The Utilization of Current and Emerging Technologies to Monitor Wildfire Activity in California

Many parts of California experience wildfires, and some portions of the state are prone to particularly destructive wildfires based on their typography, local weather, and the health and density of local forests. The California Department of Forestry and Fire Protection (Cal FIRE) estimates that significant portions of the state face a high to extreme threat of wildfires, including most forested regions of the state. A 2018 University of Wisconsin-Madison study found that over 11 million Californians live within the Wildland-Urban Interface (WUI), the geographical area where man-made structures and other human development meets or intermingles with wildland or vegetative fuels, and where wildfire problems are most pronounced.

The majority of the deadliest, largest, and most destructive fires in state history have taken place within the past 20 years. Over the past generation, the fire season has grown at the front end by approximately 30 days and extended at the back end by about another 30 days. Fires today burn twice as many acres and for twice as long as they did in the 1990s. Experts believe that a combination of factors will result in serious fire seasons for the indefinite future.

The state's two most recent wildfire seasons were unprecedented, both in terms of scope and destruction. The Camp Fire in November of 2018 was the deadliest and most destructive ever in California, resulting in 85 deaths and nearly 19,000 structures destroyed. In June of 2018, the Mendocino Complex Fire became the state's largest in history, burning nearly 460,000 acres, and in August of 2018, California was battling 17 large fires simultaneously. Although there were fewer fires in total in 2018 than in 2017, the number of acres burned was 73 percent greater. In 2017, an intense series of fires in the North Bay area of the state destroyed more than 200,000 acres and killed 44 people.

The speeds of some of these fires were notable. For example, at one point the Camp Fire burned 80 acres per minute and burned 70,000 acres in 24 hours. According to Neil Lareau, an atmospheric scientist at the University of Nevada, Reno, "we have a weather event, in this case a downslope windstorm, where, as opposed to the normal westerly winds, we get easterly winds that are cascading off the crest of the Sierra Nevada." In addition, fire itself can create wind, further accelerating the conflagration. Another example is the Tubbs fire, which was pushed downhill at unusually high speeds by winds that sometimes exceeded 50 miles per hour. Burning embers blew ahead of the main front, leaping ahead and igniting new fires. Some wind-driven fires of 50-60 miles an hour can throw embers that can ignite a roof a half of a mile or a mile in advance of the flaming front of the fire.

The following table shows the number of wildfires and acres burned in calendar years 2017 and 2018.

Number of Fires and Acres Burned

Interval	Fires	Acres
January 1, 2018 through December 30, 2018 (CalFire)	6,284	876,147
January 1, 2017 through December 30, 2017 (CalFire)	7,117	505,956
5-year average (same interval)	5,756	233,483
2018 Combined YTD (CalFire & US Forest Service)	7,571	1,671,203

Note: Statistics include all wildfires responded by Cal FIRE in both the State Responsibility Area (SRA), as well as the Local Responsibility Area under contract with the department. Statistics may not include wildfires in SRA protected by Cal FIRE's contract counties. Final numbers will be provided in the annual Wildfire Activity Statistics Report once it is published. Source: Cal FIRE.

Experts believe that there are three primary reasons why California wildfires have become more catastrophic: (1) the climate is becoming warmer; (2) more people are living in combustible places; and (3) there is more fuel for the fires to burn.

In addition, the continued expansion of human development into previously undeveloped land plays a significant role in the destructiveness and deaths involved in recent wildfire events. On average, 95 percent of fires in California are caused by some form of human activity, such as: vehicle sparks, lawn mowers, faulty residential electrical connections, power lines, target shooting, fireworks, cigarettes, debris burns, campfires, and power equipment. As human activity is increasingly the cause of most wildfires, more people are impacted by the damage from them as well.

Fire protection efforts in California's wildlands involve firefighting resources at the state, federal, and local levels. The responsibilities for each level of government are set forth in law and policy directives. However, these responsibilities and the geographic areas of protection often overlap among governments. In order to reduce overlap and maximize the use of resources across jurisdictions, firefighting agencies generally rely on a complex series of agreements which result in a multiagency wildland fire protection system.

In order to efficiently and effectively respond to wildfires, emergency responders need access to reliable and timely information on the fire's location and future forecast, and the ability to quickly share this information. To that end, researchers and first responders are working together to develop and implement technologies for swift emergency response to wildfires.

Advances in various technologies are helping to better prepare communities for, and help first responders in identifying and battling wildfires. Examples include the Santa Ana Wildfire Threat index, operated by the United States Forest Service, which uses advanced simulation models to forecast wildfire threats up to six days in advance for communities in Southern California; drones used to map routes for firefighters, and to identify small fires in thick smoke; temperature and humidity sensors to detect the presence of a fire, and infrared cameras used to detect hot spots; satellite imagery used to map the current position of wildfires and using that knowledge to model and forecast the future movements of a fire. Additionally, fire modeling, weather stations, prepositioning of fire equipment, and utilities shutting down electrical grids during dangerous fire conditions are all playing a role in more effectively preventing and fighting wildfires.

California's Emergency Responders

California Governor's Office of Emergency Services. In 2009, the California Legislature merged the powers, purpose, and responsibilities of the former California Office of Emergency Services with those of the Office of Homeland Security into the newly created California Emergency Management Agency (EMA). In 2013, Governor Edmund G. Brown Jr.'s Reorganization Plan #2 eliminated (EMA) and restored it to the Governor's Office, renaming it the California Governor's Office of Emergency Services (Cal OES), and merging it with the Office of Public Safety Communications.

California is home to over 800 miles of coastline, dozens of fault lines, and thousands of square miles of forest, and 39 million residents. Unfortunately, the extensive coastline, fault lines, and forestry in the state combined with the large population base create a recipe for costly man-made and natural disasters. Potential disasters include flood, fire, earthquake, dam or levee failure, hazardous material spills, civil unrest, energy disruption, cyber-attack, severe weather, food and/or agricultural emergency, and pandemic/epidemic.

The role of Cal OES is to address risks and threats, maintain a state of readiness, and plan for and mitigate impacts. The office coordinates the state agency response to major disasters in support of local governments, and homeland security activities throughout the state. Cal OES provides leadership, assistance, training, and support to state and local agencies; and coordinates with federal agencies in planning and preparing for the most effective use of resources in emergencies.

Today Cal OES is responsible for overseeing and coordinating emergency preparedness, response, recovery, and homeland security activities within the state. Cal OES also coordinates the California Fire

and Rescue Mutual Aid System which includes responses to major fires, earthquakes, tsunamis, hazardous materials and other disasters.

California Department of Forestry and Fire Protection. Cal FIRE is an emergency response and resource protection department that protects lives, property, and natural resources from fire. Cal FIRE's varied programs work together using ongoing assessments of the condition of natural resources and challenges of an increasing population to plan protection strategies for California. Cal FIRE is responsible for providing wildland fire protection and resource management on over 31 million acres of State Responsibility Area (SRA) lands throughout California. In addition, Cal FIRE provides emergency services to 150 local government cooperators through agreements with districts, cities, and counties.

Cal FIRE responds to more than 5,750 wildland fires each year, and covers the state with 21 operational units, 802 fire stations (234 state and 568 local government), 43 conservation camps, 12 air attack, and 10 helitack bases. The heart of Cal FIRE's emergency response and resource protection capability is a force of over 6,100 full-time professionals, foresters, and administrative employees; 2,600 seasonal firefighters; 2,750 local government volunteer firefighters; 600 Volunteers in Prevention; and 3,500 inmates, wards and Conservation Corp Members.

Cal Fire has significantly increased its efforts in fire prevention in recent years. Cal Fire's resource management and fire prevention programs include: forest and vegetation treatments, wildland pre-fire engineering, land use planning, education and law enforcement. The purposes of these activities are to reduce the number of fire starts, create more fire resistant and defendable communities, and reduce the overall intensity of wildfire. Typical projects include: forest thinning, vegetation clearance, prescribed fire, defensible space inspections, emergency evacuation planning, fire prevention education, fire hazard severity mapping, and fire-related law enforcement such as fire cause investigation and civil cost recovery for negligently started fires.

Forestland in California. Despite a small percentage of state-owned lands, the state is responsible for fire protection on more than just land it owns. There are 33 million acres of forest in California, including:

- 19 million acres (57%) owned and managed by federal agencies (including the US Forest Service, Bureau of Land Management, and National Park Service).
- 700,000 acres (3%) owned by state and local agencies, including CalFire, local open space, park and water districts and land trusts.
- 13.3 million acres (40%) privately owned, including individuals/families, Native American tribes, and companies.

State's Forests Maintain Increased Risk of Severe Wildfires. According to the Legislative Analyst's Office (LAO), roughly one-third of California is forested, and these forests provide critical air, water,

wildlife, climate, and recreational benefits. However, a combination of factors have resulted in poor conditions across these forests, including excessive vegetation density and an overabundance of small trees and brush. Such conditions have contributed to more prevalent and severe wildfires and unprecedented tree mortality in recent years. Experts are concerned these trends will continue if steps are not taken to significantly improve the health of the state's forests.

Emergency Response Funding

2018-19 Budget Provided Approximately $670 Million in Budget Augmentations. This included (1) $245 million for firefighting resources, such as helicopters; (2) $266 million to implement elements of the Forest Carbon Plan and conduct other forest health and fire prevention activities and (3) $163 million for fire recovery.

2019-20 Governor's Budget Proposal. The Governor's proposed budget for the 2019-20 fiscal year includes an additional $440 million to improve the health of the state's forestlands and enhance Cal OES's and Cal FIRE's fire protection capabilities.

- Increasing Fire Prevention -- $213.6 million from various funds to complete more fuel reduction projects, implement the recently enacted wildfire prevention and recovery legislative package, and dispose of illegal and dangerous fireworks.
- Enhancing Aviation Resources -- $120.8 million General Fund to add aircraft with increased tactical capabilities
- Expanding Firefighting Surge Capacity -- $64.4 million General Fund to enhance Cal FIRE's fire protection capabilities, including resources to add 13 new year-round fire engines, expand heavy fire equipment operator staffing, accelerate the replacement of fire engines and other mobile equipment, and operate five additional Cal FIRE/California Conservation Corps fire crews.
- Mutual Aid System -- $25 million General Fund ongoing for prepositioning of existing Cal OES and local government resources that are part of the statewide mutual aid system.
- Improving Use of Technology -- $9.7 million General Fund for an additional 100 fire detection cameras that will be linked into the existing command centers to provide additional data on conditions, and for dedicated staff to review data gathered via remote sensing technology, situational awareness software and satellite imagery, which will support Cal FIRE's incident commanders in developing more effective initial and extended attack fire suppression strategies.
- Supporting Emergency Responders -- $6.6 million from various funds to expand Cal FIRE's health and wellness program and to provide medical and psychological services.

Other Disaster-Related Proposals. The budget also includes disaster-related proposals that are not specifically focused on wildfires, but that would allow Cal OES to improve the state's emergency response and preparedness capabilities: 1) State Emergency Telephone Number Account (SETNA); 2) California Earthquake Early Warning System - The budget includes a one-time augmentation of $16.3 million General Fund to finish the build-out of the California Earthquake Early Warning System; 3) Public Education; and 4) California Disaster Assistance Act (CDAA).

Examples of Technologies to Monitor Wildfire Activity

ALERTWildfire. ALERTWildfire is a consortium of three universities – The University of Nevada, Reno, University of California San Diego, and the University of Oregon – providing access to state-of-the-art Pan-Tilt-Zoom (PTZ) fire cameras and associated tools to help firefighters and first responders identify fire ignition, quickly scale fire resources up or down, monitor fire behavior through containment, help evacuations through enhanced situational awareness, and ensure contained fires are monitored.

There are currently 128 pan-tilt-zoom cameras (PTZs) installed throughout California placed on towers and atop mountains. The PTZs are cameras capable of remote directional and zoom control, can scan 5,000 square miles during daylight, and up to 20,000 square miles at night for fires with near-infrared capabilities. Networks of live video feeds from PTZs allow officials, utilities, and every-day Californians to monitor wildlands, essentially crowdsourcing in order to watch for signs of wildfires.

Fire Weather Research Laboratory. The Fire Weather Research Laboratory at San José State University conducts research on a number of problems related to fire weather and fire behavior. These include phenomena at the regional and mesoscales to microscale fire-atmospheric interactions at the fire front. According to its Internet Web site, The Fire Weather Lab is an international leader in conducting field studies of fire-atmospheric interactions, and maintains a large set of data from various field campaigns.

WIFIRE. The WIFIRE system is a combination high-speed fiber optic and fixed wireless network that connects the San Diego supercomputer center, an Organized Research Unit of the University of California, San Diego, with hundreds of remote weather stations across the county. The high-resolution weather data provided by the system helps WIFIRE's modeling program predict how a fire will spread in real time. The system also allows responders to prepare for fires before they occur by running simulations of possible fire scenarios, allowing firefighters to spot potential vulnerabilities.

Fire Research Group at the University of California, Berkeley. The Fire Research Group (FRG) consists of researchers at the University of California, Berkeley, the Space Sciences Laboratory (Berkeley), and Lawrence Berkeley National Labs that bring together expertise in engineering science, environmental science, policy, management, ecology, and forestry to bolster research in fire science, mitigation, suppression, management and control.

Related Legislation

Pending Wildfire Related Legislation:

SB 130 (Galgiani, 2019). Would provide that it is the intent of the Legislature to enact legislation that would authorize the installation of a siren warning system for wildfires in populated areas and communities in state responsibility areas. (Pending in the Senate Rules Committee)

SB 133 (Galgiani, 2019). Would state the intent of the Legislature to enact legislation to create and fund a program for installing remote infrared cameras that can help in detecting wildfires. (Pending in the Senate Rules Committee)

SB 190 (Dodd, 2019). Would require the Office of the State Fire Marshal (SFM) to develop, in consultation with representatives from local, state, and federal fire services, local government, building officials, utility companies, the building industry, and the environmental community, a model defensible space program to be made available for use by a city, county, or city and county in the enforcement of the defensible space provisions. The bill would set forth required components of the program. (Pending in the Senate Governmental Organization Committee)

SB 209 (Dodd, 2019). Would establish the California Wildfire Warning Center comprised of representatives from the Public Utilities Commission, Cal OES, and Cal FIRE, tasked with various responsibilities relating to fire-threat weather conditions including overseeing the development and deployment of a statewide network of automated weather and environmental stations. (Pending in the Senate Governmental Organization Committee)

AB 38 (Wood, 2019). Would require, no later than July 1, 2020, the State Fire Marshall to develop, and the California Building Standards Commission to review, building standards for buildings in very high fire hazard severity zones. The bill would require, beginning on July 1, 2020, all newly constructed buildings and all transferred buildings in very high fire hazard severity zones to comply with the building standards. This bill would establish the State Fire Preparedness Council, consisting of specified members, as specified. (Pending in the Assembly Governmental Organization Committee)

AB 1375 (Bigelow, 2019). Would increase the state's share, from 75% to 90%, of costs incurred for removing dead and dying trees pursuant to the Governor's Proclamation of a State of Emergency issued on October 30, 2015. (Pending in the Assembly Governmental Organization Committee)

AB 1631 (Gray), 2019). Would require the SFM to employ at least 5 traveling training officers and any necessary equipment to provide weekend and evening training classes year-round, as specified, to volunteer fire departments and those fire departments consisting of a combination of volunteer, partly paid, or fully paid members. The bill would also authorize firefighters to receive 100% reimbursement of actual costs from the SFM for attending training classes at a local community college if the State Fire Marshal is unable to provide training classes. (Pending in the Assembly Governmental Organization Committee)

Bills chaptered during the 2017-18 Legislative Session relating to prevention, detection, and mitigation of wildfires:

SB 833 (McGuire), Chapter 617, Statutes of 2018. Required Cal OES, in consultation with specified stakeholders, to develop voluntary guidelines for alerting and warning the public of an emergency.

SB 901 (Dodd), Chapter 626, Statutes of 2018. Addressed numerous issues concerning wildfire prevention, response and recovery, including funding for mutual aid, fuel reduction and forestry policies, wildfire mitigation plans by electric utilities, and cost recovery by electric corporations of wildfire-related damages.

SB 1260 (Jackson), Chapter 624, Statues of 2018. An omnibus fire prevention and forestry management bill intended to promote long-term forest health and wildfire resiliency. The bill authorized federal, state, and local agencies to engage in collaborative forestry management, created new opportunities for public and private land managers to mitigate wildfire risks, and enhanced Cal FIRE's role in identifying wildfire hazards as local governments plan for new housing and neighborhoods.

AB 289 (Gray), Chapter 106, Statutes of 2017. Required Cal OES to update the State Emergency Plan on or before January 1, 2019, and every five years thereafter.

AB 2126 (Eggman), Chapter 635, Statutes of 2018. Required, no later than January 1, 2020, the Director of the California Conservation Corps to establish a forestry corps program.

AB 2380 (Aguiar-Curry), Chapter 636, Statutes of 2018. Required Cal OES, in collaboration with Cal FIRE, and the board of directors of the Firefighting Resources of California Organized for Potential Emergencies Program, to develop standards and regulations for any privately contracted private fire prevention resources operating during an active fire incident in the state.

AB 2518 (Aguiar-Curry), Chapter 637, Statutes of 2018. Directed Cal Fire, in collaboration with the Board of Forestry and Fire Protection, to identify barriers to in-state production of mass timber and other innovative forest products. Additionally, the bill required other entities to develop recommendations for siting of additional wood product manufacturing facilities in the state.

AB 2911 (Friedman), Chapter 641, Statutes of 2018. Made changes to local planning processes, provided for new building standards based on data from the 2017 fire season, provided for new vegetation management guidance, defensible space authorizations, and re-vegetation requirements in order to improve fire safety, and provided that utilities may be liable for damages removing vegetation not within their easements.

AB 1956 (Limón), Chapter 632, Statutes of 2018. Required Cal Fire to establish a local grants program and established the criteria for those grants, including prioritizing projects that are multi-year. Grants to local public entities are prioritized based on those entities' activities that result in being considered "fire adapted communities" on a list maintained by Cal Fire.