



Wildfire Effects on Water Quality: Risks, Responses, and Emerging Solutions

STATE POLICY TEAM RESEARCH PUBLICATION

This report examines how increasingly frequent and intense wildfires disrupt water quality by introducing ash, sediment, metals, and toxic pollutants into rivers and reservoirs. It highlights key water quality indicators, human health risks, policy responses, and new treatment technologies. Understanding these interactions is essential for protecting ecosystems and ensuring safe drinking water in wildfire-prone regions.

Prepared by: Gabrielle Fannin, Shijia Tang
and Arman Rostomyan

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I. Abstract

Wildfires are becoming more frequent and intense, and their effects often continue long after the flames are gone, especially when it comes to water. When vegetation burns, and soil is disturbed, rain can wash ash, dirt, metals, and other materials into rivers, streams, and lakes. These changes can affect important water quality parameters such as pH, temperature, dissolved oxygen, and turbidity, which, in turn, can impact ecosystems and drinking water safety. In some cases, wildfire runoff can even bring old pollutants back into the water, increasing risks to human health. Understanding these issues is essential as wildfires continue to shape landscapes and the water resources that communities depend on. This publication examines the key indicators of water quality, explains how wildfires affect these conditions, discusses potential health concerns, and reviews current policies and new treatment approaches.

II. Introduction

Wildfires are becoming more common

and more intense, and their impacts don't end once the flames are out. When a fire burns through a landscape, it changes the soil, removes vegetation, and alters how water moves through the area. As a result, rain and snowmelt can wash large amounts of ash, soil, and other materials into nearby rivers, streams, and lakes, degrading the water quality that people, wildlife, and communities depend on. These changes can lead to murkier water, higher nutrient and organic matter levels, and the introduction of substances that weren't present before the fire, creating challenges for both ecosystems and drinking water systems. Although scientists know that wildfires influence water quality, many questions remain about how long these effects last, how severe they can be, and what factors make some watersheds more vulnerable than others. Understanding these patterns is essential for developing proactive strategies that protect drinking water supplies, reduce public health risks, and improve long-term watershed resilience in fire-prone regions.

III. Indicators of Water Quality

Indicators of water quality are measurements used to assess physical, chemical, and biological changes in water systems, and they are especially important for evaluating disturbances caused by wildfires. In post-wildfire conditions, the loss of vegetation and increased surface runoff can rapidly alter water chemistry and physical properties, making water quality testing critical for identifying contamination risks that threaten drinking water safety and downstream ecosystems. Among the many available indicators, water temperature, dissolved oxygen, and pH are particularly useful for assessing post-wildfire impacts because they respond quickly to ash inputs, increased organic matter, and changes in hydrologic flow paths (U.S. Environmental Protection Agency [EPA], 2024). When evaluated alongside turbidity and specific conductance, these parameters provide an integrated framework for detecting wildfire-related water quality degradation and informing timely management and treatment responses.

IV. Wildfire Frequency and Impacts

Over the past four decades, the frequency and intensity of wildfires in the western United States have risen dramatically, driven by prolonged droughts, rising temperatures, and expanding human settlements in the

wildland–urban interface (WUI). According to data from the California Environmental Data Center (CEDC), the number of large wildfires has nearly doubled since the 1980s, with both the total burned area and duration increasing significantly. Beyond the immediate destruction of vegetation and property, wildfires initiate cascading ecological and hydrological consequences that persist long after the flames are extinguished.

The loss of vegetation exposes soils to erosion and reduces infiltration capacity, allowing rainfall to transport ash, sediment, and nutrients into rivers and reservoirs. These processes elevate turbidity and increase concentrations of heavy metals, nutrients, and organic pollutants in surface water. Additionally, the combustion of urban structures releases hazardous compounds, including plastics, fuels, and volatile organic compounds, further contaminating local water sources. As a result, post-wildfire environments often experience a sharp and prolonged decline in water quality, exposing the limitations of current watershed management and infrastructure preparedness.

V. Human Health Concerns

Post-wildfire, there is a risk of water contamination, which can have implications for human health. Soil

erosion, increased flooding, and the flow of debris and potential contaminants are all factors that severely affect water quality post-wildfire. Along with this, wildfires can also result in the resuspension of legacy mines and industrial waste that have settled in riverbeds. These after-effects of wildfires make the water undrinkable. If an individual were to drink this contaminated water, it could cause immediate health symptoms, including dizziness, vomiting, convulsions, and unconsciousness, in addition to long-term health risks such as increased risk of cancer (Pastrana & Low, 2025).

VI. Policy Landscape and Legislative Responses

As wildfires intensify across the western United States, policymakers have begun to reassess the strength and adaptability of existing water protection laws. At the federal level, the Clean Water Act (CWA) and the Safe Drinking Water Act (SDWA) provide the main legal framework for surface and drinking water quality (Clean Water Act, 1972; Safe Drinking Water Act, 1974). However, these acts were designed for conventional pollution control rather than for emergency contamination from wildfire debris, ash, and infrastructure damage (EPA, 2021). The Federal Emergency Management Agency (FEMA), under the Stafford Act, offers emergency relief

funding, but its scope remains limited to short-term restoration, leaving long-term watershed rehabilitation largely unsupported (Stafford Disaster Relief and Emergency Assistance Act, 1988; FEMA, 2022). This fragmented approach often results in inconsistent recovery outcomes and overlapping responsibilities among agencies.

Recognizing these shortcomings, states have begun filling the policy gap with more targeted legislation. In California, Assembly Bill 541 (California Assembly Bill No. 541, 2023)—the Wildfire Aftermath: Benzene Sampling law—was enacted following the 2018 Camp Fire. It requires public water systems affected by wildfire to conduct immediate testing for benzene and other volatile organic compounds once conditions are safe, while granting the California State Water Resources Control Board authority to enforce follow-up monitoring and public notification. This law represents a pivotal shift from reactive emergency management to proactive contamination prevention, setting a precedent for other wildfire-prone states. However, AB 541 primarily addresses short-term chemical testing following wildfire events and does not fully account for long-term water-quality degradation or cumulative watershed-scale impacts. Future legislation could build on this framework by expanding mandatory monitoring beyond benzene

to include metals, nutrients, and organic matter, and by requiring long-term post-fire surveillance rather than one-time testing. (California State Water Resources Control Board, 2023).

VII. Innovations in Water Quality Treatment

While policy reform remains essential, technological and ecological innovations are equally critical in mitigating wildfire-induced water contamination. In recent years, researchers and engineers have developed advanced systems capable of addressing the unique challenges posed by fire-altered watersheds (NanoChem Solutions, 2025).

1. Advanced Filtration and Adsorption Systems:

Technologies such as granular activated carbon (GAC) filtration and ion exchange resins are being widely deployed to remove benzene, toluene, and other volatile organic compounds. Portable filtration systems and modular treatment units enable rapid restoration of safe drinking water supplies to remote or damaged communities. These systems are highly effective for removing specific chemical contaminants and can be rapidly deployed following wildfire events. However, they are often costly, energy-intensive, and better suited to short-term emergency response than to long-term watershed recovery.

2. Real-Time Monitoring and Sensor Networks:

Low-cost, field-deployable sensors and remote sensing data are used to continuously monitor parameters such as turbidity, conductivity, and organic carbon levels. The primary advantage of real-time monitoring is early detection, which enables proactive decision-making before contamination reaches treatment facilities or distribution systems; however, these systems require ongoing maintenance, technical expertise, and reliable data integration to remain effective.

3. Nature-Based Solutions:

Post-fire watershed restoration projects increasingly integrate green infrastructure, including riparian buffer restoration, biochar application for soil stabilization, and vegetated barriers to reduce sediment and nutrient runoff. These ecological engineering approaches promote recovery of water quality while enhancing ecosystem resilience. While nature-based solutions are generally more cost-effective and sustainable over the long term, they require time to establish and may be insufficient on their own for addressing acute contamination immediately following large wildfire events.

Taken together, these approaches highlight the need for an integrated strategy that combines rapid-response

technologies, continuous monitoring, and long-term ecological restoration to effectively manage wildfire-related water quality risks.

VIII. Conclusion

Wildfires are becoming more frequent and intense, and their impacts on water quality can last long after the fires are out. Burned vegetation, exposed soil, and damaged infrastructure allow ash, sediment, and pollutants to enter rivers and reservoirs, threatening ecosystems and human health. While existing federal laws like the Clean Water Act and Safe Drinking Water Act provide a foundation for water protection, they are not fully equipped to address wildfire-related contamination. State-level efforts such as California's AB 541 and advances in water treatment and monitoring technologies offer promising steps forward. Continued collaboration among scientists, policymakers, and communities will be essential to ensure safe and resilient water systems in a changing climate.

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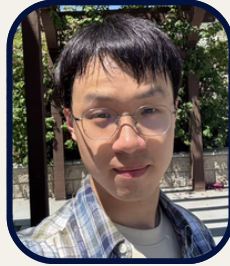
Publication Team



Gabrielle Fannin

AUTHOR

State Team Policy Analyst



Shijia Tang

AUTHOR

State Team Policy Analyst



Arman Rostomyan

SENIOR EDITOR

Vice President of Policy