

# The Impact of Wildfires on California Agriculture

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Received: September 18, 2025 Accepted: October 21, 2025 Online Published: October 23, 2025

## Abstract

This paper examines the complex impacts of wildfires on agriculture in California, analyzing the consequences across the environment, society, and economy both during and after the events. Given the agricultural sector's high importance and hefty contributions to a region's well-being, it is among the most severely affected areas. Understanding these in-depth effects, particularly on the environment and agriculture, is essential for grasping the broader implications for the economy and society. This paper analyzes past wildfires and investigates fire mitigation methods. Additionally, graphical analyses illustrate trends in wildfire damage over the past century, along with corresponding increases in pollutants. Furthermore, graphs are utilized to visualize the scope of damage by showing wildfire damage of the past century and the increase in pollutants in water. Ultimately, the data supports the crucial need to implement policy changes that prioritize wildfire preparation, response strategies, and long-term resilience.

**Keywords:** wildfires, impact, California agriculture

## 1. Introduction

California has experienced fires for decades, but in recent years, there has been a noticeable increase in frequency and intensity (Energy Safety, 2020). Wildfires are commonly associated with structures getting damaged and worsening air quality. Still, other impacts, such as on agriculture, are often overlooked—California's agriculture is a key pillar of the state's economy and national food supply. Fires that happen on or near agricultural lands or during harvest season can devastate crops and be an environmental strain. Furthermore, Wildfires impede social services and threatens farmers' safety and income (Gabi Raab, University of Oregon, 2021).

Despite the many years of wildfires, many regions remain underprepared and end up being impacted the most. Under preparedness is seen in many forms beyond training, such as farmers lacking proper safety gear or experiencing rising insurance premiums. Further under preparedness can be seen in utility providers like PG&E, whose failure to adequately maintain power lines near vegetation led to their aging and unreliable equipment, starting major blazes in 2017 and 2018 (Wildfire task force, 2021). In addition, nonprofit organizations that aim to support these areas also struggle with limited funding, weak infrastructure, and inadequate emergency training, revealing broader gaps in wildfire preparedness and community resilience (Cnmsocal, 2025).

In this current decade, California has faced and experienced some of the most severe wildfires. At the start of this decade in 2020, six of the ten largest wildfires in California occurred concurrently, totaling 4 million acres, which is double the previous record. In the same year, with approximately 92,000 wildfires in California, many of the 4.2 million acres affected were relatively close to agricultural lands. As a result, the fire had a more direct path to impact agricultural lands negatively, and its effects could be felt in greater magnitude on the economy and crops (California Department of Fish and Wildlife, 2020). Elevated levels of toxic metals such as lead and zinc were found as far as 150 miles away. Moreover, these wildfires struck during August, the peak harvest season—when many crops are most vulnerable, making huge losses for farmers. This combination of increased wildfire risk and disrupted harvest leads to increased potential for job losses and a decrease in food availability.

Amount of Acres burned over time (Fig. 1)

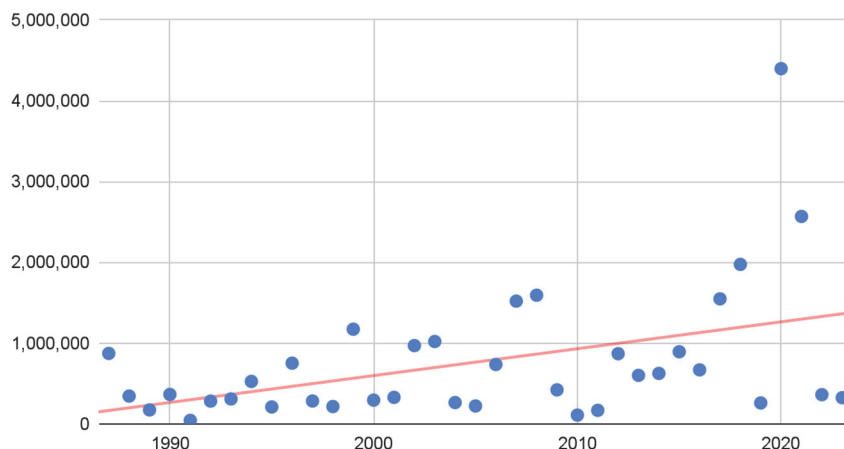


Figure 1. The Amount of Acres Burned Over Time

The graph of Figure 1(CALFIRE, 2023) shows that the current impact of wildfires on agriculture has been increasingly more serious. Even though the total amount of wildfires has been decreasing in Fig. 2(CALFIRE, 2023), the yearly damage gets more destructive, a trend shown by the increasing upward trendline of the amount of acres that wildfires burned each year (Fig. 1). Contributing to soil degradation, through wildfire destroying organic matter (such as roots), making farmland less productive and healthy. With agriculture being more vulnerable, it makes crops more prone to invasive species and to future fire damage.

Number of Wildfires over Time

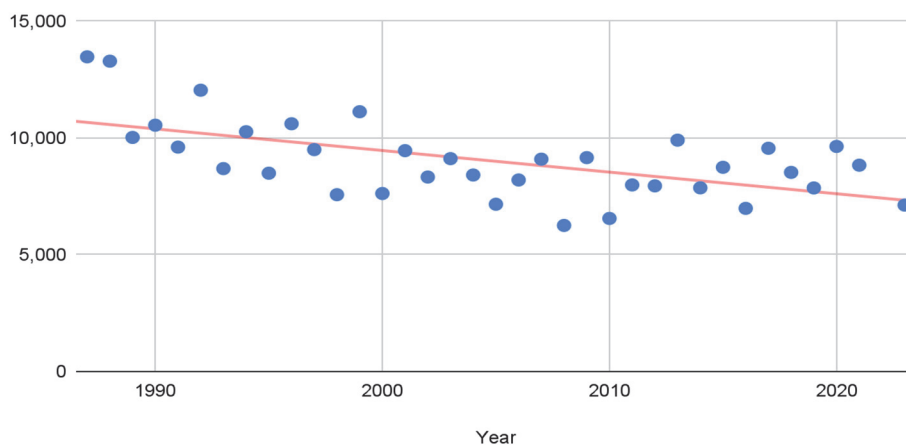


Figure 2. Number of Wildfires Over Time

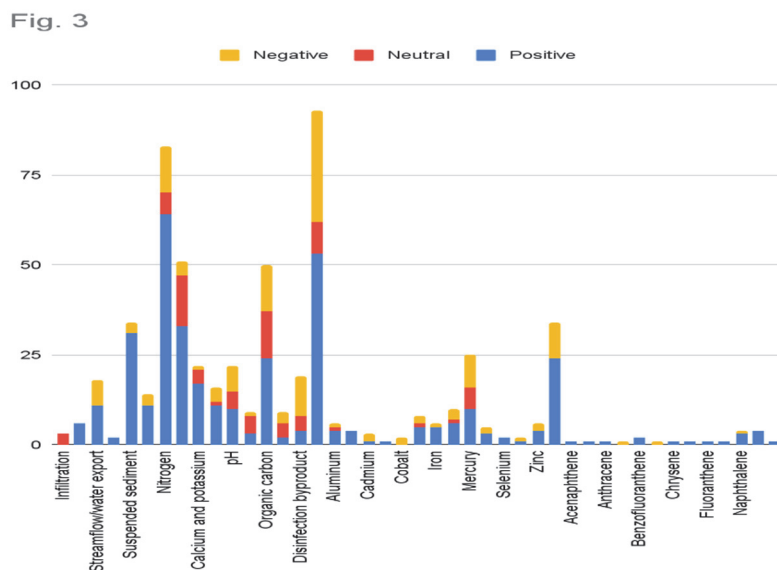


Figure 3. Effects of Wildfire on Water Quality

Further wildfires can be seen in Figure 3 (Paul et al, 2022, American Geophysical Union) reporting changes in the amount of studies on “Conceptual Model Endpoints.” The search criteria focus on literature that quantitatively assesses wildfire effects on water quality, such as the directionality of change (increase, decrease, or no change) of various Physical, Chemical, and biological response endpoints. It can be seen that there is a higher proportion of studies claiming an increase than no change or a decrease in a specific quantity at water endpoints. The table's data represents the compilation of results from studies pointing towards the increase of specific particles: nitrogen, aluminum, zinc, or Mercury. Interestingly, more studies are focusing on the increase of Disinfectant Byproduct particles than on heavy metals and suspended sediment in water, emphasizing the complex and widespread effects of wildfires on both agricultural systems and water resources.

Effects of wildfires extend beyond environmental degradation and into the livelihoods of the farmers. Even after the wildfire's threats have been eliminated, the aftermath is still damaging. According to the President of the California Farm Bureau Federation, Jamie Johansson, assessment of farmers' situation to damage includes: some counties having over 1500 farmers' applications for financial help; 70% lacking appropriate Personal Protective Equipment, such as an N95 mask; and crop Insurance premiums jumping from \$8,000 to \$36,000 for some agricultural policyholders. Lost wages can be seen through farmers experiencing cuts of as much as \$5,500. When added up, the lost wages could be as much as \$50 million in wages for Napa farmworkers alone. Beyond economic disruption, other damages are seen through social impact. Nonprofit organizations, during normal operations, can play a vital role in sustaining and maintaining, sustaining specific communities by providing important services. These services, such as medical services, medical care, mental health support, or shelters, will be reduced (CNMSocal, 2025).

## 2. Thesis

The effects of wildfire have had hefty impacts on the societal, economic, and environmental well-being of an area. One of the most affected sectors is agriculture, given its high precedence with its benefits and contributions. Hence, it is important to prioritize and improve upon wildfire preparation and response by looking at the effects on agriculture, through analyzing past wildfires and looking at potential fire mitigation methods. To visualize the damage of wildfires throughout the years, graphs are utilized to show wildfire damage over time and pollutants in water after a wildfire.

As stated, agriculture has benefits and hefty contributions to the societal, economic, and environmental well-being of an area. Hence, it is important to prioritize and improve upon wildfire preparation and response by looking at the effects on agriculture, through analyzing past wildfires and looking at potential fire mitigation methods. This paper will characterize the impacts of wildfire on agriculture in California. To understand the in-depth effects

primarily on the environment and agriculture, with economy and society, it's necessary to understand the broader impacts.

### 3. Literature review

#### 3.1 Environmental

Most of California's ecosystems are fire-dependent or fire-adapted, as fire can promote biodiversity and healthy ecosystems. Wildfires naturally allow succession and changes in the ecosystem cycle. Wildfires' environmental impact beneficially alters the balance between biodiversity and composition of forest ecosystems: the presence of "habitat heterogeneity" boosts biodiversity (Ayars, Kramer Jones, 2023, PNAS). However, as vegetation has become more susceptible to fire due to increasingly frequent and severe droughts and global warming. Wildfires becoming sporadic or higher frequency bring challenges to wildlife, natural resource management, and hinder the adaptation ability of organisms to wildfires. (Ayars, Kramer & Jones, 2023, PNAS). For example, during the wildfires of 2020 to 2021, there were 19,000 km<sup>2</sup> of forest vegetation burned: a number that is a magnitude more than the historical average (Ayars, Kramer & Jones, 2023, PNAS).

Commonly, persistent wildfires that are exacerbated by prolonged droughts make vegetation more prone to fire. While natural wildfires occur due to lightning or dry conditions, human activities such as land clearing, resource extraction, and climate change have greatly increased wildfire's frequency and intensity. Allowing issues to arise, such as the balance of essential natural resources like groundwater and timber in many recreational areas, expansion of invasive species, or impairing the conservation of native biodiversity via long-term (or permanent) loss of native vegetation (California Department of Fish and Wildlife).

Environmental health is also directly impacted by prolonged and destructive wildfires, as seen in the water quality worsens due to an increase in foreign particles. After a wildfire, there's an increase in streamflow due to the loss of vegetation's canopy and roots and heat from the wildfire that bakes the ground, creating a hydrophobic layer of soil. With increased mobilization of nutrients, ions, metals, and certain organic chemicals in the waterway. Concentrations rising 10–100 times or more above reference levels. The water quality is degraded below the criteria for aquatic life or drinking water standards/regulations for an average of two years, persisting for up to fifteen years. Additionally, other factors such as particulate matter in the air and heavy metals will also be affected. In some cases, an area after a wildfire may experience an increase in particulate matter in the air to increase fourfold (California Air Resources Board, 2021).

Furthermore, the plant is weakened and stunned from a lack of light or heat. Both smoke and the fire itself will delay plants, resulting in decreased growth rates and minimized sunlight reaching plants. This prevents them from reaching their full size. Since they are being planted late, their maturity date shifts into winter.

#### 3.2 Economics

The economy is affected by a loss of profit for many insurers. For example, the Los Angeles fire caused losses of 16521 registered and insured structures. The majority involved homes, which were estimated to be valued from \$65 to 131 billion. Insurers were able to cover a portion and lost as much as \$44.5 billion. Additionally, a 0.48% decrease has occurred in the county's GDP value. Beyond homes getting damaged, infrastructure structures were also damaged and limited. So, without appropriate structures to operate, loss of productive capital, businesses, and labor markets.

While all communities suffer damage, the magnitude isn't proportional across different communities. Unfortunately, disadvantaged communities are more often to experience recurring damage. Such as disadvantaged communities don't have proper resources to have future strengthened responses with personnel training, equipment, safety, and protection equipment, or for prevention methods. Additionally, structurally disadvantaged communities are less likely to implement essential measures such as roof replacements (for protective purposes) and could therefore be significantly more exposed to the consequences of wildfires in the future. Homes in communities classified as disadvantaged by the US government are 29 percent more likely to be destroyed by wildfire within 30 years than homes in less disadvantaged communities.

#### 3.3 Agriculture and Environment

Agriculture's presence matters deeply to society, serving as the only viable source of income for three-quarters of people globally living below the poverty line, reflected in \$1.3 trillion in global revenue (World Wildlife Organization). Furthermore, this sector matters to people by fostering a healthy society by encouraging cultural heritage, community, involvement, and local resilience through self-sufficiency (Bloom Ranch). However, this essential resource is vulnerable to wildfires, impacting communities by hindering communities' main source of income (Gabi Raab, University of Oregon, 2021). Beyond wildfire directly destroying equipment and agriculture,

the impact is felt through unsafe conditions for farmers, equipment damage, and an increase in poverty (California State Assembly Committee on Agriculture, 2020). At a larger scale, there also comes the disruption of croplands, which leads to food shortages and releases significant amounts of greenhouse gases, emphasizing the damage wildfires do to agriculture.

As stated before, agriculture is a major economic driver that boosts GDP and creates employment opportunities. Furthermore, appropriately managing agricultural lands is vital to the state's environment: sustainable practices are necessary in preserving and restoring critical habitats, protecting watersheds, and improving water quality and soil health (World Wildlife Organization). These contributions to the economy, environment, and overall society's welfare show the importance and presence of agriculture in California's security and strength as a state.

The recent impacts of California have highlighted agriculture's extreme vulnerability, with losses to property and human lives. Property such as crops was notably impacted by smoke and ash, rather than direct fire. Not only can particles in the atmosphere block out sunlight and lower temperatures, but plants can also be affected by smoke taint: see the LNU Lightning complex fire with hundreds of millions in damages (California State Assembly Committee on Agriculture, 2020). As a consequence, many wildfires' trail of destruction has allowed agricultural insurance premiums to surge (e.g., from \$8,000 to \$36,000) for some agricultural policyholders, and many coverages have been canceled. Moreover, the FAIR Plan, a last-resort insurance program providing superficial fire insurance to homeowners and businesses, does not cover ranches or farms (California State Committee on Agriculture, 2020). Furthermore, wildfires have led to significant impacts on humans and labor. For example, the Glass Fire reduced approximately an average of \$5,500 per worker, summing up to an estimate of \$50 million of reduced wages (California State Assembly Committee on Agriculture, 2020). Beyond wages, a society's well-being is impacted through loss of housing and exposure to hazardous conditions.

#### 4. Methodology

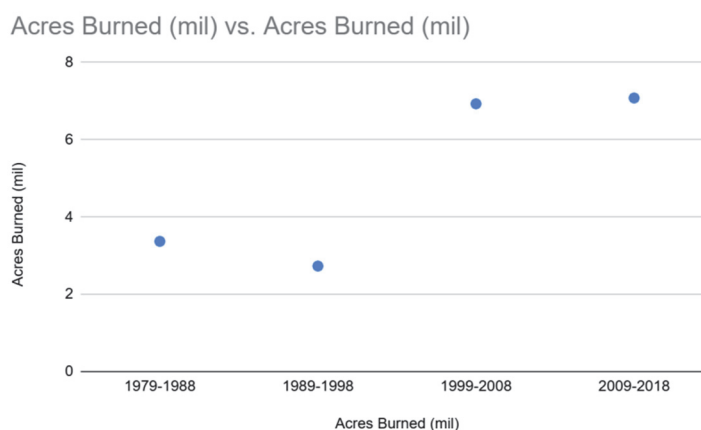


Figure 4. Acres Burned (Mil) VS. Acres Burned(mil)

##### 4.1 Data Analysis

Figure 4 reinforces the idea that the overall escalating wildfire frequency and intensity is a real threat in the millions of acres burned. Data showing that the problem is growing, sharing an upward trend. After 2 decades of relatively stable burns with 3.37 million and 2.73 million acres burned, respectively, the acres burned tripled in the latter half. Hence, environmental, economic, and social consequences have increased too. Such widespread destruction accelerates soil degradation through more hydrophobic layers of soil, increases risk for smoke taint on crops, and provides the context for the surge in insurance premiums and lost wages that destabilize the agricultural sector.

##### 4.2 Discussion

Naturally, forests and wildfires have some degree of resilience to disturbances and changes to their surroundings. Wildfires that are less concentrated often give a chance for habitat variety: positive outcomes from appropriately spaced-out wildfires allow an ecosystem to build up resilience and boost biodiversity rates (Ayars, Kramer & Jones, 2023, PNAS). However, the disturbances caused by consistent wildfires are not inherently destroying habitats; rather, frequent wildfires with tight timing between them often leave wildlife unable to quickly respond by adapting in time. Additional harm from wildfire is its output of the release of greenhouse gas, which contributes

to climate change and puts the environment at risk through an imbalanced food chain. However, in the past century, the number of acres damaged by wildfires has increased dramatically (CALFIRE, 2023), highlighting the growing threat to California's agricultural sector and overall economy.

Too frequent and strong wildfires impact beyond the environment. Wildfires bring social aspects that impact communities at large. Seen with slowing down or disabling shelters that normally empower communities through medical care, shelter, supplies, mental health support, and housing assistance. Shelter employees often may not come into work due to increased health risks (CNMSocal, 2025) and face a shortage of supply donations. Beyond shelters, other institutions that normally provide support are also affected, including schools being shut down. Affecting children with health issues caused by the wildfire, and confusion about the lack of an established routine (USC, 2025). On the other hand, fires reduce the flow of transportation of goods and humans by creating dangerous and uncertain conditions. Further compromising shelters that are unable to provide aid. Fires not only stop a society from functioning normally but also hinder society from attempting reconstruction.

Another way in which fire blocks the normal operation of society is by affecting agriculture. During wildfire, both agricultural equipment and crops can get destroyed through direct inflammation, and further crops destroyed with smoke persisting in the atmosphere that blocks sunlight. The important needed consistent flow of food and goods for a functioning society is interrupted, further exacerbating food scarcity and employee salaries.

Seeing the significance of agriculture and its relation to social, environmental, and other aspects of society, wildfire prevention and defense need to be increased and given greater weight. First, wildfire defense can be strengthened through governments helping more with farmers fending for themselves less, through farmers and ranchers being allowed into designated evacuation zones. The purpose of relocating at-risk animals is to assist firefighters by creating firebreaks (an effective way is targeted grazing using animals to consume excess fuel) or providing water for firefighting efforts (California State Assembly, 2020). For context, firebreaks are most prevalent on landscapes that are hard to access (i.e., landscapes that are steep, rocky, or too remote). Furthermore, wildfire responses can be improved by having the California FAIR Plan to cover commercial buildings and equipment, similar to other California businesses' coverage. Instead of the plan covering only crop losses for farmers (California State Assembly, 2020). Lastly, wildfire response may be improved by creating a surplus source of Personal Protective Equipment that may be sourced to community or farmworker organizations (California State Assembly, 2020).

Some of the suggestions made in November 2020 were later implemented, most notably in "California's Wildfire and Forest Resilience Action Plan" published in January of 2021. With plans to "draw upon the practices of Native Americans, ranchers, and rural communities to rapidly expand the use of prescribed fire and bring these best practices to these lands". Thereby, diverse landscapes require unique management strategies of fire prevention. Such as, Grasslands and rangelands are vulnerable to fast-moving fires, hence fuel breaking needs to prevent invasive species. However, there are still limitations in the action plan: as fires increase in severity, it highlights the need to contain the growing presence of invasive species (leading to a process where other vegetation takes over and increases fire risk and frequency) or changes to a more supportive FAIR Plan. These unaddressed issues show that while steps have been taken in forest resilience, the full scope of Wildfire preparedness and resilience has not yet been reached.

Current vulnerabilities of wildfire response and wildfire impacts can be further reduced through direct prevention. Currently, the California Wildfire Mitigation Program is working towards the goal of encouraging cost-effective structure protection, facilitating vegetation management, and creating and maintaining defensible spaces (California Wildfire Mitigation Program, 2022). As said, fire breaking is frequently an effective way to remove the fuel for potential wildfires, allowing the CWMP to properly manage vegetation and create defensible spaces. A sufficient amount of fire-breaking strategy results creates a large network of fuel breaks specifically situated around vulnerable communities (Wildfire Task Force, 2021). As a result, wildfire-prone homes and neighborhoods are protected through a buffer. Moreover, fire breaking can create fire-safe roadways and evacuation routes, established by clearing combustible vegetation for effective linear fuel breaks (Wildfire Task Force, 2021).

However, fire breaking often is hindered by a high frequency of 'no-burn' decisions by air pollution control districts and air quality management district's managing decisions on prescribed burns (California State Assembly, 2022). To encourage prescribed fires, a "gross negligence standard" should be supported, under the condition that "burn bosses" (trained professionals) are legally held liable for gross negligence, instead of minor mistakes, reducing the magnitude of disincentives and concerns, such as concerns of liability or insurability. Furthermore, prevention includes applying mature models/simulations to assess and evaluate infrastructure and utility capabilities in reducing wildfire risk (Energy Safety, 2020). This overlaps with the goals of the California Public

Utilities Commission (CPUC), which initiated a project to create a vision, strategy, and roadmap to outline its efforts to systematically reduce the risk of ignition of wildfires from utility infrastructure.

## 5. Conclusion

The escalating frequency and damage from wildfires make it clear that wildfires can't be seen as standalone natural disasters. Rather, they give rise to both standing environmental and societal issues. In agriculture, by delaying the growth of plants and destroying equipment, wildfires have triggered a cascade of events that touch both the economic vitality and social well-being of California. Understanding said issues of the connection between the environment and social issues better can contribute to society. It points out issues brought by fires, which, with appropriate responses, can lead to a safer and healthier environment. With more resilience, through focusing on both proactive and reactive approaches, the agricultural sector can allow for long-term resilience against future damaging wildfire seasons.

Ultimately, this paper shows that despite California's decades of experience, significant gaps in strategy still exist in wildfire preparedness. A prepared response strategy that closes these gaps will reduce the long-term damage done to the economy, society, and environment.

Closing these gaps. By establishing how serious and negatively impactful wildfires are, the investment of additional resources is justified to help better the planning, defense, and appropriate response to the fire. These challenges underscore the need for stronger prevention and a proactive strategy. More thorough wildfire prevention, preparedness, and recovery efforts-particularly for agricultural regions-remain essential to protecting both local communities and the state's broader Stability.

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