Santa Barbara County Office of Emergency Management.

A Watershed Moment

In 2012, a major wildfire burned 87,000 acres near Fort Collins, Colorado. In the months following the fire, ash and mud choked the Poudre River, which provides drinking water for 135,000 downstream residents. Sediment clogged the pipes of the local water treatment plant, requiring extra clean-up and treatment and leading the city to install sensors that monitor sediment in the river. “We had been privileged and in some ways probably took for granted that these watersheds were providing us consistently clean, clear water, all the time,” the city’s water quality manager, Jill Oropeza, told a local radio station (Runyon 2020). “That was the first time, for many of us working there, that we had to grapple with the fact that our watersheds are under pressure.”



Maria Gilvarry, utilities director for Las Vegas, New Mexico, on a tour of the Gallinas watershed in 2022. Gilvarry said the flooding caused by the Hermits Peak–Calf Canyon fire was “beyond anything we could have fathomed.” Credit: Nadav Soroker/Searchlight New Mexico.

Many communities in the West take great pride in the places where their water comes from. Protecting watersheds from high-severity wildfire—and, thus, debris flows—is an easy sell to the communities that rely on the resources these ecosystems provide.

According to the U.S. Forest Service, the forested watersheds of the United States provide drinking water for 180 million people. Ninety-nine percent of people who rely on public water systems in the United States get at least some of that water from forested ecosystems (USFS 2022). Research suggests that post-wildfire flooding contaminated the drinking water of hundreds of thousands of people in the West between 2017 and 2020 (Romero 2022).

In Mora County, “people sent me photos of turning their water on and having sludge come out,” said Serna, the county commissioner. Many wells were destroyed, with some residents only getting their water back online in October and

November. The city of Las Vegas, in nearby San Miguel County, almost ran out of water for its 13,000 residents after debris from the fire found its way into the local reservoir. With only 20 days’ worth of clean water remaining, the city used emergency state funding to convert a local lake into a short-term back-up water source. Longer-term relief came in the form of \$140 million from the omnibus bill that will allow Las Vegas to invest in water treatment and filtration upgrades.

In response to situations like these, organizations including the Coalition for the Poudre River Watershed in Fort Collins and the Greater Santa Fe Fireshed Coalition, which focuses on a high-risk area just south of the Hermits Peak–Calf Canyon fire area, are bringing stakeholders together to better understand the risks wildfire poses to water supply and water quality. Many communities in the West take great pride in the places where their water comes from. Protecting watersheds from high-severity wildfire—and, thus, debris flows—is an easy sell to the communities that rely on the resources these ecosystems provide, and building resilience in watersheds inherently builds resilience for downstream communities.

Whether focused on making a watershed more resilient, guiding development to less vulnerable areas, or envisioning and preparing for multiple possible futures, communities can take

many steps to build resilience to wildfire and post-fire flooding. The profound influence of past and present land management decisions on wildfire and flood outcomes makes it increasingly clear that we can better prepare for events that are exacerbated by human actions—and, in some cases, inaction. Adequately planning for wildfires and subsequent debris flows or flooding in the West requires significantly more funding, resources, and creative policy solutions than are currently available, but taking action and making investments on the front end can lead to stronger communities that are better prepared to face future disasters. ☐

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The Coalition for the Poudre River Watershed in Fort Collins, Colorado, works to protect the area's ecological health through community collaboration. Credit: Coalition for the Poudre River Watershed.



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