DAY ✓ ONE PROJECT

Reduce Disaster Costs by Better Tracking Health Impacts of Wildfire Smoke

Teresa Feo
Mary Prunicki
Brie Lindsey
Sarah Brady
Amber Mace

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Summary

Smoke from wildfire disasters kills many more people than direct exposure to wildfire flames, and impacts many more communities than the communities located directly in wildfire perimeters. Direct exposure to the 2018 California wildfires caused 104 deaths statewide, but smoke from those fires were responsible for over 3,500 more.[1] The United States currently lacks a systematic way to track health impacts (and associated costs) of wildfire smoke. This critical knowledge gap inhibits our nation's ability to effectively recover from, respond to, and prevent future wildfire disasters.

The Biden-Harris Administration should address this gap by establishing a national public record of wildfire-smoke health impacts: a resource that would enable better accounting of wildfire costs and would support evaluation of the cost-effectiveness of efforts to prevent and mitigate catastrophic wildfires. Specifically, the Biden-Harris Administration should take the following actions to improve understanding of wildfire-smoke health impacts, better guide investments into wildfire management, and ultimately reduce the costs of wildfire disasters:

(1) Systematically track mortality and morbidity due to smoke from wildfire disasters.
(2) Fund research to better understand the scale of wildfire-smoke health impacts, and to develop cost-effective approaches for reducing those impacts.
(3) Ensure that approaches to respond to, recover from, and prevent wildfire disasters include goals to equitably reduce the wildfire-smoke health impacts.

Challenge and Opportunity

Deaths and costs due to wildfire smoke are typically excluded from reported assessments of impacts associated with wildfire disasters due to a lack of readily available data.[2] However, a growing body of research has found that wildfire smoke represents a significant portion of the costs incurred by society from catastrophic wildfires. Wildfire smoke exposes populations to hazardous levels of air pollutants, including particulate matter of 2.5 microns or less ($PM_{2.5}$). Increased $PM_{2.5}$ levels caused by wildfire smoke are associated with increased cases of respiratory (e.g., asthma, pneumonia), cardiovascular (e.g., heart attacks), and cerebrovascular (e.g., stroke) complications.[3] Costs associated with these health impacts include the cost of health care, the value of lost wages, and the value of lost lives.

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[1] Wang, D.; et al. (2021). Economic footprint of California wildfires in 2018. *Nature Sustainability*, 4: 252–260.
[2] California Council on Science and Technology.(2020). *The Costs of Wildfire in California: An Independent Review of Scientific and Technical Information*. Sacramento, CA: California Council on Science and Technology.
[3] Cascio, W.E. (2018). Wildland fire smoke and human health. *Science of The Total Environment*, 624: 586–595.

Smoke from wildfires has been found to be more deadly and more costly than the heat and flames from those same fires. A recent study estimated that smoke from the 2018 California wildfires—including the catastrophically deadly Camp Fire, which destroyed the town of Paradise—were responsible for 3,652 deaths in California.[4] This count is considerably greater than the 104 deaths reported due to direct exposure to the wildfires. Similarly, estimated costs of smoke deaths from the 2018 California wildfires represented a loss of $32.2 billion. This is greater than the capital losses from those wildfires, estimated at $27.7 billion. The relatively large impacts of wildfire smoke are due in part to the fact that smoke from a wildfire regularly spreads far beyond the fire perimeter, meaning that many more communities are exposed to hazardous levels of wildfire smoke than are exposed to fire heat and flames. Moreover, $PM_{2.5}$ from wildfire smoke may be up to 10 times more toxic than an equal dose of $PM_{2.5}$ from other sources of ambient air pollution.[5]

Catastrophic wildfires that blanket large swaths of the country with hazardous levels of smoke have become a common occurrence: one that is only predicted to worsen in the future as a result of climate change. Burke et al. (2020) found that wildfire smoke in western regions now accounts for up to 50% of overall exposure to air pollution ($PM_{2.5}$ levels) for people living in those regions, compared to less than 20% a decade ago. Long-distance transport of wildfire smoke from western states accounts for more than 50% of smoke exposure in the rest of the United States.[6] Long-distance transport of wildfire smoke also means that the negative impacts of wildfire smoke—and the benefits of effective management—regularly cross jurisdictional boundaries. The federal government and local, state, and Tribal governments must therefore coordinate to effectively reduce wildfire destructiveness.

Impacts of wildfire smoke disproportionally affect vulnerable populations.[7] Outdoor workers, those who are unsheltered, and other populations unable to access indoor clean-air spaces due to socioeconomic factors are at greater risk of exposure to hazardous levels of air pollutants during wildfire-smoke events. The elderly, children, pregnant people, and those with pre-existing medical conditions are at greater risk of health complications when exposed to wildfire smoke. Equitable implementation of disaster resilience policies must address these disproportionate impacts of wildfire smoke on disadvantaged communities and vulnerable populations.

A clear understanding of the scale of past disasters is important to ensure that public investments in prevention and mitigation will be effective at reducing loss of life and other negative outcomes of future disasters.[8] However, our understanding of the scale of wildfire-smoke health impacts across the nation is poor. There is currently no systematic nationwide accounting of excess deaths and injuries due to smoke from wildfires. Without a public record of health impacts due

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[4] Wang, D.; et al. (2021). Economic footprint of California wildfires.

[5] Aguilera, R.; et al. (2021). Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California. *Nature Communications*, 12: 1493.

[6] Burke, M.; et al. (2021). The changing risk and burden of wildfire in the United States. *Proceedings of the National Academy of Sciences*, 118(2): e2011048118.

[7] National Academies Press. (2019). *Implications of the California Wildfires for Health, Communities, and Preparedness: Proceedings of a Workshop*. Washington, DC: National Academies Press.

[8] National Academies of Sciences, Engineering, and Medicine. (2020). *A Framework for Assessing Mortality and Morbidity After Large-Scale Disasters*. Washington, DC: National Academies Press.

to wildfire smoke, it is difficult to gauge the full scale of damage caused by wildfire disasters or to evaluate the cost-effectiveness of prevention and mitigation efforts. This critical knowledge gap inhibits our nation's ability to effectively respond to, recover from, and prevent catastrophic wildfires.

Creating a national public record of wildfire-smoke health impacts aligns with the Biden-Harris Administration's priorities to:

(a) Tackle the climate emergency and address racial equality.[9]

(b) Make evidence-based decisions guided by the best available science and data.[10]

(c) Assist federal agencies and state, local, Tribal, and territorial governments, communities, and businesses in preparing for and adapting to the impacts of climate change by expanding and improving climate-forecasting capabilities and information products for the public.[11]

(d) Enhance data collection and collaboration capabilities for high-consequence public-health threats.[12]

Plan of Action

The Biden-Harris Administration should take the following actions to reduce the destructiveness of catastrophic wildfires:

Action 1. Systematically track the public-health impacts of smoke from wildfire disasters.

There is currently no nationwide, systematic tracking of mortality and morbidity due to wildfire smoke. The absence of robust tracking makes it difficult to compare wildfire disasters, draw conclusions about the scale of the problem, or assess effectiveness of prevention and mitigation efforts. The Biden-Harris Administration should direct relevant federal agencies, such as the Department of Health and Human Services, Centers for Disease Control and Prevention (CDC), Environmental Protection Agency (EPA), and Federal Emergency Management Agency (FEMA), to develop appropriate protocols to collect, analyze, and publicly report estimates of population exposure to wildfire smoke, as well as of excess mortality and morbidity due to wildfire smoke.

A 2020 report by the National Academies of Sciences, Engineering and Medicine provides detailed recommendations for implementing a national framework for assessing mortality and morbidity of large-scale disasters.[13] In addition, the CDC's Health Information Innovation Consortium provides a useful forum in which to develop new approaches for surveilling the

[9] The White House. (n.d.) The Biden-Harris Administration Immediate Priorities.
[10] The White House. (2021). Memorandum on Restoring Trust in Government Through Scientific Integrity and Evidence-Based Policymaking. January 27.
[11] The White House. (2021). Executive Order on Tackling the Climate Crisis at Home and Abroad. January 27.
[12] The White House. (2021). Executive Order on Ensuring a Data-Driven Response to COVID-19 and Future High-Consequence Public Health Threats. January 21.
[13] National Academies of Sciences, Engineering and Medicine. (2020). A Framework for Assessing Mortality and Morbidity.

public-health impacts of wildfire smoke.[14] The forum utilizes improved informatics, real-time sharing of electronic medical records, and an open-source, more integrated approach that enables cloud-based communication between data sets (e.g., data on health impacts and on smoke plumes). The CDC's Flu View program, which tracks excess cases of pneumonia attributable to seasonal influenza activity, may provide a useful model for tracking excess cases of heart attack, asthma, stroke, and other health complications attributable to wildfire smoke.[15] Development of protocols for tracking wildfires should be established immediately, perhaps starting by integrating relevant data from the state and local levels in western states. Integrated datasets should include sufficient geographic and demographic detail to identify disproportionate impacts to specific populations, such as disadvantaged communities. Efforts should also be made to retroactively estimate health impacts for past wildfire disasters to the extent feasible with existing data.

Action 2. Fund research and monitoring to better understand wildfire-smoke health impacts and to identify cost-effective strategies for preventing and mitigating those impacts. Although a growing body of research has found that wildfire smoke is a serious public-health threat, there remain critical knowledge gaps that impede our ability to mount cost-effective prevention and mitigation campaigns. The federal government has mounted some laudable efforts to address these gaps. For example, the EPA—in partnership with 10 federal, state, tribal and local organizations—recently launched the "Cleaner Indoor Air During Wildfires Challenge" to stimulate development of new technologies to help address health impacts of wildfire smoke.[16] The Biden-Harris Administration should continue to fund research, monitoring, and innovation to improve our understanding of the public-health impacts of wildfire smoke. Priority areas for investment include:

(a) **Improved monitoring of population exposure to wildfire smoke.** Existing ground and satellite monitoring infrastructure is mostly designed to monitor ambient air pollution. There is a need for monitoring infrastructure optimized for monitoring wildfire smoke, which is much more variable in time and space than ambient air pollution.

(b) **Generation of dose-response curves specific to wildfire smoke.** Dose-response curves for ambient air pollution may not adequately reflect the health impacts of wildfire smoke, which typically exposes populations to potentially more toxic and relatively higher concentrations of air pollutants for shorter time periods.[17] Dose-response curves specific to wildfire smoke are necessary to improve predictions of the health impacts of future wildfire disasters.

(c) **Improved understanding of the health impacts of smoke from managed and prescribed fires relative to the health impacts of smoke from uncontrolled wildfires.** Managed and prescribed fires can be effective at reducing the risk of future

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[14] Centers for Disease Control and Prevention (CDC). (2018). Surveillance Strategy Report—When Informatics Promotes Innovation.
[15] CDC. (2021). Weekly Influenza Surveillance Report.
[16] U.S. Environmental Protection Agency (EPA). (2021). Cleaner Indoor Air During Wildfires Challenge.
[17] Aguilera, R.; et al. (2021). Wildfire smoke impacts respiratory health.

uncontrolled wildfire but are themselves a potential source of harmful smoke exposure.

(d) **Cost-benefit analyses of different approaches to mitigating wildfire smoke.** Actions such as reducing outdoor activities, masking, and operating HEPA filtration systems can reduce population exposure to wildfire smoke. More research is needed to assess the cost-effectiveness of these and other impact-mitigation strategies.

(e) **Improved understanding of how exposure to wildfire smoke—and ability to mitigate wildfire-smoke health impacts—varies among populations.** Many disadvantaged populations are especially vulnerable to negative health outcomes from wildfire smoke because socioeconomic factors prevent them from following public-health recommendations for reducing smoke exposure. For example, agricultural workers without paid time off may be unable to reduce time spent outdoors. Lower-income households without access to air conditioning may be unable to close windows on hot days to create a clean-air indoor space at home.

Action 3. Ensure that approaches to respond to, recover from, and prevent wildfire disasters include steps to equitably reduce wildfire-smoke health impacts. Wildfire response, recovery, and prevention efforts should all strive to reduce losses from wildfire smoke as well as losses from wildfire flames in order to reduce the total destructiveness of wildfire disasters. For example, approaches to harden homes to prevent wildfire losses typically focus on installation of ignition-resistant roofs or ember-resistant vent screens to prevent houses from catching fire. Home-hardening approaches should also include steps to prevent losses from wildfire smoke (e.g., installation of whole-house HVAC systems with HEPA filters to maintain clean-air indoor spaces). Particular emphasis should be placed on reducing smoke impacts to vulnerable populations, including children, the elderly, those with pre-existing medical conditions, disadvantaged communities, outdoor workers, and populations unable to take mitigation actions due to socioeconomic factors. For instance, the federal government could subsidize installation of whole-house HVAC systems for households below a minimum income threshold.

Conclusion

Smoke from wildfire disasters kills many more people than direct exposure to the flames and impacts many more communities than the communities located directly in wildfire perimeters. Disadvantaged communities bear an outsized portion of the public-health burdens of wildfire smoke. The United States currently lacks a systematic, nationwide accounting of the scale of health impacts of smoke from wildfire disasters. Without a public record of wildfire-smoke health impacts, it is difficult to gauge the full scale of damage caused by catastrophic wildfires or to evaluate the cost-effectiveness of prevention and mitigation efforts to reduce wildfire impacts. This critical knowledge gap inhibits our nation's ability to effectively respond to, recover from, and prevent future disasters. The Biden-Harris Administration should act to (1) systematically

track mortality and morbidity due to wildfire smoke; (2) fund research and monitoring to better understand wildfire-smoke health impacts and to identify cost-effective approaches for preventing and mitigating those impacts; and (3) ensure that approaches to respond to, recover from, and prevent wildfire disasters include steps to equitably reduce wildfire-smoke health impacts. With climate change poised to increase the severity and frequency of wildfire disasters, our nation must act now to develop the deep understanding of wildfire-smoke health impacts that will support increased resilience to this aspect of global change.

Frequently Asked Questions

What steps has the federal government already taken to address wildfire disasters?

In 2018, as part of the Disaster Recovery Act, Congress instructed the National Academies of Sciences, Engineering and Medicine to produce a report on assessing mortality and morbidity after large-scale disasters. The report concludes that "timely and accurate counting and attribution of deaths and morbidities can improve disaster response and lead to a more accurate assessment of the extent, types, and causes of morbidity and mortality in disasters and drive changes in policy, practice, and behavior that will prevent suffering and save lives." A growing body of research has found that the health impacts of smoke from catastrophic wildfires can be more deadly than the heat and flames from those same fires. However, the United States currently lacks a national, systematic way to track the health impacts of wildfire smoke. Establishing a national public record of wildfire-smoke health impacts directly follows the recommendations made in the National Academies report to improve tracking of disaster-related mortality and morbidity.

Why should the federal government be getting involved in wildfire-smoke tracking? Why not leave it to states?

The federal government must take action on this issue because wildfires and their smoke plumes can—and regularly do—cross jurisdictional boundaries. In the absence of a robust national framework, any efforts made by individual state, local, and Tribal governments to track wildfire-smoke health impacts within their own jurisdictions will likely be inconsistent with each other. Inconsistent tracking methodologies across jurisdictions will make it difficult to compare different wildfire disasters, draw conclusions about the scale of the impacts, or assess the cost-effectiveness of different prevention and mitigation efforts to reduce wildfire-smoke impacts.

Do any other countries have a national system for tracking wildfire-smoke health impacts?

Research has found that many other countries experience significant health impacts from wildfire smoke,[18] but we know of no other countries that are systematically tracking smoke-related mortality or morbidity. The lack of tracking by other countries underscores the fact that poor recognition of the devastation wreaked by wildfire smoke is a global issue—one on which the United States has an opportunity to lead by example.

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[18] Borchers Arriagada, N.; et al. (2020). Unprecedented smoke-related health burden associated with the 2019–20 bushfires in eastern Australia. *The Medical Journal of Australia*, 213: 282–283.
Matz, C. J.; et al. (2020). Health impact analysis of PM2.5 from wildfire smoke in Canada (2013–2015, 2017–2018). *Science of the Total Environment*, 727: 138506.

What is the first step towards making progress on this issue?

We recommend that the Biden-Harris Administration begin by convening a group of researchers and other stakeholders to establish national protocols for assessing population exposure to wildfire smoke and mortality and morbidity due to smoke from wildfire disasters. Identifying key datasets and analytical capabilities is a necessary first step for identifying the federal agencies best suited to carry out ongoing national smoke tracking and determining associated budget needs. Establishing standardized national protocols for assessing wildfire-smoke health impacts will also allow state, local, and Tribal governments, scientific researchers, and other interested entities to conduct tracking in their own jurisdictions while facilitating accurate comparisons across jurisdictions and time.

About the Authors

Teresa Feo is a Senior Science Officer with the California Council on Science and Technology (CCST), where she contributes to CCST's science services, including peer-reviewed reports and expert briefings. Dr. Feo was previously a CCST Science and Technology Policy Fellow in the California Senate Office of Research, where she worked on a range of policy topics including natural resources, environmental quality, and health. She was also a Postdoctoral Research Fellow at the Smithsonian's Natural History Museum. Dr. Feo received her Ph.D. in Ecology and Evolutionary Biology from Yale University and her B.A. in Integrative Biology from UC Berkeley.

Mary Prunicki is Director of Air Pollution and Health Research at the Sean N. Parker Center for Allergy & Asthma Research at Stanford University. Dr. Prunicki's research investigates the impact of environmental exposures on the immune system. Her studies focus on Fresno, CA, a city that is always in the top four in the nation for ozone and particle pollution and is also exposed to wildfire smoke. Dr. Prunicki is especially passionate about helping at-risk populationswho disproportionately share the burden of air pollution exposure. Prunicki received her Ph.D. from Northwestern University and her M.D. from Southern Illinois University.

Brie Lindsey is Director of Science Services for CCST, where she manages projects requested by decision makers and supports outreach efforts that connect CCST's network of experts, state policymakers, and other partners. Prior to joining CCST, Dr. Lindsey served in the Senate Office of Research as a CCST Science and Technology Policy Fellow. There, she provided research and analysis on a broad range of policy topics including oil and gas, crude transport by rail, and genetically modified salmon. Dr. Lindsey received her Ph.D in Biological Oceanography from Oregon State University and a B.A. in Environmental Sciences from UC Berkeley.

Sarah Brady is the Deputy Director of CCST, where she leads outreach efforts to connect CCST's network of experts with state policymakers. Prior to joining CCST, Dr. Brady served as Legislative Director in California State Assemblymember Susan Bonilla's office, where she was hired after her placement as a CCST Science and Technology Policy Fellow in 2014. Dr. Brady earned a Ph.D. in Chemistry at the University of Oregon, and bachelor's degrees in Chemistry and French from North Central College. She was also a GK-12 Fellow and an NSF-IGERT Fellow, in which capacity she worked at Hong Kong Baptist University.

Amber Mace is the Executive Director of CCST, where she devotes her time to increasing the impact and value of science-informed policy. Prior to joining CCST in 2013, Dr. Mace served as Associate Director of the UC Davis Policy Institute for Energy, Environment and the Economy. She was appointed by Governor Schwarzenegger to serve as the Executive Director of the California Ocean Protection Council (OPC) and Assistant Secretary for coastal matters at the California Natural Resources Agency. Dr. Mace earned a B.A. in geography from UC Berkeley, a Ph.D. in ecology from UC Davis, and an M.B.A. from Wharton.

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