

[Deadly mudslides threaten more Americans as heavy rains loom over scorched lands](#)

USA Today

A flash of light from an exploding transformer stopped Jerry Wilkerson in his tracks.

The 79-year-old retiree was just pulling onto the bridge separating him from his family cabin in [Poudre Canyon, Colorado](#), when he watched in shock as a 10-foot wall of sludge roared past.

Churning with heavy debris, logs and boulders, it swept into his small residential community with such force that it toppled cabins like dominoes and shoved them, one by one, into the river.

One of those homes had vehicles parked nearby, he noticed, almost certain that people were trapped inside.

With his wife, Barbara, in the passenger seat, Wilkerson reversed back onto the highway to find help. But it was too late.

Dick Brown, his son, David or “DB”; daughter, Pat; and daughter-in-law, Diana, died in the July 20th disaster.

As little as 30 seconds likely spared the Wilkersons.

“If I hadn’t stopped at the bridge and witnessed this, I’d be dead,” he said. “I’ve no doubt.”

Decades of rising temperatures and more intense wildfires have turned parts of the American West into a nearly impervious landscape where even one downpour can trigger deadly, post-fire debris flows, commonly called mudslides.

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Source: <https://uphelp.org/deadly-mudslides-threaten-more-americans-as-heavy-rains-loom-over-scorched-lands/> Date: July 19,

The once-infrequent events now threaten an area nearly twice the size of the entire state of Connecticut. Some 6.5 million acres across Arizona, California, Colorado, Nevada, New Mexico, Idaho, Utah, Oregon and Washington are in harm's way. That's double the size of the hazard from just three years ago.

For years, local, state and federal officials invested in more pressing threats, like the wildfires that lay the groundwork for these debris flows. Now, possibly hundreds of thousands of Americans face a risk they may not even realize. And by the time they find out, it may be too late.

USA TODAY spent five months examining the growing phenomenon of post-fire debris flows as part of a broader investigation into the impacts of climate change on precipitation patterns.

Reporters found that a warming planet can cause more dramatic swings between periods with too much rain and too little rain. These prolonged droughts that help fuel devastating wildfires, followed by intense bursts of rain, can create the perfect conditions for post-fire debris flows.

For this story, USA TODAY interviewed dozens of researchers, scientists and families who survived such disasters across five states, as well as read through hundreds of pages of government records and scientific studies.

Among the findings:

The growing threat of post-fire debris flows has outpaced scientists' understanding of how the phenomenon impacts areas now in the crosshairs. Models developed to pinpoint risks may not be enough to effectively protect those newly in harm's way.

Even in areas where the risk is better understood, the back-to-back wildfires and heavy rainfalls more common in a changing climate leave little time to protect communities. The U.S. Geological Survey and others generally wait until after a fire starts, or ends, to map debris flow hazards. But disasters like the [deadly 2018 Montecito mudslides](#) proved that those efforts must start sooner – well before a fire has burned.

The rapidly expanding risk of post-fire debris flows may have caught the insurance industry off guard. Few if any homeowner's policies specifically cover the disaster, but as claims roll in, changes could be

coming.

In the past four years alone, the fast-moving flows have damaged and destroyed hundreds of homes, closed major transportation routes across at least three states and caused more than \$550 million in property damage. Close to 170 people have been injured and 28 people died since 2018.

But because other natural disasters like fires and floods have been more widespread and inflict more damage, the phenomenon of post-fire debris flows has been overshadowed. Experts say more work and resources could help better protect communities.

Over the past two decades, researchers created models to map burn scars, pinpointing the most hazardous spots, the probability and the volume of potential flows. They figured out ways to predict what rainfall intensity will trigger a post-fire debris flow, the crucial piece to effectively warn people of the danger.

But the work keeps getting harder as wildfires ravage more of the West. The models developed and adapted to places with longer records of the post-fire hazards now need to be tested in a slew of new locations. That's left scientists racing to keep up.

"The game has unquestionably changed," said Scott McCoy, a geologic engineer at the University of Nevada. "Now, we have fire everywhere - in places that we're not used to having severe fire at least in the historic record."

Many in the field also are calling for more work to identify the hazards before a fire even starts.

"We're always behind the problem," said Jason Kean, a research hydrologist and part of a team of USGS scientists who develop debris flow hazard maps after a fire.

"We know fires are going to happen," he said. "So, in vulnerable places, why don't we start mapping out where these are most likely before a fire even occurs?"

The fire that laid the foundation for this summer's deadly Poudre Canyon debris flow was Colorado's biggest in history.

Called the [Cameron Peak fire](#), it burned nearly 209,000 acres in the north-central part of the state between August and December last year. The flames scarred one-third of the area so badly that the soil could barely absorb moisture, according to a U.S. Forest Service report issued in January. That meant the threat of post-fire debris flows was high.

Six months later, when the flow slammed into home after home on Black Hollow Road, many living there say they had little or no warning.

Colorado Brown, 28, lost his grandfather, aunt and both parents that day. His mother's body was found just last month.

His parents, he said, were there visiting his grandfather's cabin – an annual summer tradition that included hiking among the canyon's tall pine and aspen trees and eating fish his dad caught from the river.

With no cellphone service on site, Brown said, his mom texted him to check in on July 19 while she was closer to town.

"The last text I sent her was asking if she's having a good time," he said. "And, that was the day before the flood."

He never heard back. Two days later, other family members broke the news.

"Everyone told me that there was no way anyone could have known this was going to happen," Brown said. "I just, I really wish that there was a better way to see these things coming."

More extremes, more risk

Two things must occur to trigger the post-fire flows: a severe fire and a downpour. Both are expected to happen more frequently as a result of the changing climate.

Rising temperatures have lengthened dry spells in the West, depleting the moisture from the soil and helping create conditions for wildfires to spark and spread.

The length of time between precipitation events across the West increased over the past four decades by nearly three days on average but as much as 17 days in some places, especially in the desert Southwest, according to [research published this year](#) by scientists with the U.S. Department of Agriculture and the University of Arizona.

With less rain and more drought, bigger and more frequent wildfires have raged.

All but two of California's 20 largest wildfires in history have happened since 2000, including its largest – [the August Complex fire](#) that burned more than 1 million acres and destroyed 935 structures, according to the California Department of Forestry and Fire Protection.

Wildfires also recently have swept through Arizona, Colorado, Oregon, Montana, and Washington. [Oregon had one of its most destructive wildfire seasons](#) on record last year with a spate of fires that burned more than 1.1 million acres and destroyed more than 4,000 homes.

Even places that typically never burn – like the Sonoran Desert – are now experiencing wildfires, said Ann Youberg, a senior research scientist at the Arizona Geological Survey. She said fires ravaged swaths of desert in her state over the past three years.

“We’re not only seeing these bigger, larger and more severe fires, but we’re seeing it impact ecosystems that are not fire adapted because of climate change and because of invasive species,” she said.

Flames can leave behind a landscape devoid of plants and vegetation that otherwise protect the soil from erosion. If the fire burns hot enough, it can change the soil to such a degree that it becomes impervious to moisture.

The result is a barren, water-repellent surface that, on a steep slope, acts as a chute for the next heavy rainfall. With enough sediment or debris in that mix, it becomes a river with the consistency of flowing concrete, one that can carry burned trees, giant boulders, cars and almost anything in its path.

If you put sand, sticks and water in a concrete mixer and tip it over on a hill, the sand and sticks drop out on the ground while the water keeps going, Youberg said.

“If you actually have concrete in there, the concrete can carry those rocks and sticks and everything else

much further downslope,” she said. “It’s a slurry. It just behaves differently.”

Climate change has already increased the area burned in the West and the severity of the fires, said Daniel Swain, a climate scientist at UCLA and the National Center for Atmospheric Research.

It also has increased the odds of extreme precipitation.

“It is not just that we have a wildfire problem. It is not just the precipitation extremes increasing. It is not just that droughts are becoming more severe in a place like California,” Swain said. “All of these things can actually interact with each other in ways that produce new hazards.”

It doesn’t take a big storm or a lot of rain to cause a catastrophic debris flow, said Nina Oakley, a research meteorologist with the University of California, San Diego.

“You just need that high intensity rainfall,” Oakley said, adding that the more intense the rain, the higher the probability of a larger flow.

“With climate change, we’re expecting rainfall to intensify,” she said. “And with more locations burned, you have a greater likelihood of post-fire debris flows.”

Race against time

Research into post-fire debris flows is still relatively new compared to other natural disasters and is largely based on data from a few geographic areas.

The USGS work began in earnest 25 years ago, after torrential rains triggered post-fire debris flows that trapped dozens of vehicles along a stretch of Interstate 70 in Colorado. USGS research geologist Sue Cannon, now retired, developed some of the earliest models to predict why and when they happen and helped launch the agency’s post-fire debris flow project.

Study by study and sometimes storm by storm, Cannon and others gained a better understanding of what makes a burned slope behave differently, how the severity of the fire matters, and that it’s typically the intensity – not the amount – of rain that acts as a trigger.

The USGS uses the information and data collected in the field to map hazard areas and help estimate rainfall thresholds that set off the flows.

Those are key for the National Weather Service to issue accurate warnings. If the rainfall expected to trigger debris flows is too high, people could die. If it is too low, it could lead to costly, unnecessary safety measures – erecting barriers, closures and evacuations – and people could stop trusting the warnings.

Scientists first developed those models for Southern California, the region with the best-quality data at the time. Then, using figures from other locations, they tested the models for other areas.

But the work is still incomplete, mounting as more spots get added to the list of those at risk and further complicated by the shifting precipitation patterns caused by climate change.

Rainfall thresholds differ across the West for a host of likely reasons, said McCoy, who studies burn scars in California and Nevada. He cited the unique climate, vegetation, soil and topography of each region.

In parts of Arizona, for example, a typical monsoon may have as much as two or three times the intensity as a downpour in Southern California. Areas in Northern California, Oregon, Washington and Nevada could all need different rainfall thresholds.

How long the land takes to recover to lower or eliminate the risk of the post-fire flows also may vary by location.

In drier regions, the post-fire debris hazard generally drops year to year as the land recovers. But in a wetter climate like western Oregon, researchers say the opposite could be true as burned trees fall and their deep roots give way, making hillsides more susceptible to the flows.

“We absolutely were very concerned. In fact, we’re still concerned, because we just don’t have a good handle on it yet,” Bill Burns, a state engineering geologist in Oregon, said about the recent rash of fires and the expanding debris flow risk. “Other parts of the country, they’ve studied this post-fire debris flow phenomenon for decades.”

A wake-up call

Even in those parts of the country better prepared for the risk, post-fire debris flows can take people by surprise.

On Jan. 9, 2018, one of the worst such disasters slammed into Montecito, California, in what researchers and public policy experts described as a wake-up call.

It happened just weeks after what was then the state's largest wildfire on record chewed through the rugged mountains above the seaside community of 8,500.

The fire hadn't even been declared extinguished when the first storm of the rainy season hit. It dropped a half-inch of precipitation in just five minutes shortly before 4 a.m. It was an extreme downpour several times higher than what's needed to trigger a post-fire debris flow in the area.

Within minutes, one of several flows severed a gas line and set off an explosion.

In all, more than a million tons of mud, boulders and trees barreled into neighborhoods, knocked homes off their foundations and buried others up to their eaves. Roughly 24 million cubic feet of debris dumped onto the town – enough to fill 272 Olympic-size swimming pools. Twenty-three people died.

The sheer size and force of the flows, along with the casualties and extensive damage, shook even researchers who knew the region was susceptible to such risks.

Many called Montecito a game changer. Afterward, awareness of the phenomenon and potential consequences grew, galvanizing researchers and others to try to help and learn more. And, for those already concerned, it delivered a call to double down on their work and be better prepared the next time, said Kean, the USGS hydrologist.

Three years later, the job has gotten harder as a warming climate and bigger, more severe wildfires doubled the area at risk of the post-fire hazards and left some spots newly in the crosshairs.

USGS maps the post-fire debris flow hazards so officials can prepare and warn the public when a storm might trigger one. But the mapping generally happens only after a wildfire has scarred the earth.

It can take months or even years before the right kind of rain causes catastrophe. But, as in the case of

Montecito, it can come much sooner, leaving little time to prepare.

Teams from local, state and federal agencies had acted quickly after the fire that burned above Montecito, a blaze that spanned nearly 440 square miles in Ventura and Santa Barbara counties.

But the magnitude of the disaster still caught most off guard.

Montecito resident Susan Moe said she never heard the term “post-fire debris flow” or knew she was at risk before January 2018.

It wasn’t until she heard what sounded like a roaring train out her window that she understood the threat. She watched stunned as the thick river tore through her neighborhood, carrying a roof, a septic tank, telephone poles and cars in the muddy mass.

Moe doesn’t remember how long she, her husband and three children sat together in shock in their one-story home that night.

“The power was out. You couldn’t see anything. It was freezing cold,” she said. “You’re just so helpless.”

A friend sent a text message asking if they were OK. Moe typed back that they were surrounded. Stay put, the friend responded, and don’t open any doors – advice Moe thinks may have helped save their lives.

Many of her neighbors were not so lucky.

Making those predictions before a fire would buy time to figure out where a flow will go and better identify who and what is at risk, Kean said. The science is complicated, he said, and there’s typically too little time to get it done between the fire and the storm.

Some efforts to do the pre-fire assessments have happened – Youberg was part of a team that did it in Coconino County, Arizona – but researchers are still working to improve the science. Routinely applying the inundation models after a fire is still further off and making it happen broadly before a fire even starts still could be years away, Kean said.

“My big regret about our work (in Montecito) is we didn’t provide maps of where the flows were going to go,” he said. “If we can get a head start by using wildfires scenarios that are likely, I think we can be a little bit better prepared for the inevitable.”

‘Chocolate shake, not chocolate cake’

Insurance companies, too, must prepare for the spreading risk of post-fire debris flows and the growing numbers of claims from policyholders after an impact.

Few if any homeowner’s policies specifically cover the disaster, meaning survivors left to pick up the pieces could face the additional trauma of having to pay for damages out of pocket.

Wilkerson is among them.

Debris from the Poudre Canyon flow smashed open Wilkerson’s front door, leaving three feet of sludge, rocks and a couple of logs inside. After 31 years of paying insurance on the cabin, his claim for damages was rejected, he said.

His insurance company deemed it flood damage, an exclusion on his and most homeowner policies. He never bought separate flood insurance, never thought he needed it, and didn’t know a fire could change that.

Federal flood insurance policies cover mudflows, but people may not know they need it until after a fire or even then and that may be too late.

Even with flood insurance, a policy owner still may wind up in a dispute over coverage, according to Amy Bach, an attorney and cofounder of United Policyholders, an insurance consumer advocacy organization.

“If you have a flood policy, we say it covers chocolate shake, not chocolate cake,” she said.

FEMA’s flood insurance covers a mudflow, but not a debris flow or earth movement. If there is more mud and liquid than wood, rocks and other debris, the damage likely gets covered, according to Bach. But if there’s more earth and debris, it may not.

That may leave policyholders in what Bach called a soft spot in the insurance industry.

In California, that changed after Montecito debris flows, she said.

The state insurance commissioner issued a formal notice, saying the fire likely had caused the debris flow. If a policy covers fire, insurers would be on the hook for the claims. State legislators also passed a law that year that similarly said coverage should extend to post-fire damage caused by a blaze.

“But that’s just California,” Bach said. “I worry a lot about people in Oregon, Washington and Colorado.”

Carole Walker, executive director of the Rocky Mountain Insurance Association, knows of no similar efforts in Colorado, New Mexico, Utah or Wyoming.

The trade association represents insurers in those states and typically points homeowners to flood insurance after a fire, saying policies specifically exclude flood and mudslide or debris flow damage.

If insurance companies are required to pay claims on damages, they may face more incentive to learn about disasters and develop the kinds of models that will help accurately pinpoint the risk.

Surprises aren’t welcome in the insurance business, said Shelly Yerkes, senior director of product management with CoreLogic, a property data analytics firm.

Companies want to know every risk on the horizon, she said. Unless they can measure it, they generally don’t feel like they have control over what could happen.

When something new emerges and it’s relatively small, it may not create shockwaves in the industry and may get overlooked.

But when a disaster like Montecito happens – causing a huge loss of life and big hit to some of the most expensive real estate in the country – every insurer takes notice, she said.

“That’s when they start coming to us and asking for models or risk indicators for certain types of perils,” Yerkes said.

In some cases, companies may decide that the risk is too small to spend the resources to try to measure it. Sometimes, it may not even be possible yet to do so, according to Yerkes.

“We’re being faced with that right now with climate change,” she said. “There’s a need to measure climate change, but yet, the data doesn’t even exist to understand it fully.”

Insurers received more than 2,000 claims totaling \$421 million in losses in the Montecito disaster, according to the California Department of Insurance.

Yerkes’ company started getting some calls. But models take time to build, she said, and she doesn’t know of one yet to measure financial loss from a post-fire debris flow.

Right now, insurance companies also aren’t required to pay those claims except in certain situations, like after the Montecito debris flow.

If that changes, research efforts may gain more momentum.

After the July 20 flow, researchers showed up in the small community in Poudre Canyon to learn what they could.

Dan Bond, who lived in the area most of his life, talked to those scientists about what made the spot vulnerable to the hazard – one he said he hadn’t heard about before the deadly event that forever changed his neighborhood.

A full-time resident of Black Hollow Road, the volunteer firefighter said he pulled on rubber boots the evening of the debris flow and headed outside where the nearby creek raged and homes and rocks the size of small cars washed down the mud- and log-filled river.

Four months later, Bond, 59, sees reminders of the deadly debris flow daily.

“To walk around it and see the devastation, it’s just overwhelming,” he said.

Officials say it could happen again, a risk that could last years, he said. But he has no plans to move.

“If something happens, it happens,” he said. “But I can’t live in fear of every rainstorm.”

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