

# Impact of Climate Change on the Frequency of Wildfire----Taking California as Example

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**Abstract:** Based on the analysis of various data over the years, this paper analyzes whether the increase of warm season will affect the fire frequency, intensity and fire season length. Combined with the specific situation and data of mountain wildfires in California in the past decade, the causes of wildfires in California are obtained, that is, climate change plays an important role in forest fires. And greenhouse gas emissions significantly affect the fuel dryness (CWD) and fuel availability (AET) in mountain forests from two aspects of reducing rainfall and increasing temperature, thereby increasing the probability of mountain fires. After that, through the analysis of other human factors, the indispensable influence of human activities on wildfires was confirmed.

**Keywords:** Wildfire; Climate Change; Greenhouse Effect

## 1. Fire background in recent years

February 16, 2022 should have been an ordinary day, but it is in this cold day that the world-renowned forest fire "AIRPORT fire" occurred. It started around 12:41 noon outside the East Sierra Regional Airport in Inyo County, California. The fire spread rapidly from 50 acres to 100 acres in 45 minutes. Even if the local fire brigade intervened in time to put out the fire, the fire extinguishing efficiency was not very good because the vegetation was too lush and tall. On Thursday, it was estimated that the fire had scorched six square miles. Firefighters have been trying to prevent fires from harming small communities. The California Fire Department said late Thursday that the AIRPORT fire had been controlled by 20%. At the same time, most of the residents living around them were forced to evacuate. In the same week, two unusual winter wildfires broke out near Los Angeles and Laguna Beach in Southern California, burning down several houses, prompting evacuees to evacuate, and the government closed part of the iconic Pacific coast highway. In less than a month, another fire broke out on a section of California's famous Highway 1, prompting nearby residents to evacuate. The economic and personnel losses caused are countless.

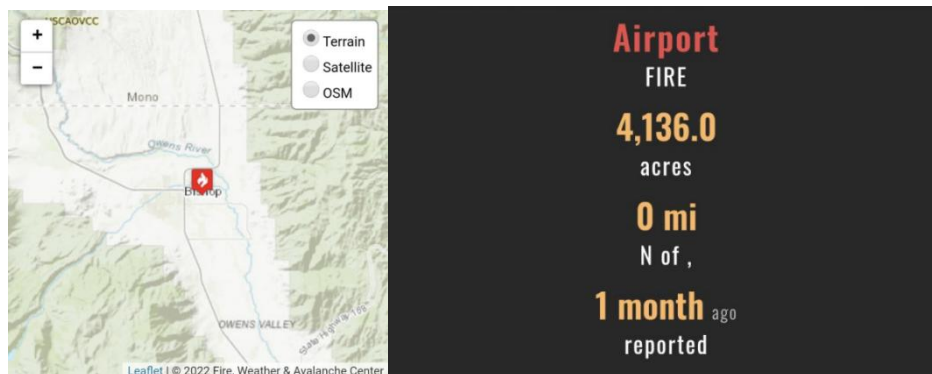


Figure 1 The Information of The AIRPORT Fire

## 2. The relationship between warm season and the fire frequency, intensity

Yizhou Zhuang currently works as a postdoctoral scholar at University of California, Los Angeles (UCLA). His main research interests are fire weather and drought over Western US and Great Plains, attribution of internal variability and anthropogenic warming. His recent studies of fire behavior in the WUS have indicated warm season increases in the area burned by fires, fire frequency and intensity, and fire season length (2–12). (Zhuang 1) This is true: according to the National Interagency Fire Center (NIFC) report, the area burned by wildfire during the 2020 warm season reached 8.8 million acres, more than five times the average during 1984 to 2000.(Zhuang 1)

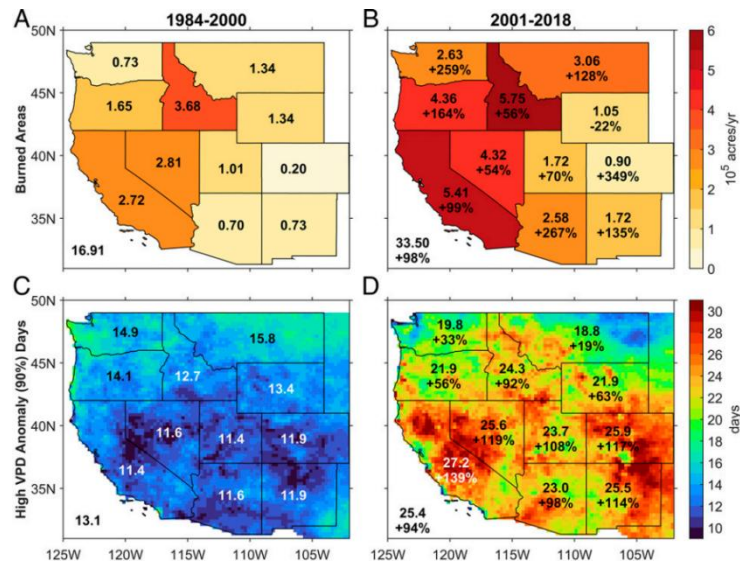


Figure 2 The Burned Areas of California Fires is Increasing/pnas.org

## 3. The specific situation and data of mountain wildfires

Mountain fires are very common in California, and there are fire accidents almost every year. On October 8, 2017, forest fires broke out in many places in the northern San Francisco Bay area, California. The fire lasted half a month, killing at least 42 people, burning more than 7000 houses and commercial buildings, and about 100000 people were evacuated urgently. On November 8, 2018, a mountain fire broke out in Paradise Town, Butte County, Northern California, covering an area of more than 150000 acres. Paradise Town, which has only 27000 people and is the closest to the fire source, was almost burned to ruins, killing 85 people. In 2019, 580000 people were evacuated from the "fire" county of California in the "fire" mode again. On September 7, 2020, a fire broke out in Sierra Leone National Forest, California, and then spread rapidly. The fire burned for two months, burning nearly 16000 square kilometers of California (equivalent to 16 New York), killing 31 people. In 2021 alone, more than 8800 mountain fires occurred in California, and more than 60000 people were displaced.



Figure 3 California Wildfires Map/latimes.com

## 4. Relationship between greenhouse gas emissions and wildfire

The probability of mountain fires and wildfires in the United States and even around the world is significantly increasing, and climate change is the culprit. Scientists have made it very clear that climate change has played an important role in forest fires in recent years. Due to the greenhouse effect of greenhouse gases, the number of dry, warm and windy autumn days in California has more than doubled since 1980, which is a period of high vulnerability to forest fires.

We must significantly reduce greenhouse gas emissions. Otherwise, in a few decades, we may recall the more than 4 million acres of California forest burned so far this year, and think that this is a relatively less severe wildfire season. However, the area of forest burned in 2020 has broken the previous record in 2018. This expectation, which has scientific basis and can obviously destroy life and property, is unacceptable.

In the past few years, two-thirds of the northern part of the state has received only half the normal rainfall. The US drought monitoring agency has classified 85% to 90% of California as areas experiencing "abnormal" or "extreme" drought throughout the summer of 2021. According to the National Environmental Information Center, the period from September 2019 to August 2021 is the second dry period in the state since records began. Experts say the severe drought in the southwestern United States has become very serious. The entire West of the United States is in a severe drought that has lasted for 22 years, which is the most serious drought crisis the land has experienced in 1200 years.

California gets most of the water in autumn and winter. For most of the summer, the vegetation here is slowly drying up due to insufficient rainfall and rising temperatures. These plants can be used to light a fire. Dr. Isaac Park through the investigation of historical fires, he analyzes and models relevant parameters that may have an impact (including human activities, agriculture, historical fires, etc.), in which historical fires and human activities mainly affect fuel dryness (CWD) and fuel availability (AET), compares his own model with the real historical situation, and constantly modifies the model and the proportion of each parameter. It turns out that all the above parameters play a good role, and it shows that the local climate - due to the limitations caused by fuel dryness (CWD) and fuel availability (AET) - plays an important and predictable role in determining the annual fire probability in California. (Park 16)



Figure 4 California is Getting Drier and Drier

Of course, even if the conditions for a wildfire are appropriate, it still needs something or someone to light it. Sometimes the trigger is nature, such as lightning, but it is more non nature. For example, many fatal fires are caused by collapsed wires. The Carl fire in 2018 is the sixth largest fire recorded in the state. It was caused by a flat tire of a truck, the edge of which scratched the road and produced sparks. Some are caused by wrong decisions, such as fires caused by fireworks at a party in Eastern Los Angeles. Park has proved that local climate conditions, human activities and deviations from long-term climate normals jointly affect the probability of mountain fires in California.(Park 8)

Meanwhile, Sacramento lawmakers have passed dozens of bills over the past few years to address the risk of forest fires, including six new laws regulating combustion. Last year, the governor announced a state of emergency to protect 35 communities, and the governor also implemented 200 projects to reduce risks. This data comes from the website of the United States Environmental Protection Agency.

However, fuel treatment alone can not solve the problem of forest fire; We cannot ignore our impact on climate change and continue to exacerbate our own risks. Reducing greenhouse gas emissions is a vital part of protecting our future communities and ecosystems. The UCLA scholar Zhuang mentioned above also addressed the impact of the greenhouse effect on the frequency of fires in his paper. He finds that over the period 1979 to 2020, anthropogenic warming has contributed at least twice as much as natural variability to the rapid increase of fire weather risk.(Zhuang 7) Their results suggest that the California appears to have passed a critical threshold and that the dominant control on the fire weather variation in the California has changed from natural climate variability to anthropogenically forced warming. While natural climate variability can still significantly modulate the interannual to decadal variations of fire weather risk, the trend toward increasing risk will likely continue over the California. This change in risk requires urgent and effective societal adaptation and mitigation responses.(Zhuang 7) Benjamin Nauman, who is studying for a doctorate in geography at the University of California, Los Angeles, found that modern wildfires are similar to California during the Middle Ages by studying charcoal, which represents the occurrence of forest fires. This confirms once again that climate change, especially the greenhouse effect, will increase the possibility of wildfires. (Nauman 28)

In 2017, California re-authorized its landmark greenhouse gas reduction efforts and extended its goal of reducing greenhouse gas emissions to 40% below 1990 levels by 2030.(Bernal 1).

Alexis A Bernal, from the University of California, Berkeley, said that over the past century, overly aggressive fire-fighting measures and forest management have led to an increase in forest density, biomass and fuel load. However, the annual carbon absorption rate is declining, and the absorption of carbon dioxide has decreased by 35% from 2018 to 2019.

This may not be easy to understand, and some readers may wonder why excessive fire prevention is easy to aggravate the fire frequency. Robert Sanders made a good explanation in his article "wildfire management vs. fire suppression benefits forest and watershed". A group of scholars from the University of California at Berkeley conducted experiments in Yosemite

National Park for 40 years and proved: "managing fire, rather than suppressing it, making wilderness areas more resistant to fire, with the added benefit of increased water availability and resistance to drought". Because they found that when fire is not suppressed, you get all these benefits: increased stream flow, increased downstream water availability, increased soil moisture, which improves the habitat of plants in the watershed. It increases the drought resistance and fire resistance of the remaining trees, because you created these natural fire belts.



Figure 5 A fire turned a forest in Yosemite National Park into a wetland

Back to Bernal's article, through the analysis of four models of future climate change, he concluded that the increase of temperature led to the increase of the proportion of pine trees, which in turn led to the decrease of the overall tree density (because the proportion of pine trees is inversely proportional to the overall tree density). Eventually, although the overall forest density is increasing, it is basically the pine forest, and fires tend to occur in the pine forest (however, the risk of pine fire is very low and the harm is very small). The final result is that forest fires will be more frequent and the efficiency of carbon sequestration will gradually decline. Therefore, we need to understand that the more frequent fires and the decline of carbon sequestration are due to a series of chain reactions caused by the deterioration of the greenhouse effect. Therefore, if we want to fundamentally solve these problems, we need to do more than simply prevent fires and rack our brains to improve the efficiency of carbon storage, but to trace the source and reduce the greenhouse effect. At the same time, we should also try to make the fire serve us, such as turning the forest into wetland through fire. Of course, the premise is to ensure the safety of everyone. Therefore, local policies should comply with this objective law. While reducing the expectation of carbon storage, we should be prepared for frequent fires. Match policies with actual needs. We must not blindly formulate absolute policies to reduce fires, or still apply the policies of decades ago, which is easy to backfire. Facts have proved that California's forests have their unique response mechanism to climate change, so we can't intervene excessively.(Bernal 8) At the same time, we should also try to make the fire serve us, such as turning the forest into wetland through fire. Of course, the premise is to ensure the safety of everyone. What we should do is to reduce carbon dioxide emissions and the deterioration of the greenhouse effect, instead of focusing on forest prevention and control. The improvement of the probability of forest fire is only one of the many hazards of the greenhouse effect.





TAKING FIRE PREVENTION TO THE NEXT LEVEL

Figure 6 Do Not Make any Fire Near Forest

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