PART 2

MITIGATION

MITIGATION PROGRAMS AIM TO REDUCE RISK THROUGH strategies that reduce the amount of brush, dead branches, and other combustible material around buildings and residences and prepare communities to defend against fire. ArcGIS allows fire managers to implement and track the progress of projects to reduce hazardous fuels, determine defensible space between homes and surrounding wildlands, prepare homes to resist fire, and conduct prescribed burns for healthier forests.

Fuel reduction

Reducing the amount of vegetation in a forest and around homes and businesses can help communities reduce their wildfire risk. ArcGIS tools help agencies define project boundaries, identify vegetation to be removed, monitor fuel-reduction progress, and quantify the effectiveness of their efforts after a wildfire begins. Using ArcGIS technology can help agencies implement fire plans with real-time mapping and allocation of resources as firefighters respond to reduce the impact of fire on communities and the environment.

Defensible space and home hardening

Creating areas where firefighters can safely defend homes and ensuring that those homes are prepared for the worst can reduce their risk during a wildfire. Using ArcGIS technology, firefighters

and other agencies can use mobile field data collection apps to assess the condition of residences at risk, identify ways to increase defensible space, and record recommended home-hardening actions that increase a structure's resiliency to wildfire.

Prescribed fire

Fire supports the health of forests and ecosystems. Agencies can use GIS to determine where to conduct prescribed fires while considering fuel type, topography, wildlife habitat, and weather conditions. Fire managers can also predict how a prescribed fire will behave and spread under a variety of conditions and view the impact of the resultant smoke on population centers. With GIS, fire managers can set prescribed fires in areas and under the conditions where it will have the greatest benefit.

GIS in action

The rest of this section will look at real-life stories about how wildland fire organizations use GIS to plan and support mitigation activities.

AS THE WAYS WE FIGHT WILDFIRES CHANGE, SO WILL THE FORESTS THEMSELVES

Esri and Technosylva

WHAT WE'VE LEARNED ABOUT WILDFIRES—THEIR BEHAVIOR, fuels, chosen paths—has changed as dramatically as the technology used to study them. As a result, the way we fight them is changing, too.

After nearly seven million acres were scorched in California in 2020–2021, the state and country realized the need to fight fires differently, spending billions of dollars to prevent fires rather than suppress them. California set aside $1 billion in 2021 for fire efforts focused on clearing forests of potential fuel such as dry vegetation and plans to spend at least $200 million annually through 2027. Nationally, lawmakers have proposed billions to do the same across the country.

Californians and much of the country must learn to live with good fire to prevent devastating fires and adjust to a future where familiar forests may never grow back. It will take careful human intervention to foster a new kind of wilderness, according to experts at the Geography of Wildfire and Forest Resilience: Preparing for What's Next conference in 2021.

Modern technology is helping to build the healthy forests of the future by observing, even predicting, fire behavior and helping determine which species of tree may endure climate change and the threat of wildfire better than others.

A complex fire quilt

The many factors driving shifting wildfire behaviors include climate change, weather, local winds, water-stressed vegetation, fuels, topography, soils, and human impacts.

The complexities resemble a "fire quilt," said Joaquin Ramirez, founder of Technosylva, which developed the fiResponse software system, built with ArcGIS technology and used by states and fire agencies in predicting and monitoring active wildfires.

Society must learn to live with the type of fire that keeps forests in balance and resist the temptation to rebuild homes in the same locations of previous, recent, fires.

The majority of California's largest and most intense wildfires have occurred in recent years. Despite that, it could have been far worse, Ramirez said. There were likely countless more acres saved because of early detection and simulations through technology, he said.

Technology has been made even more necessary to study fires as their size and severity have grown.

"We can't ground truth a million-plus acres of land each year," said Libby Pansing, a forest and restoration scientist with American Forests, referring to the practice of checking assumptions in person. "We can't do this work on the ground by ourselves."

GIS has filled the gaps where landscapes can't be inspected in person. When restoring forests, the group must target its efforts to areas with the greatest ecological need and potential. Following the 2020 Creek Fire near Shaver Lake, California, which burned nearly 380,000 acres, the group used GIS to create a heat map to show distances to the nearest green trees needed for natural regrowth where the wildfire had burned. Another map layer showed a one-mile buffer from surrounding roads to determine where forestry workers could most easily access areas for replanting.

Seeing through smoke

California has become NASA's laboratory for testing new instruments and developing tools as it observes wildfires that have almost burned to the edges of its own Jet Propulsion Laboratory campus in Pasadena.

Dr. David Shimel, the agency's lead for carbon cycle and ecosystem programs, said radar technology has made it easier to observe topographic landscapes and forest structure, allowing them to distinguish the types of vegetation below the tree canopy. Lidar has led to 3D reconstructions of forests showing what an area looked like before and after a wildfire.

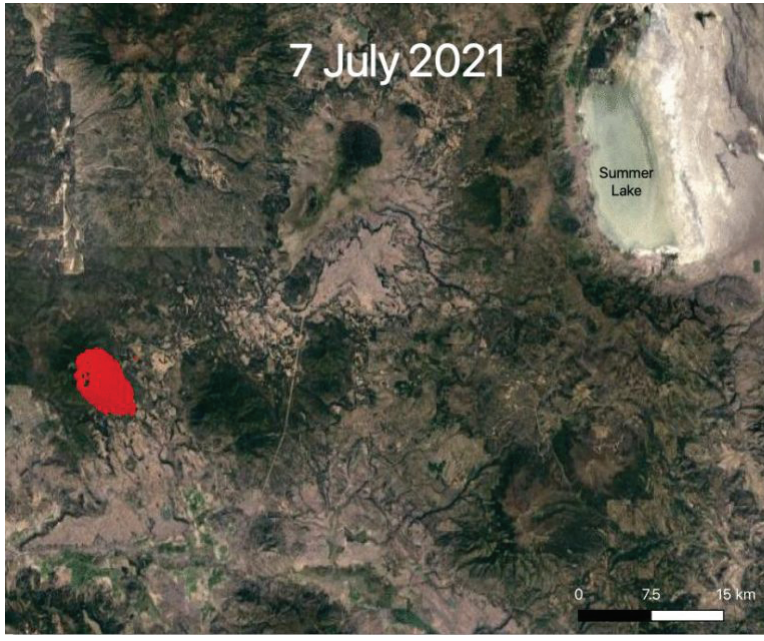
Thermal sensors can measure evapotranspiration and show whether vegetation is water stressed, risking worse fire situations. Positioned on the International Space Station, the ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), shows the most stressed areas before a major fire and how that stress abates, or doesn't, as a burn scar recovers. Scientists can see through smoke and observe the energy of active fires.

NASA's tools provide input into the models that American Forests creates for a science-based approach to reforestation on burn scars. The nonprofit has developed a restoration plan for the site of the 2018 Camp Fire, California's deadliest fire that killed 85 people and left a huge swath of forest without trees. In the three years that followed, two more large fires burned nearby.

Austin Rempel, senior manager of American Forests, showed how each of the three burn scars met like puzzle pieces. Something unusual was happening, he said.

The fires had also managed to destroy the landscape in a way that trees weren't going to naturally return.

"If you lose all of your trees that can produce cones, you're in trouble," Rempel said, referring to the importance of the seeds



NASA's ECOSTRESS radar technology supports the fight against fires (shown at left) in the western United States. Image courtesy of NASA/JPL-Caltech.

housed inside those cones. "Without intervention, there will be no trees."

As a result, his group and others are building a forest that will be better equipped for what's coming, whether it's more fires and worsening climate conditions. Using GIS, the group determined that the seeds of trees grown in and around Redding, California, have adapted to higher temperatures and would be better suited for planting in the Camp Fire burn area as it's brought back to life.

Where fire is part of the forest

Experts in fire behavior, forest management, and disaster response hope some of the state and federal funding goes to increasing data

collection at the local level to help make communities more resilient, doing more to reduce fuels in forests statewide, and additional research.

"We still don't have a good handle on predicting extreme fire behavior," said Craig Clements, director of the Wildfire Interdisciplinary Research Center.

Big fires, even intense fires, have been happening for a really long time, said Matt Jolly, a US Forest Service ecologist. What's different now is that fires are "more present in people's lives," forcing people to think about them in a different way. Technology can help provide the public context about why a fire is being allowed to burn in a controlled way to maintain environmental balance.

A healthy forest "is going to be a place where fire is part of that forest," Jolly said.

A version of this story by Kimberly Hartley titled "The Ways We Fight Wildfires Are Changing, So Will the Forests Themselves" originally appeared in the *Esri Blog* on December 13, 2021.