Fighting Fire With Research: How a Scientist is Protecting People and Property From Wildfires

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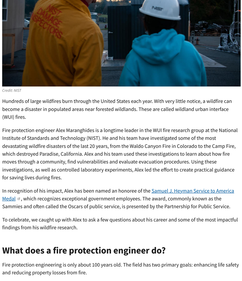
By: Brian Gutierrez



Credit: NIST

Hundreds of large wildfires burn through the United States each year. With very little notice, a wildfire can become a disaster in populated areas near forests. These are called wildland urban interface (WUI) fires.

Fire protection engineer Alex Maranghides is a longtime leader in the WUI fire research group at the National Institute of Standards and Technology (NIST). He and his team have investigated some of the most devastating wildfire disasters of the last 20 years, from the Waldo Canyon Fire in Colorado to the Camp Fire, which destroyed Paradise, California. Alex and his team used these investigations to learn about how fire moves through a community, find vulnerabilities and evaluate evacuation procedures. Using these investigations, as well as controlled laboratory experiments, Alex led the effort to create practical guidance for saving lives during fires.

In recognition of his impact, Alex has been named an honoree of the Samuel J. Heyman Service to America Medal ®, which recognizes exceptional government employees. The award, commonly known as the Sammies and often called the Oscars of public service, is presented by the Partnership for Public Service.

To celebrate, we caught up with Alex to ask a few questions about his career and some of the most impactful findings from his wildfire research.

What does a fire protection engineer do?

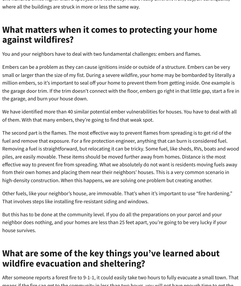
Fire protection engineering is only about 100 years old. The field has two primary goals: enhancing life safety and reducing property losses from fire.

Historically, the profession has focused on fire inside buildings. But the problem of outdoor fires is escalating rapidly. Wildfires are becoming larger and more intense, so they have a larger impact on life safety and infrastructure.

What's behind this increase in wildfire danger?

There are a few reasons. Occasional small fires are healthy. They clear out the dry leaves and dead wood. But for over three-quarters of a century in the U.S., we tended to put out all forest fires early. That policy resulted in an extensive buildup of material ready to burn. And that, together with droughts and other environmental conditions, is now creating explosive fire behavior.

But that's not the whole story. We're also building more homes in and near forested areas. These areas are called the wildland urban interface (WUI). And they are our main concern.



NIST researcher Alex Maranghides is researching dangerous wildfires, with the goal of helping communities protect themselves from this persistent threat.
Credit: W. Ying/NIST

How has wildfire research changed during your career?

As wildfires have gotten larger, we've needed to change our approach from actively fighting the fire to reducing the hazards ahead of time and having an evacuation plan.

When the town of Paradise, California, was hit by a fire in 2018, 20,000 structures were exposed at the same time. There aren't 20,000 fire engines in the entire state of California. Actively fighting a fire that large is unrealistic.

How is fire different from other types of natural disasters, such as earthquakes or hurricanes?

Most of my work has been about studying fires after they happened. We want to know what went wrong and find the success stories, so we can learn from these tragedies and avoid repeating mistakes.

There are a few unique challenges to investigating fires compared to other natural disasters. For one thing, fire makes more fire. Other disasters don't self-propagate. Hurricanes don't make more hurricanes; tornadoes don't make tornadoes.

Another challenge is that firefighters save structures during the event. That makes it really hard to know: Did a home survive because of the way it was built, or did it survive because it was defended by a firefighter?

A third fundamental difference is that the exposures are extremely local. The heat in one spot could easily be one hundred times higher than a spot just five feet away. That's really different from, say, an earthquake, where all the buildings are struck in more or less the same way.

What matters when it comes to protecting your home against wildfires?

You and your neighbors have to deal with two fundamental challenges: embers and flames.

Embers can be a problem as they can cause ignitions inside or outside of a structure. Embers can be very small or larger than the size of my fist. During a severe wildfire, your home may be bombarded by literally a million embers, so it's important to seal off your home to prevent them from getting inside. One example is the garage door trim. If the trim doesn't connect with the floor, embers go right in that little gap, start a fire in the garage, and burn your house down.

We have identified more than 40 similar potential ember vulnerabilities for houses. You have to deal with all of them. With that many embers, they're going to find that weak spot.

The second part is the flames. The most effective way to prevent flames from spreading is to get rid of the fuel and remove that exposure. For a fire protection engineer, anything that can burn is considered fuel. Removing a fuel is straightforward, but relocating it can be tricky. Some fuel, like sheds, RVs, boats and wood piles, are easily movable. These items should be moved further away from homes. Distance is the most effective way to prevent fire from spreading. What we absolutely do not want is residents moving fuels away from their own homes and placing them near their neighbors' houses. This is a very common scenario in high-density construction. When this happens, we are solving one problem but creating another.

Other fuels, like your neighbor's house, are immovable. That's when it's important to use "fire hardening." That involves steps like installing fire-resistant siding and windows.

But this has to be done at the community level. If you do all the preparations on your parcel and your neighbor does nothing, and your homes are less than 25 feet apart, you're going to be very lucky if your house survives.

What are some of the key things you've learned about wildfire evacuation and sheltering?

After someone reports a forest fire to 9-1-1, it could easily take two hours to fully evacuate a small town. That means if the fire can get to the community in less than two hours, you will not have enough time to get the people out. In that scenario, ordering an evacuation can be very dangerous. When cars are stuck in traffic trying to escape, those cars can be overrun by fire, causing fatalities.

We recently updated a report called ESCAPE that helps the decision makers - fire chiefs, city officials and law enforcement - plan for these no-notice or limited-notice fires. The report helps you figure out if you're going to have enough time to evacuate your community. It also helps you plan for what to do when there isn't time for a full evacuation. In those cases, we want to bring people to open spaces nearby - such as golf courses or big parking lots - to serve as Temporary Fire Refuge Areas. These areas don't guarantee safety, but it's better to be in an open space than to be trapped in your car or home.

The key idea behind ESCAPE is to be ready ahead of time. If you're not prepared, it will be very dangerous. You have to do the training, educate the public, work with mutual aid, label the Temporary Fire Refuge Areas, do drills, collect the information and work with your other jurisdictions so that it's all connected. It's impossible to do all this work when a fire is approaching.

It seems like a critical part of your work is not only doing the research, but also telling local fire officials and the public about it. How do you balance those two responsibilities?

If we do research and file it away, it doesn't do anything. It is absolutely critical to make sure that we translate the science into readily understandable material. For example, our full report on the Camp Fire is 1,000 pages long to date. To make it easier to use, we distilled our advice for evacuation and shelter into a 100-page report, which can teach people the core ideas, and they can refer back to the longer documents to learn more. That was still a little too much, so we simplified that further into a free online training tool that can teach you the core ideas in three hours.

It's up to us to make sure that the science is usable, and we're always searching for ways to make our findings more accessible.

> "Alex is so deserving.... California is better because of Alex."
>
> -Daniel Berlant, State Fire Marshal, CAL FIRE

You've been studying wildfires for more than 20 years. What has driven you to work so hard at this problem for decades?

It's not an easy thing to witness a destroyed community. When I go out and see the devastation, and I know I can do something about it, that's the incentive for me to do the work that I do.

There's a great opportunity here at NIST, not just to do science but to have an impact on people's lives.

Is there any advice you have for young people who are thinking about going into wildfire research?

I think this is the largest fire problem for the next generation. There is at least a generation – if not two – worth of high-impact work to be done here.

Wildfire used to be a problem only for Western states. It's no longer a Western problem. This year, we've had fires in South Carolina all the way to north of Boston, and in some cases, 100 fires at once. The bad news is that the East is even less prepared; they don't have the infrastructure, the experience or the building codes. The good news is that we can leverage the knowledge from previous fires to prepare.

What has been the biggest factor in completing this important work?

We had the help of many, many people who made this research possible. Over the years, we have had hundreds and hundreds of external collaborations that have helped us re-create these catastrophic events so that we can learn from them. We've also had a lot of support internally at NIST to create our wildfire research group and create high-impact case studies, laboratory experiments, reports and online tools. It has really been a team effort.

Real-life fire experiments are providing new insights into the complex question of how far apart two structures, such as a house and a shed, should be in order to limit the risk of fire spreading from one to the other. The experiments conducted by the National Institute of Standards and Technology, in collaboration with CAL FIRE, the U.S. Forest Service, and the Insurance Institute for Business and Home Safety examine how fires spread from sheds of different sizes and with a range of fuels to identify critical separation distances. This information will be used to develop better building codes and preventive measures to mitigate the impact of wildfires.

Buildings and Construction, Fire and Wildland urban interface fire

ABOUT THE AUTHOR

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Brian Gutierrez is a public affairs specialist covering energy, climate, fire and wildfire science, buildings and construction, community resilience, robotics, and manufacturing research. Prior to working at NIST, he worked as a podcast producer for institutions including National Geographic, *The Wall Street Journal* and Freakonomics Radio. In his free time, he enjoys reading science fiction, tinkering with electronics and playing with his dog, Olive.

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