U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HEARING CHARTER

The State of Federal Wildland Fire Science: Examining Opportunities for Further Research & Coordination

Tuesday, June 29, 2021
10:00 am EDT
2318 Rayburn House Office Building and Online via Zoom

PURPOSE

The hearing will provide an opportunity to discuss the current state of wildland fire research, with a focus on how to improve understanding of on-the-ground conditions as well as how climate change is impacting wildfire risk. The Committee will also examine research gaps and additional federal coordination, investment, and engagement needed to improve wildland fire prediction, management, and post-fire response.

WITNESSES

- **Dr. Craig Clements,** Professor of Meteorology, Director of Wildfire Interdisciplinary Research Center, San José State University
- **Dr. Jessica McCarty,** Assistant Professor of Geography, Director of the Geospatial Analysis Center, Miami University
- **Mr. George Geissler**, State Forester and Deputy, Wildland Fire and Forest Health and Resiliency, Washington Department of Natural Resources
- **Fire Chief Erik Litzenberg (Ret.)**, Chair, Wildland Fire Policy Committee, International Association of Fire Chiefs

KEY QUESTIONS

- What are the major gaps in our understanding of fire weather forecasting, fire detection and monitoring, fire behavior, and other topics related to wildland fire research?
- How do federal science agencies and non-federal partners contribute to this research? How can collaboration and coordination be improved?
- What scientific information is most useful to fire managers? How can this information be made more accessible?
- How can we improve community engagement to improve wildfire preparedness and resilience?
- How does climate change impact wildfire risk, and how do wildfires contribute to climate change? How can this feedback loop be mitigated?
- How can we prevent catastrophic wildfires?

BACKGROUND

Fire is a natural phenomenon. In some environments, fire rejuvenates ecosystems by clearing dead material, returning nutrients to the soil, and supporting plant reproduction.[1] However, in recent

[1] https://www.fws.gov/northeast/refuges/fire/firewildlife.html

years, we have seen larger and more severe fires, longer fire seasons, and more destruction.[2] This has been brought about by a changing climate, more widespread development into the wildlands, and fire suppression practices over the past century that have resulted in a buildup of fuels.[3] The shift over time to catastrophic infernos has undermined the benefits that can come with wildland fires and has instead presented the general public, businesses, and government at all levels with a growing threat to lives, public health, property, and financial stability.

In 2020, over 10 million acres in the U.S. burned due to wildfires. While wildfires occur in many parts of the country, California has been impacted the most by wildfires. In 2020, California saw over 4.1 million acres burned, which is more than double its previous annual record for acreage burned set in 2018. Furthermore, five of the six largest wildfires on record in California burned between August and September of 2020. Colorado's three largest fires on record also occurred in 2020. Wildfires in the U.S. are estimated to have cost $16.6 billion and resulted in 46 deaths in 2020 alone.[4]

The ability to accurately anticipate, detect, monitor, and contain wildland fires is largely dependent upon the scientific information available and how accessible that information is to users. Similarly, the ability to predict and monitor fire weather, or weather conditions that affect the likelihood, magnitude, and movement of wildland fires and associated smoke, both in the short-term and seasonally, is an essential tool for fire managers. Factors such as wind speed and direction, temperature, humidity and chance of precipitation, and lightning activity influence fire danger.[5]

Fire managers also rely on the characterization of fuels on the ground—critical information that is obtained through remote sensing by satellites and aircraft, as well as surface observations. Fuels in the wildland-urban interface (WUI) are particularly difficult to accurately characterize as they include both natural vegetation and manmade structures. Fuels information is also important for safe and effective prescribed burns, as fire managers try to keep fire intensity low and minimize smoke exposure to nearby communities as much as possible.

CLIMATE CHANGE AND WILDLAND FIRES

Although natural variations in climate can influence the severity of different fire seasons, anthropogenic climate change is exacerbating the frequency and severity of wildfires. Climate change has led to increased global temperatures and more severe drought, thereby drying vegetation and intensifying fuel aridity. Fire-season fuel aridity is a key driver of wildfires. As temperatures rise, so does the vapor pressure deficit (a measure of the potential amount of water vapor the air can hold). Heightened vapor pressure deficit encourages more evaporation of water from fire-season fuels, ultimately leading to fuel dryness.[6] This effect has been most pronounced in the intermountain western U.S. From 2000 to 2015, climate change effects on temperature and vapor pressure deficit contributed to 75 percent more of the forested areas in the western U.S. experiencing high fire-season fuel aridity, leading to approximately nine extra days, annually, of

[2] https://www.pnas.org/content/113/42/11770
[3] https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2019EF001210
[4] https://www.ncdc.noaa.gov/billions/events/US/2020
[5] https://www.spc.noaa.gov/misc/NSWW05/16%20rhett_FWXProgram2005.pdf
[6] https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019MS001790

high fire potential over that period.[7] Climate change's influences on fuel dryness have tremendously impacted recent fire seasons. Climate change has also been estimated to have increased U.S. wildfire area by about 4.2 million hectares (the combined size of Connecticut and Massachusetts) from 1984 to 2015. This growth in fire area has been calculated to be double the wildfire area had climate change been absent.[7]

Beyond worsening fire-season fuel aridity, climate change has the potential to increase thunderstorm prevalence throughout the U.S.[8] In some parts of the U.S, climate change is predicted to increase lightning strikes from thunderstorms by as much as 12 percent per every degree Celsius of warming.[9] This is a great cause for concern as lighting from thunderstorms can ignite dry fuels leading to wildfires.[7] While much of this increase in lightning strikes will likely take place in the South, Northeast, and "Tornado Alley", lightning strikes will also become more common in the western U.S. due to climate change.[9] As atmospheric carbon concentrations continue to contribute to a warming planet, wildfires in the U.S. will become deadlier and more widespread.

FEDERAL WILDLAND FIRE ACTIVITIES

Federal Wildland Fire Science

While federal land management agencies, in conjunction with state and local entities, are responsible for on-the-ground fire management, several federal science agencies provide crucial support services.

Environmental Protection Agency (EPA): The EPA's Air Climate and Energy (ACE) Research Program, within the Office of Research and Development (ORD), conducts research on air quality, emissions, and ecological and health impacts from wildfires. ORD also conducts wildfire research in its Safe and Sustainable Water Resources, Homeland Security, and Sustainable and Healthy Communitites research programs. EPA researchers collaborate with the U.S. Forest Service (USFS) to assist with air quality information during wildfire events. EPA also maintains a national real-time ambient air quality data system (AirNow) that the public relies upon for air quality information during wildfires.[10] Additionally, EPA's "Smoke Sense" app focuses on using crowdsourcing and citizen science to increase public awareness and engagement related to wildfire smoke health risks.[11]

National Aeronautics and Space Administration (NASA): Through the Science Mission Directorate's (SMD) Earth Science Division (ESD), NASA develops and operates Earth-observing space satellites and conducts basic and applied research programs at its Centers and extramurally, through grants and cooperative agreements. NASA research, measurements, and data products improve scientific understanding of and inform decision-making and operational responses to wildland fire across the pre-fire (conditions, fuel, forecasting), active burn (ignition, behavior, smoke plumes, and tracking) and post-fire (soil, vegetation, and air quality conditions) phases. The ESD Applied Sciences program's Disasters element facilitates the transfer and translation of fire-

[7] https://www.pnas.org/content/113/42/11770.short
[8] https://www.pnas.org/content/104/50/19719
[9] https://europepmc.org/article/med/25395536
[10] https://www.epa.gov/planandbudget/fy-2022-justification-appropriation-estimates-committee-appropriations
[11] https://www.epa.gov/air-research/smoke-sense-study-citizen-science-project-using-mobile-app

related satellite data to inform fire management and air quality warnings from smoke plumes.[12] NASA's Fire Information for Resource Management System (FIRMS)[13] distributes Near Real-Time active fire data to the USFS, partner agencies, and the general public within three hours of satellite observation from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) aboard each of the sun-synchronous polar-orbiting Terra and Aqua satellites and NASA's Visible Infrared Imaging Radiometer Suite (VIIRS) aboard the joint NASA/NOAA Suomi National Polar orbiting Partnership (Suomi NPP) and NOAA-20 satellites. At least nine of ESD's operating space-based missions collect data relevant to the pre-fire phase for vegetation and fire fuel conditions: Soil Moisture Active Passive (SMAP); Global Precipitation Measurement Mission (GPM); ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS); Ice, Cloud, and land Elevation Satellite-2 (ICESat-2); Global Ecosystem Dynamics Investigation Lidar (GEDI); Landsat; Terra; Aqua; and Suomi National Polar-orbiting Partnership (S-NPP). Two missions in development would also collect data relevant to fuel content and conditions: NASA-Indian Space Research Organization Synthetic Aperture Radar (NISAR, scheduled for launch in 2023)[14] and the Soils, Biology, and Geology Designated Observable Mission (in study, anticipated for launch later this decade).[15] The ESD also tests early versions of science instruments on board NASA research aircraft, including by observing active fires and post-fire environments. The Aeronautics Research Mission Directorate (ARMD) has a small research activity, the Scalable Traffic Management for Emergency Response Operations project (STEReO), exploring new ways to respond to disasters, including wildfires, using piloted and unmanned aircraft. STEReO will conduct a live flight demonstration of a wildfire event.

National Institute of Standards and Technology (NIST): Research at the NIST focuses on advancing measurement science, standards, and technology. The NIST Engineering Laboratory does work on fire prevention and control and research done by the Fire Research Division focuses in part on fires at the WUI. The research focuses on improving resilience in communities located at the wildland-urban interface, understanding the start of these fires, and preventing or reducing the ignition of structures located at the wildland-urban interface. NIST's Firebrand Generator is used for research to better understand the spread of fires from flame, contact, embers and thermal radiation. NIST research also helps identify structures at risk of ignition and fire spread as well as to inform the development of new coatings and materials to improve the resilience of these structures to ignition and fire spread. NIST conducts extensive research on past fires, including those at the wildland-urban interface, which helps identify vulnerabilities in structures lost to fire. Given its role in advancing measurement science and standards, NIST research on fires and fires at the wildland-urban interface helps inform and improve building and fire codes.

National Oceanic and Atmospheric Administration (NOAA): The National Weather Service (NWS) provides fire weather forecasts that range from short-term warnings to long-term seasonal predictions. NWS also provides "spot forecasts" that are important tools for both wildfire suppression and prescribed fire. Red Flag Warnings are issued to alert the public of an ongoing or imminent critical fire weather. Incident Meteorologists (IMETs), specially trained forecasters, are on the front lines alongside firefighters, constantly reassessing weather conditions and supporting

[12] https://appliedsciences.nasa.gov/what-we-do/disasters/fires.
[13] https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms.
[14] https://nisar.jpl.nasa.gov/files/nisar/NISAR_Applications_Fire.pdf.
[15] https://sbg.jpl.nasa.gov/.

operational decisions that enable firefighters to be as effective and safe as possible.[16] The National Environmental Satellite Data and Information Service (NESDIS) manages two satellite missions that are critical to NWS's ability to detect active wildfires and assess potential fire risk. The Joint Polar Satellite System (JPSS) is a constellation of satellites that orbits the Earth from pole-to-pole and across the equator to provide full global coverage twice a day.[17] JPSS is not only capable of detecting active fires and smoke, but it is also able to discern fire temperature,[17] enabling the NWS to determine the intensity of a fire. NOAA also employs the Geostationary Operational Environmental Satellites – R Series (GOES-R), which maintain geostationary orbit over the entirety of the U.S. and outlying territories.[18] GOES-R can monitor fires every five minutes. It is also equipped with the Geostationary Lightning Mapper that detects and measures total lightning within a cloud—a useful metric for fire ignition risk.[19] Observations from JPSS and GOES-R allow NOAA to analyze pre-fire conditions like drought and health of vegetation. Additionally, these satellite systems allow NOAA to observe burn scars after fires to create maps of areas that would be prone to post-fire landslides.[20] Information provided by JPSS and GOES-R improves NOAA's High-Resolution Rapid Refresh (HRRR) model, developed in the Office of Oceanic and Atmospheric Research (OAR), producing better smoke forecasts.[21]

National Science Foundation (NSF): The NSF supports foundational research focused on wildfire science through all of NSF's directorates. This includes research funded through the core NSF funding mechanism as well as special funding mechanisms such as NSF Grants for Rapid Response Research (RAPID). NSF also supports investments in research infrastructure such as the National Ecological Observatory Network (NEON), Natural Hazards Engineering Research Infrastructure (NHERI) and Long Term Ecological Research (LTER). Sensors from NEON help enable research projects at larger scales as well as the study of factors that increase fire hazard such as drought. NSF also collaborates with other Federal science agencies including NIST, NOAA, and NASA in support of wildfire research such as through the NSF-NIST Disaster Resilience Grants (DDRG) Program as well as the National Windstorm Impact Reduction Program (NWIRP). The Foundation also supports the National Center for Atmospheric Research (NCAR), a Federally Funded Research and Development Center (FFRDC) headquartered in Boulder, CO. NCAR supports research aircraft used in part for wildland fire studies and has remote sensing capabilities that are used for fire research. NCAR produces the daily National Fuel Moisture Database using data from a number of federal science agencies. Basic research supported by the Foundation in fields such as artificial intelligence and machine learning as well as the social, behavioral and economic sciences are also key to improving our understanding of wildfires. Between FY 2015 – FY 2020, NSF supported 237 awards totaling $133.3 million in support of wildland fire research.

Federal Wildland Fire Interagency Coordination

The National Interagency Fire Center (NIFC) is a multi-agency support center for wildland firefighting that includes the Bureau of Land Management, the National Park Service, the U.S.

[16] https://www.noaa.gov/media-advisory/wildfire-season-and-fire-weather-resource-guide-for-reporters-and-media
[17] https://www.jpss.noaa.gov/mission_and_instruments.html
[18] https://www.goes-r.gov/
[19] https://www.goes-r.gov/spacesegment/glm.html
[20] https://www.usgs.gov/news/post-wildfire-landslides-becoming-more-frequent-southern-california
[21] https://rapidrefresh.noaa.gov/hrrr/

Fish and Wildlife Service, the Bureau of Indian Affairs, and the USFS. NIFC facilitates information sharing and coordinates shared usage of firefighting supplies, equipment, and personnel among its member agencies.[22]

The National Wildfire Coordinating Group (NWCG) provides national leadership to enable interoperable wildland fire operations among federal, state, local, tribal, and territorial partners. Its member agencies include many within at the Department of the Interior, along with the USFS the U.S. Fire Administration and a few non-federal organizations. The National Weather Service is an Associate Member of the NWCG.[23]

Federal Wildland Fire Science in the Fiscal Year 2022 President's Budget Request

The President's Budget Request (PBR) for fiscal year 2022 (FY 2022) includes a $15 million increase across NOAA to support research, operations, and observations to enable better fire weather forecasts and fire detection and management. The additional funding would also improve local communities' access to fire weather data, products, and services. $7 million of the increase is for the fire weather program at NOAA's Office of Oceanic and Atmospheric Research. $4 million is designated for NWS for its fire weather predictions, and $4 million is for NESDIS to advance its fire weather priorities. The increase in NOAA funding is also intended to establish a new NOAA Fire Weather Testbed, facilitating coordination between NOAA line offices, the USFS other federal agencies, and non-federal partners.

The FY 2022 PBR for the EPA includes a $30 million increase to the ACE Research Program that would include climate research on how extreme events, including wildfires, affect air quality, water quality and availability, and human health, with a focus on vulnerable communitites.[10]

The administration's budget request for NASA for FY 2022[24] includes a $9.8 million increase to the Earth Science Division's Applied Sciences program, provided "to initiate an Applications and Research Team focused on science-informed solutions and addressing climate impacts together with underserved communities." Within that effort, Applied Sciences "will initiate efforts to build resilience to environmental disruptions and climate risks" and "target specific activities on wildfires."

OPPORTUNITIES FOR FURTHER RESEARCH AND INVESTMENT

There remain ways to improve fuels, fire, and smoke management through science and coordination.[25] Further research of fire hazards and fire behavior in the WUI can help reduce the risk of fire dangers. Higher resolution – both spatial and temporal – data of fuels in the wildland can inform decisions to both reduce the risk of extreme fire and help managers anticipate fire behavior and spread. Additional research into smoke plume behavior may lead to improved public health outcomes and provide additional actionable information to fire managers. Scientists are also increasingly finding value in the development of artificial intelligence and machine learning. Ultimately, more data will require additional computing capacity and data storage.

[22] https://www.nifc.gov/about-us/what-is-nifc
[23] https://www.nwcg.gov/
[24] https://www.nasa.gov/sites/default/files/atoms/files/fy2022_congressional_justification_nasa_budget_request.pdf.
[25] https://link.springer.com/content/pdf/10.1007/s40725-020-00127-2.pdf