

Influence of Climate Change on Australia Forest Fire and Future Prevention Strategy Analysis

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Abstract. The problem of Australian forest fires has always captured the world's attention. Each forest fire will bring huge losses. It can be huge death of animals, leading to more animals becoming endangered species, and it causes a high mortality rate. The study is about the impact of climate change on Australia's forest fires. The study contains information about Australia's current climate change and the analysis of the relationship between climate change and forest fires, finding that climate is the main factor for the increasing possibility of the forest fire. The study also includes the measurement used by governments and suggestions to reduce the cost of forest fires. For example, the wide no-fuel or micro-fuel Asset Protection Zone (APZ) can greatly influence the operation and viability of small lands and public reserves. Reducing the use of flammable matter and house density and building residential areas with fire suppression devices are necessary. The study shows the severity of problems caused by climate change and the necessity of fire prevention.

Keywords: Climate change, forest fire, prevention strategy.

1. Introduction

In this paper, by comparing the temperature in the past with that in recent years, we can draw a clear conclusion that the extreme weather caused by global warming and Australia's unique geographical environment are the main reasons for the possibility of forest fires. This statement is conflicting. Many people think that the causes caused by nature are more obvious than human factors. For example, eucalyptus trees in Australia play a helpful role in the spread of forest fires, but some people also think that the increase in carbon dioxide emissions is also an important reason, in the following, the specific data of these discussions will help the reader review the reasons affecting the possibility of forest fire, and finally give feasible control plans in the future.

Based on previous studies in this direction, in recent years, the temperature change is different from the past, which is more significant and influential. In Australia, the area and frequency of forest fires are also stronger, so the current and future trends are valuable for research.

2. Australia's Present Climate Influence on Forest Fire

2019 was the hottest and driest year. The temperature in Australia was above the long-term average by 1.52°C. Clipping drought, temperature records, heatwaves, and devastating bushfires occurred this year. It is even hotter than 2013, the previous record holder, by 0.19°C. The national daily average maximum temperature in 2019 was exceeded for 33 days, and the hottest days happened in Port Augusta Aero in South Australia, where the temperature reached 49.5°C on January 24 [1].

Since 1910, the surface air temperature in Australia has raised by 1.44°C [2]. Massive emission of greenhouse gases produced by coal, oil, and gas mainly causes the high temperature in Australia. Although fossil fuel emission has declined because of the pandemic, it still has a huge impact. Carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and water vapor are the main components of greenhouse gases. In 2019, the level of carbon dioxide caused by human activity increased by 50%,

resulting in 1°C of global warming. Fortunately, both per capita carbon dioxide emissions and the country's annual carbon dioxide emission have decreased from 2016 to 2020, but the general trend of carbon dioxide emissions has continued to rise since the 19th century. Meanwhile, methane emissions (the second most abundant greenhouse gas) in Australia were 126, 070.0 kt of carbon dioxide equivalent in 2019 [3]. Although methane emissions in Australia have fluctuated wildly in recent years, they tended to decline from 2000 to 2019. Agriculture is the main cause of methane emissions, which also contributes about 13.5% of Australia's greenhouse gas emissions [4]. Most of these methane emissions are produced by the livestock in a process known as enteric fermentation (A process carried out by the digestive system). Apart from agriculture, fugitive emissions produce a significant amount of methane. The pattern of variation for nitrous oxide from 2000 to 2019 is very similar to that of methane. Though Australia's nitrous oxide fluctuated substantially in recent years, it tended to decrease and end at 60,870.0 thousand metric tons of carbon dioxide equivalent in 2019 [5].

Drought is another significant issue in Australia. It can cause financial losses, personal deprivations, environmental damage, crop dying, and water quality declines. However, climate change and anthropogenic activities cause the drought to become worse and last for a longer period of time. The term "drought" generally refers to a period of less water than normal. From 2001 to 2009, southeast Australia suffered its worst drought on record. This event is termed "millennium drought", and contributed to the destruction of the ecosystem, economy, and society. The millennium drought also had a huge impact on southwest Australia. It was caused by poor rainfall during the cool season. In the last two decades, 15 out of 20 of Australia's average rainfall has been below the 1961-1990 climatological mean [6]. From April to October, 17 out of 20 rainfalls in southern Australia have been below the average during the cool season months, and the rainfall in the southwest of Australia during this period has decreased by nearly 16% since 1970. In the cool season of May to July, the rainfall has decreased by 20% [2]. In contrast, the federation drought, which mainly affects the whole continent, was caused by poor rainfall during the warm season. The number of tropical cyclones observed in the Australian region also has declined by about 11% since 1900 [7]. This downtrend leads to a lack of cloud formation and therefore affects the precipitation.

The bush fire usually takes place from December to May in southern Australia, happening in northern Australia from May to October, and in central Australia during the period of August to March [8]. Natural or manmade causes often start the forest fire. Fire weather would increase the likelihood of ignition. High air temperature, low precipitation, low soil moisture, and gusty winds all contribute to fire weather. Ignition can be caused by natural sources or anthropogenic sources. Lightning, especially dry lightning, is the main cause of natural ignition, taking responsibility for more than 50% of burning in some regions of Australia [9]. Dry lightning occurs with less than 2.5 mm of rainfall, which leads to a higher possibility of a wildfire, and it is more likely to happen on ridges and at high elevations. While Anthropogenic ignition usually takes place in a crowded area or built environment.

3. Impacts of Climate Change on Forest Fire

Especially when it comes to temperature, changes in humidity and temperature are frequently crucial variables causing fires. The length of forest fires and the difficulty of rescue may be inferred from the particular statistics provided above, which indicate that the drought and decrease in rainfall produced by the rise in temperature are proportionate. However, fires are sometimes affected by other relatively insignificant factors, such as local wind conditions or moisture of the land [10]. Australia has a large number of forest resources, and the dispersion of trees is highly dense. However, this does not imply that when temperatures rise and precipitation falls, the likelihood of forest fires would rise. Australia's unusual environment has a direct impact on the country's raging forest fires. First off, this nation has 157 million hectares of forest area, most of which are broad-leaved forests, with 97% of the tree species in these forests being eucalyptus and maple. There is substantial oil reservation in

eucalyptus, and this substance can make the possibility of burning higher. However, their own bark can withstand fire. According to the rise of the specific temperature in Australia mentioned above, it can be seen that the temperature change has an absolute impact on inducing the spontaneous combustion of oil in the eucalyptus. Secondly, drought and low rainfall will directly accelerate forest fire spread because forest fire is a natural disaster. In other words, when people find forest fire, its fire is difficult to be artificially suppressed and interfere with. However, the most unexpected point should be the impact of animals on forest fires. In the past, forest fires caused devastating damage to biodiversity and the natural habitats of animals. Every year, countless animals are burned to death. Some birds that eat small birds found that forest fires can drive their prey out, so sometimes they even took the burning wooden stick to the forest.

Due to the vast territory and sparse population, the increase in carbon dioxide emission, and the change in temperature, it is not easy to adopt solutions promptly. Australia has two distinct climatic zones, with a tropical north. Considering that they are so near the equator, January and February are typhoon seasons. So local people should not undervalue typhoons' effect on forest fires. Its strength will be more than 10 times greater than the original if the wind is favorable. The temperate region includes the southern part of Australia. In contrast to the lush and rainy coastal region, the Midwest is a barren, arid desert with high temperatures and wide temperature variations. The rainfall in 2019 is definitely a topic worth discussing for Australia. This year, the rainfall in more than half of Australia can be said to have broken through the historical low. With the violent reduction of rainfall, accompanied by an ultra-long drought, the frequency of forest fires has long been beyond people's control [11].

A number of wildfires that started raging in Australia in September 2019 as a result of the deteriorating and uncontrolled weather are referred to as the 2019-2020 Australian bushfires. The regional fire department of New South Wales believes the fire that broke out on January 8, 2020, to be the worst blaze in recorded history since it resulted in the destruction of more than 5000 homes. The NSW government had no choice but to declare a state of emergency in December 2019 after some external factors made the bushfires worse. [12-17] According to pertinent scientific data, over a billion animals, including land and amphibians, have perished in forest fires over the past several years, and some animals that survived have also lost their original habitats. Forest fires often have a terrible effect on biodiversity. Australia exports the largest proportion of coal in the world. There is no doubt that its carbon emissions have been on the rise over time, but the head of the country believes that high carbon emissions are for the better development and future of the country. In other words, development and environmental protection can only choose one. Therefore, he was listed by the UN climate summit as one of the members hindering the Paris climate agreement. Therefore, the government chose the former for economic development and environmental pollution.

The government currently focuses on reducing the emission of carbon dioxide. Climate change makes the summer weather more hot and dry, and the government's emission reduction target needs to be gradually changed. Especially in the Black Summer fires during the forest fire season from 2019 to 2020, as the temperature rises, the frequency and intensity of forest fires will increase, and more and more animals will die from forest fires if they cannot get one [18].

4. Bushfire Presentation Strategies

4.1. Land Management

Human life and urban housing become the focus of people's attention. To prevent damage, the public sector in southeast Australia may establish an "asset protection zone" around the urban areas in order to prevent fires.

AZP creates an area where firefighters can operate safely and effectively. The approach focuses on the management of individual dwellings, with an emphasis on fuel management for fires, such as houses in close proximity to urban areas. However, while AZP provides a safe operating area for firefighters, there are limits. Firefighters cannot put the flames burning in the tree canopy out. And

the glowing embers or burning fires can pass through the fuel ports and buffer zones, igniting the fuel downwind. The second is thermal radiation from the flame, which can be a potential ignition source—high radiation levels may cause bushfires. Several possible solutions have been proposed by researchers:

Wilson found how flame length is related to its line intensity. He used flame modeling and analysis to derive the flame properties of forest fires. Find out the flame lengths, angles, heights, and tip velocities of head fires and calm-air fires [19].

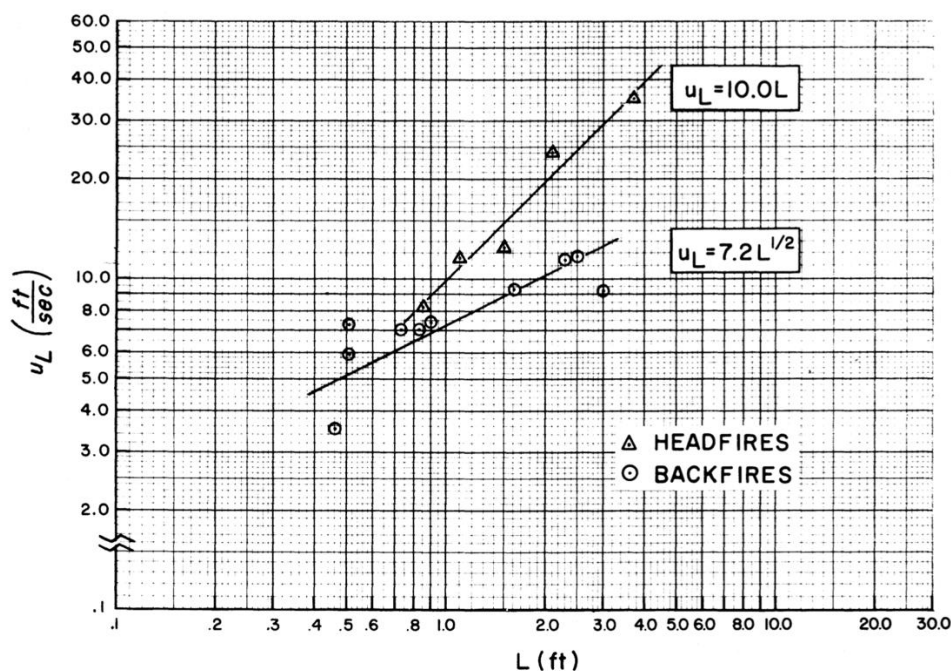


Fig 1. Flame length-flame tip velocity relationships for head fires and backfires in southern fuels [20]

4.2. Building Management

An investigation into the aftermath of the Ash Wednesday fire has revealed that sparks and embers released from the blaze were the cause of the house fire. As a result, how to make buildings more resistant to these fire emissions has become an essential problem. Standards and building guidelines soon been developed [21].

In some communities, local government authorities have regulations on the siting, design, and use of building materials in forest fire-prone areas. These control measures not only minimize damage to homes and losses caused by fire but also help prevent and spread forest fires. For example, reduce the use of flammable materials such as wood to protect homes from sparks and embers that can cause fires. And to equip residential areas with efficient fire suppression devices to prevent the spread of fire. At the same time, the density of housing construction should be reduced to prevent the fire from spreading too fast and affecting too many residents.

5. Conclusion

Australia's bushfires have been a serious hazard. Global warming and drought will bring about economic losses, personal safety problems, environmental problems, crop death, and other serious problems. The bushfire in Australia is caused by multiple climate-related reasons. The human activity-derived carbon emission, the increased long-term average temperature, and the reduced rainfall have caused severe drought in recent decades; besides, the ignition caused by natural or manmade resources has further increased the possibility of bush fire in Australia. At the same time, the fire behavior is also closely related to climate change and meteorological conditions, Australia's

forest wealth and 97% of its eucalyptus and maple trees make it extremely prone to bushfires. Also, the mutual effect between biodiversity and fire activity are considerable factors to reckon with. However, the damage caused by forest fires can be reduced by building AZP and more governmental measures.

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