Study finds potentially harmful chemicals lingered in homes affected by Marshall Fire

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A researcher scrapes dust from a sliding door frame. Credit: Caroline Frischmon

Potentially harmful chemicals generated by the Marshall Fire in late 2021 may have lingered inside some Boulder County homes for weeks after the disaster—hiding in small particles of dust that residents could have mixed back into the air when they vacuumed carpets or turned on fans, according to recent research published in *Air Quality, Atmosphere & Health*.

The study, led by researchers from the University of Colorado Boulder, is the latest to look at the long-lasting impacts of this devastating event. The Marshall Fire ignited in the morning on Dec. 30, 2021, and within hours destroyed more than 1,000 homes and buildings.

Engineers and chemists at CU Boulder wanted to take a particularly close look at those homes that survived the blaze but still faced the towering walls of smoke.

Through late January and early February 2022, the scientists collected meticulous samples of particles of dust in the air and on surfaces in a sample of homes from the fire zone. They discovered that burning from the blaze may have left a mark on these buildings. Dust samples, for example, revealed elevated concentrations of potentially harmful materials like polycyclic aromatic hydrocarbons (PAHs), which the Environmental Protection Agency considers carcinogens.

The team can't be sure what risk, if any, the particles posed to the health of people living in these neighborhoods. But the researchers hope that their results could one day help the survivors of future wildfires make informed decisions about when they can move back into their homes.

"This is going to happen again, unfortunately," said Jonathan Silberstein, a doctoral student in the Paul M. Rady Department of Mechanical Engineering at CU Boulder. "Maybe not in Boulder, but somewhere in the United States. We hope this research will help inform best practices

for recovering after the next fire."

The study is one of several that CU Boulder researchers carried out across Boulder County in the wake of the disaster. The same team, for example, is also studying the toxic gases that may have seeped into homes from the fire to build out a more complete picture of the possible health risks.

"This was a really tragic event, but it was rewarding to have the opportunity to quickly address the concerns of the community many of us live in," said Michael Hannigan, co-author of the study and a professor of mechanical engineering. "The community members couldn't have been more receptive, helpful and gracious."

Returning home

Christine Wiedinmyer is one of those community members. She's also a co-author of the new study.

On Dec. 30, 2021, the CU Boulder air quality scientist was working from the basement of her home in the Rock Creek area of Boulder County when she started receiving texts from her friends: Authorities had just evacuated the Costco in the nearby town of Superior. Wiedinmyer and her teenage son left not long after, grabbing their laptops, some important documents and a few items of clothing.

"I really didn't appreciate the extent of the fire until I got to my brother's house in Denver, and I saw the news," said Wiedinmyer, associate director of science for the Cooperative Institute for Research in Environmental Sciences (CIRES). "I thought: We're not going back today."

When she did return to her home on New Year's Eve, Wiedinmyer

found it still standing. But the flames, which had spread to within a few hundred yards from her house, had left a fingerprint on the structure.

"It smelled like the day after a campfire," she said. "Below the doors and windowsills, you could see this black dust."

At the same time, Wiedinmyer's neighbors came to her with questions she couldn't answer: Was it safe for them to move back home? What kind of cleaning should they do?

Mechanical engineering graduate student Avery Hatch takes air quality measurements inside a Boulder County home. Credit: Casey Cass/CU Boulder

An eye on dust

To begin to answer those questions, Wiedinmyer joined a dream team of scientists from across CU Boulder. They included Hannigan; Marina Vance, assistant professor of mechanical engineering; Joost de Gouw, a chemist and professor at CIRES; and Colleen Reid, assistant professor of geography.

In a first-of-its-kind study, the team visited several homes in the burn area, a region spanning more than 6,000 acres in Superior, Louisville and unincorporated Boulder County—then picked four houses to study in-depth for this study, including Wiedinmyer's. The team scraped dust from windowsills and installed monitors to track particles in the air on a minute-by-minute basis.

The group's results revealed what may be the most detailed story to date of what happens to homes that survive this kind of fire.

The floating particles of ash produced by the fire seemed to settle out of the air in these houses within a day or two. But the dust that Wiedinmyer had seen on her windowsills lingered, and didn't stay put. In February, the researchers took measurements as a six-person cleaning crew entered one of the homes to vacuum and mop.

The concentrations of particles in the air nearly doubled during that time. Overnight in the same house, the team saw airborne particles spike about once every 20 minutes—likely due to the home's HVAC system switching on and off.

Silberstein noted that the concentrations of contaminants like PAHs and some heavy metals were higher in those samples of dust that in Boulder County homes outside of the burn zone. But levels weren't above the typical range for many urban areas in the U.S.

"Human activity, like cleaning, seemed to cause resuspension," Silberstein said. "If there are compounds in that dust that are potentially bad for human health, that's when you might see the greatest health risks."

A mailbox melted by the Marshall Fire on Dec. 30, 2021. Credit: Casey Cass/CU Boulder

Wear a mask

Wiedinmyer noted that the team's results represent just the first step in

understanding how disasters like the Marshall Fire may affect nearby homes.

"I found it really frustrating because I couldn't tell my neighbors what to do," Wiedinmyer said. "I couldn't tell them if it safe to move back in, only what I had done in my own house."

For her part, the scientist cleaned her floors and windowsills and aired out her home for a week. She and her family didn't move back in until the burning smell had gone away. Silberstein noted that anyone cleaning up a house after a fire should be diligent about wearing a mask to avoid breathing in potentially harmful dust.

He appreciated the chance to see his scientific knowledge help his community in a time of need.

"Often, our kind of research can feel removed from people's everyday lives," Silberstein said. "But this project felt like we were making a tangible difference."

More information: Jonathan M. Silberstein et al, Residual impacts of a wildland urban interface fire on urban particulate matter and dust: a study from the Marshall Fire, *Air Quality, Atmosphere & Health* (2023). DOI: 10.1007/s11869-023-01376-3

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