

## **Bushfire Study: Causes, Effects and Risks to the Ecosystem Due to Changes in Climate**

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### **Abstract**

The study focuses on the correlation between bush fire and the changes in climate and their effect on ecosystems of plant in Australia. Major plant species currently at severe fire risk are forests of eucalyptus, ecosystems which are Mediterranean, ecosystems of mountain which are restricted, steamy grassy fields and dry s. chaparral. Such networks are particularly at danger of a rise in fire as a result of change in climate. In addition, separate ecosystems have different rates of recovering. As a result, increased incidences of changes in climate fires will have different impacts on the survival-ship of habitats as a function of potentially choosing organisms having slower post-fire capabilities of regenerating. For example, larger trees will not be able to survive increased frequencies of fire. In fact, it is preferable in establishing reserves that are native for similar kind of vegetation in order of minimizing chance of fire relative to that particular ecosystem. Basically, frequency of fires changes with the zones of climate-vegetation, such that a systematic as well as coordinated address is ideal for protection, partly across national and territorial boundaries. Impact of Bushfire on interface of urban since few decades has given few lessons, many of those led to behaviour changes, understanding in community and changes in policy. The principles for the impact of bushfires on the ecosystem and urban interface are well established; however, the prediction of the synergistic effects and the specific risk of these attack mechanisms is not well quantified.

**Key words:** Bushfire Study, Changes in climate, Bushfire's Impact, Climate-Vegetation, Ecosystems, Fire Risk, Temperature

### **Introduction**

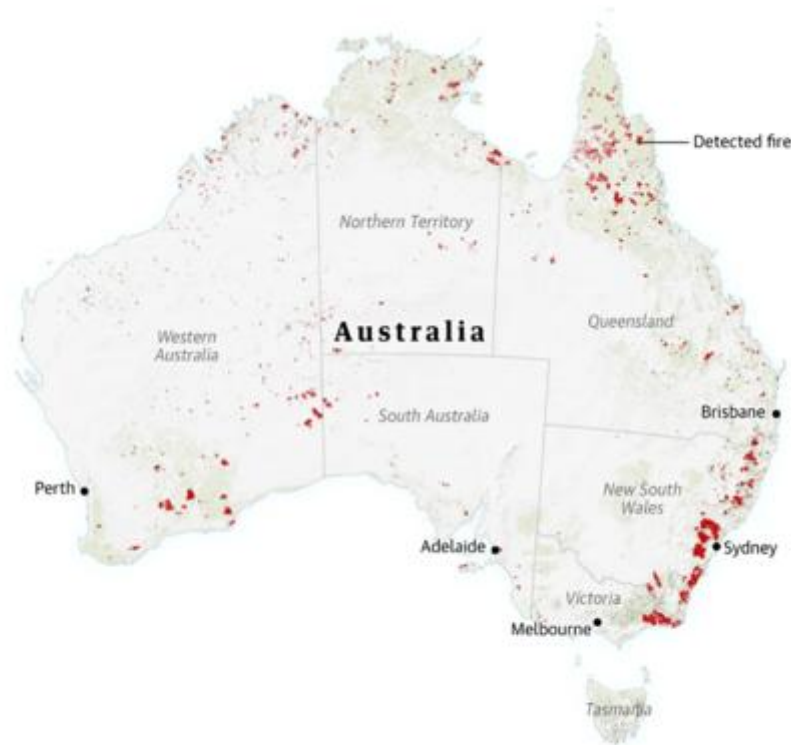
The term "bushfire" is based on "bush" concept which means scarcely-inhabited areas. In Australia, Bushfires are termed as wild, unstructured fires that burn in grass, brush, shrub, or forests. Australia is geographically and meteorically continent which is diverse, is experiencing a number bushfire. Depending on the local topography, there are two main categories. In hilly, alpine or mountainous regions fires that burn are called Hilly / mountainous. Flat or grassland fires occur over plains and slightly undulated areas. Such fires have high speed, which is increased in high winds occurring in topographies that are flat destroying any fuel or vegetation that comes in their way. Such fires have little threat to cities, as they never extend with same intensity when seen in big firestorms since land is flat, it is easy in mapping and tracking fires, and landscape [1] is easily accessible for firefighters. Most areas of flat land of Australia is entirely deforested for agriculture, reducing fuel loads which might increase fires in the regions. The past fire of Australia has been known to have

been occurring since last 400,000 years, having high frequency variability due to natural climate variability. Approximately 38,000 years ago, a significant increase in fire frequency was likely related to native Aboriginal activity, given little evidence of changes in climate correlation. The second increase in frequency of fire is in correlation with the settlement of Europe, which started in 1788. Currently, about 5% of the land area in Australia is annually burned, consuming 10% of the total primary productivity. This review focuses on the association between bush fire and change in climate and their impact on ecosystems of vegetation of Australia. How frequently fire varies will depend on climate and zones of vegetation. Thus, in order to inquire into the problem, it is first necessary to realise the different vegetation zones of climate of Australia. Bushfires of Australia have destroyed large areas and caused property damage and have resulted in the deaths of 800 people in Australia since 1851. Large firestorms resulting in significant loss to life are named on the day they occur, example Ash Wednesday or Black Saturday. Most acute, extended and dangerous bush fires occur in droughts, for example 2009 Southern Eastern Australian wave of heat [2], that led to Black Saturday bushfire in that 180 people died. Some big conflagrations include the 1851 Black Thursday bushfire, the December 2006 bushfire, and the current 2019-20 bushfire. Bushfires have always been part of the ecology and environment of Australia. Some of the native flora of the nation has evolved to rely on bush fire for survival, and fire events have been interwoven in region's ecosystem since thousands of years. Original Australia made use of fire to clear grasslands for hunting and make ways across dense vegetation; however, this was only in periods of high rainfall and in very few prairie areas surrounding the desert. With the arrival of European settlers in the 19th century, fire control, and forestry and farming methods changed considerably. This led to more frequent fires. The situation has been intensified by heat waves and droughts associated with global warming. Forest fires and grassfires are widespread across Australia. Grassfires move fast, pass in five - ten seconds and smolder for a few minutes. These are having low or medium intensity, mainly damaging crops, farm animals and infrastructure of farms. Bushfires have slower travel speed, but intensity of heat is higher. Thus, they travel for 2-5 minutes but smoke for days. Forest fires are an integral section of the Australian climate. Fire has developed natural ecosystems [3], and the landscape, has been influenced by historical and latest fires. Many native plants have property of being fire-prone and very fuel-prone, but a lot depend on fire to regenerate. Fire was used as a tool by Indigenous Australians for management of land, and still used for purpose of agriculture and protection of property. Historically, these fires have led to life loss and major property damage. These fires cannot be stopped, but their effects might be reduced by adopting mitigation strategies.

## **1. Causes & Impacts of Bushfire:**

Bushfires can be initiated by natural causes such as lightning, but more often by human activities such as arcing of OH power lines, arson, and accidental ignition during agricultural clearing, grinding and welding, campfires, cigarettes and dropped matches, machine chips, and controlled fire escapes. They spread on the basis of the type and quantity of fuel available [3]. Fuel will cover everything from trees, undergrowth and dry grassy fields to homes. Wind

provides the fire with extra oxygen that pushes the fire across the land at a faster rate. Large, violent wildfires can produce winds of their own, called fire whirls. Fire whirls are like tornadoes and are the result of vortices caused by the heat of the fire. When these vortexes are tilted from horizontal to vertical, this creates fire turbulence. These whirls have been known to hurl flaming logs and debris over considerable distances. In many reports, it is said that because of changes in the climate the upcoming or future fires will be more ferocious and last longer and this is increased further by stronger winds. This is coined as spotting and might lead to a fire of four hundred km from starting. Fires is also transmitted by brown falcons, whistling kites and black kites. They will collect burning twigs from a fire and then move and drop these twigs to a new and unburnt places leading a new fire from an existing one. This leads their prey trying to escape the flames: which are insect, birds, lizards and small mammals. The absolutely astounding collection of bushfires is currently burning across Australia, creating disturbing images like those of evacuees running to beaches or safety boats. The situation in Victoria and New South Wales, where fires engulfed Melbourne, filling the air with smoke, was particularly dangerous. So much smoke, in fact, that even New Zealand has had a significant impact over 2,000 kilometers away [4]. About 15 million acres of land have been burned to date. California's 2018 fire season nightmare, for instance, destroyed around 2 million acres. Unfortunately, the weather has yet to make a difference, although there are some encouraging signs for the near future. Specifically, Saturday saw worsening conditions and for the first time, Victoria activated emergency powers in the midst of ongoing evacuations [5]. Figure 1 represents satellite-detected hotspots in Australia.



**Fig.1: Most recent map of satellite-detected hotspots in Australia**

## **2. Changes in climate:**

The temperature of climate of Australia has increased by one degree Celsius since the last century, leading to rise intensity and frequency of hot waves and dry spell. The hottest years occurred since 2005 and these were eight out of ten. A 2018 analysis at University concluded that the significant droughts of twentieth century and in southern parts of Australia are "possibly unparalleled in last 400 years." Over the country, average temperature of summer has recorded hottest temperature. Australia's driest annual rainfall since nineteen hundred was forty per cent lower than average in 2019. Droughts and Heat waves get dried and lead to situation that alleviate the risk of forest fires[6]. It got more in thirty years. There is decline in waterfall by 15% and 25% in autumn. Rainfall In 2019 the rainfall was recorded the smallest. More than a decade ago, the Intergovernmental Panel on Changes in climate (IPCC) concluded that existing man-made changes in climate was certain to alleviate the intensity, frequency and this was concluded in various reports. In November same year, the Australian Climate Council presented a report which was titled This is Not Normal, which found that the catastrophic fire conditions affected NSW and Queensland were aggravated by changes in climate at the end of 2019. According to Nerilie Abram in Scientific America, "the link between current extremes and anthropogenic changes in climate is scientifically undisputed.

## **3. Carbon Emissions:**

Until the Australian bushfire season 2019-2020, Australian forests were expected to absorb the carbon emitted in forest-fires in the world. This means forests have overall zero pollution. However, scientists claim that global warming is leading the bushfires to be intense and frequent and it is believed that existing fires have released about three hundred and fifty million tons of carbon dioxide which is two-thirds of annual carbon dioxide emission in the last 3 months. Forests will take more than a hundred year to absorb the emission since so much damage has already been done. They increase Australia's contribution to global greenhouse gas emissions, exacerbating the problems associated with global warming. Climate studies show that the conditions that promote extreme bush fires in Australia will only worsen as more greenhouse gasses are added to the atmosphere.

## **4. Seasonality:**

Bushfires have occurrence throughout the year in Australia, but their intensity varies from time to time and across the region.

In Southeast Australia, bushfires appear to be most frequent and extreme in summer and autumn (December–March), drought years, and especially severe in El Nino years. Southeast Australia is a fire-prone country, and warm and dry conditions increase the likelihood of fire.

Southeast Australia is a fire-prone country, and warm and dry conditions increase the likelihood of fire. In northern Australia, bush fire usually occurs during the dry season (April to September) and fire severity tends to be more associated with seasonal weather patterns. Likewise, bush fire occurs in the southwest during the summer dry season, and the intensity

is usually associated with seasonal development. Fire occurrence in the north is difficult to assess, as the vast majority of fires are caused by human activity, but lightning strikes are as frequent as human-ignited fires and arson.

## **5. Impact on Wildlife:**

Animals are killed by these forest-fires and are destroyers of local ecosystems, rendering residents helpless even after the fires have passed. It has been estimated that more than eight hundred million animals were dead in NSW and around one billion in the first 3 months of the 2019-2020 forest fires. This is a count of reptiles, birds and mammals. A lot were burned to death, and a lot later died because of unavailability of shelter and food or got preyed by other large animals. Australia has the highest rate of biodiversity extinction than any other country of the world, thus the extinction of endangered species of kangaroo island has risen concern for many scientists. Koalas are most vulnerable since they move slowly but in serious fires, they climb up a tree and curl into a ball. It has been reported in January 2020 that fifty percent of total koalas on the Kangaroo Island in the Southern coast of Australia, that have been kept separate from the one on the mainland to ensure the species in case there is a danger to the species in case of a fire outbreak. Ecologist Professor Euan Ritchie of says that frogs and skinks vulnerable since fire breaks destroyed their habitats. Loss of habitat also has impact on endangered species which are the Lead beater's possum, the Mallee emu-wren western ground parrot and Gilbert's potoroo. Beekeepers also lost urchins in the bushfires. Kangaroos and wallabies will run quickly to try and avoid the flames. However, the Guardian reported in January 2020 that dozens, perhaps hundreds, of kangaroos "lost in their flocks" as they tried to outburst the flames near Batlow in the NSW. The most robust species are those that may burrow or float. Possums are often sung, but can sometimes hide in the hollows of a tree. Wombats and snakes have a propensity to go underground. Goannas can actually take advantage of the bushfires. "In Central Australia, goannas have been seen coming out of their burrows after a fire and collecting injured birds, young birds, small mammals, surface lizards and snakes." It is widely reported that almost half a billion (480 million) species have been destroyed by bush fires in Australia.

## **6. Impact on Humans:**

The most devastating impact on humanity is that more than 800 people have been killed by bushfires since 1851. With loss of life, houses, property, animals are potentially lost, thus people are homeless, traumatized and no access of electricity, infrastructure and, even drinking water.

## **7. Health:**

Bushfires lead to particulate matter which are pollution-airborne particles and are small to penetrate and create damage to tissues of human lung. After the 2014 Hazelwood fire, Fay Johnston, associate professor of public health at the for Medical Research, claims that young children exposed to smoke experience improvements in their lung function as babies, toddlers

or in the womb. Babies which were not born babies and exposed towards Hazelwood smoke had cough and cold even 2-4 years after the fire. Due to pollution caused by these fires, there was an increment in the respiratory based diseases in adults. As a result of intense smoke and air pollution caused by fires [7], In Canberra the worst air quality index was measured. Orange smoke got through homes and offices in country, rendering the process of breathing very difficult, forcing businesses and organizations to close their doors. Studies show that inhabitants of heavily polluted cities are also at elevated risk of heart attack, stroke and diabetes. The Centre for Air Pollution, Energy and Health Policy Research says: "There is increasing evidence of air pollution and neurological conditions, such as Parkinson's disease and Alzheimer's." It's pretty much a third of the Australian population that has been impacted, with prolonged, episodic exposure and sometimes extreme health impacts." Since 2019 September, more than 3,000 firefighters have been crashed every day in battling blazes [8].

## **8. Psychological Problems:**

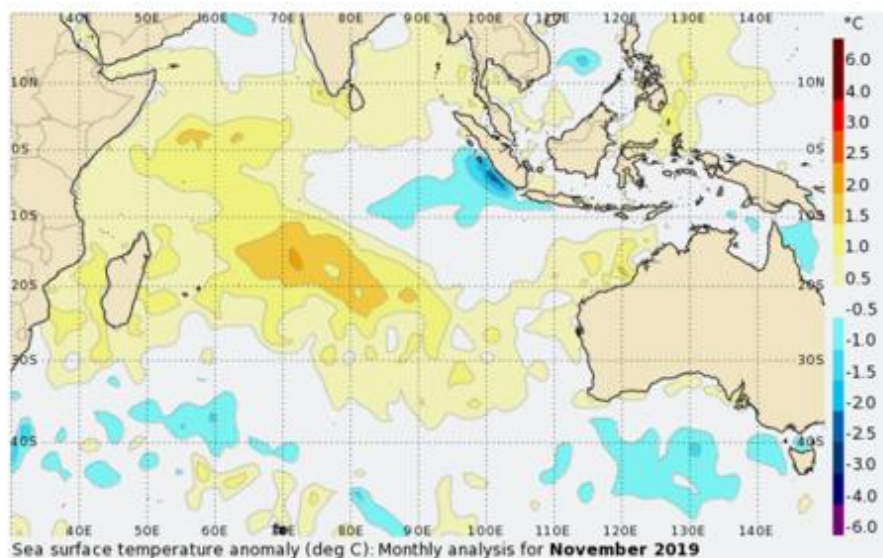
These problems after a big bushfire arise when people get a chance of relaxing and reflecting on what they have gone through. In study of one thousand five hundred and twenty-six sufferers of the Ash Wednesday said that beyond twelve months, more than half had this problem.

The 2016 Yalooop fire in Western Australia is a typical example of how people are affected. It virtually destroyed the town (population 395) including 180 homes, historic wood mills, warehouses, an old church, an old hospital, stores, a hotel, a fire station and a portion of school. Two people were killed. Infrastructure damage included the Samson Brook Bridge, the Salmon River Bridge and the energy grid supplying thousands of homes in the area. Two years later, locals are still recouping from fire injuries. Apart from economic losses of the sufferers who lived there, the movement of their lives was so great that in the community [9] were uncertain as to whether they were living there.

## **Official Inquiries**

Economic damage from the fires of 2009 Black Saturday, was the costliest history, was around 4.4 billion dollars. Moody's Analytics estimates 2019-2020 bushfire's cost is likely to go beyond that figure, undermining confidence of consumer and destroying agriculture, tourism and other industries. Existing fire and smoke haze bills are expected to reach millions of dollars, having a study that estimated that fire and smoke haze disturbances could cost Sydney as much as A\$ 50 million a day. The Insurance Council of Australia estimates that claims for damage from the fires would be more than a \$700 million, with claims expected to jump when more fire-hit areas become accessible. In January 2020, the ANZ gauge of consumer confidence fell last week to its lowest level in more than four years. In January 2020, in the midst of the 2019-2020 bushfire season, Prime Minister Scott Morrison raised the prospect of setting up another royal commission after many big bushfires [5], state and federal governments in Australia launched hearings to see what could be done to address the

issues. Morrison told the Australian Broadcasting Corporation (ABC) that any research into the crisis would need to be thorough and to address changes in climate as well as other possible causes. First of all, the long-term background. Last year was Australia's hottest and driest year, extending the drought. Like the rest of the world, Australia's temperatures are rising to ever-higher levels as the atmosphere warms, increasing evaporation and worsening droughts in circumstances like this. Rainfall trends are less clear, but declines have been partly attributed to changes in climate. In addition to the long-term warming trend, a number of factors have been responsible. Although Australia's climate is closely linked to the Southern Oscillation of El Niño in the Pacific Ocean, it has been in a neutral state. Nevertheless, there is another similar oscillation in the Indian Ocean called the Indian Ocean Dipole [10], which has been in a very positive period recently. It indicates that the waters in the western Indian Ocean were warmer than average, with cooler temperatures to the east. This has the effect of driving rainy weather away from Australia. Figure 2 represents Indian Ocean surface temperatures above and below average in November 2019.



**Fig.2: Indian Ocean surface temperatures above and below average in November 2019.**

And in the last few months, an unprecedented trend in the Antarctic stratospheric has disrupted the pole-circling winds. This has also helped to generate clear skies in Australia, as well as heavy westerly winds blowing dry air over Victoria and New South Wales stoking the fires. On Saturday, a cold front crossed southeastern Australia and entered the Sydney area in the evening. That may sound like a welcome warning, but at the end of a very hot day the temperatures outside Sydney were as high as 48.9 ° C (120 ° F) with strong winds. Winds have moved from west to south, moving the fires in a different direction. The good news is that the Indian Ocean Dipole has settled into a neutral state over the past week, paving the way for Australia's monsoon season to begin in the northern part of the country. Some areas in the south are set to see some rain soon, too. That may help, but the fire conditions in the forecast have not yet ended.

## **Factors leading to Bushfires**

Necessary condition for occurrence of bush fire are discussed in detail below [11]:

### **1. Load's fuel:**

Fuel load defines the bark's volume, litter produced by leaves and tiny branches that accumulate on the land. More the load of the fuel, the more intense and the more power packed the explosion. Fuel, is concentrated but not compacted, burns at a faster rate than the one which is compacted or dispersed sources. Tiny fuel, example twigs, litter of leaves and branches have a faster rate of burning. Bigger fuels, such as trunks, frequently burn at a slower rate.

### **2. Moisture of fuel:**

Fuel which is dry burns quickly, but the one which is wet or damp burn at a negligible rate. Thus, time of rainfall and the amount determines the severity of the bushfire. The quantity of the factor of dryness or moisture is the criteria of weather conditions.

### **3. Speed of Wind:**

Wind blows flames towards fresh fuel, thus it is set to combustion and also wind supplies an oxygen supply that is continuous. By sighting, the spread of fire takes place rapidly. Spotting will occur till 30 km towards the down side of fire. The maximum speed of wind is from 12-15 km/hr leading to a big difference in the bushfire occurrence. There is slower burning of fires having heavier fuels when speed of wind is slower. If there is a little increase in this level, fire burns rapidly. The rate is also determined by width of fire's front.

### **4. Surrounding's Temperature:**

Fire will start or continue when temperature is higher because fuel is at the near point of its ignition point.

### **5. Humidity:**

Air which is dry encourages higher strength than air which is moist. At lower humidity, plants are more burnable because of their transpiration property.

### **6. Angle of the slope:**

The fuel sources are heated by fire through convection and radiation. Thus when going uphill flame will increase and while going downhill it will slowdown. The fire rate is determined by the angle of the slope. If there is an increase of ten degrees in the slope, fire's forward speed will double from its original value.



## **7. Source of ignition:**

The origination of bushfires is from activities of humans as well as natural reasons and lightning is a major factor in that. Fires leading due to humans are coined as accidental. Some fires are lit purposefully to get a beneficial output but might lead to uncalled outbreaks. The fires which occur accidentally are mostly occurring in populous and dense areas thus having higher risk in damage to infrastructure.

### **Where Do Bushfires Occur?**

The climate of Australian is dry, hot and prone to drought. Some parts are prone to forest-fires throughout the year. Different patterns are a function of different seasons. The most danger period for southern part of Australia is and autumn, summer. In New South Wales and Southern Queensland, peak fires occur in the spring and early summer. In Northern part most of its fire is cockering in winter ,spring. After rainfall, fires occur in grassland with high frequency and this leads to a high growth and this dries out in summer. These also arise if heavy and light fuel loads are created which tends to arise after short durations if rainfalls. A large loss is expected when extreme fire expected weather is experienced near to populated area. If we talk about the area burnt in a fire, maximum one is in northern territory, Queensland and north part of western Australia. The damage to economy and life occurs in the edges of city and homes or in vicinity of burnable vegetation.

### **What is geoscience Australia's role in reducing risk from bushfire?**

Geoscience Australia has been committed to supporting ability of Australia to manage effects of natural dangers, including bushfires. Australia Geoscience:

- Developing a comprehension of natural dangers and exposure of community in supporting risk alleviation and community flexibility.
- Provides reliable, independent data and advice and other stakeholders to support risk alleviation and community resilience.
- Improves and maintains systems for preparing itself for disaster, recovery and response.
- Hand out to the international development program of Australia.
- Geoscience Australia supports the capacity of emergency managers to respond to and plan for bushfires, by giving information of information to inform managers and the public about the locations of forest-fire. It is also developing datasets and tools to mock-up the potential impact of the bushfire. Geoscience Australia in particular.
- Delivers the Digital Earth Australia Hotspots website that provides national situational awareness [12] for active bushfires and a historical archive on bushfire hotspots.

- Supports Emergency Management Australia to understand what is exposed to bushfires before, during and after events.
- Develops and maintains fundamental datasets such as elevation, land cover and wind multiplier factors that help to evaluate the local influences on the speed of the fire front.
- Develops tools to evaluate and map potential exposure of buildings to bushfire, informing construction requirements and land-use planning.

## **Conclusion**

The major vegetation species currently at severe fire risk are temperate eucalyptus forests, Mediterranean ecosystems, restricted mountain ecosystems, tropical savannahs and dry rainforests. Such processes are therefore particularly at risk of increasing the frequency of wild fires in response to changes in climate. In addition, different ecosystems can recover at different rates as a result of fire events. As a result, these habitats will be differently examined and affected by the rising fires and their frequency which is increasing. For example, larger trees are at a risk and will not be able to go pas through a frequent fire. In addition, it is better to have to have individual native reserves even for same category of ecosystem, to minimize fire risk when compared to the ecosystem in single reserve, the frequency of fire changes with zones of climate-vegetation, since an integrated approach is best for management of fire, across both national and regional boundaries. Major risks of changes in climate, due to increased fire frequency and duration of the fire season, include; reduced variability in vegetation structure due to the selection of particular fire-resistant species; and, conversely, the decline and extinction of other populations. In some cases, there may also be an increase in fire severity. It is proposed to help maintain variability in vegetation structures in landscapes facing more frequent major wildfire events. While calculating the effect of climate changes on the risks of forest-fire in some ecosystem types occurred, it is advised that future research should have designing of all ecosystem types that are at risk currently, as different systems will react differently to separate conditions. This would create an integrated view management of natural resources across Australia, partially in promote centralized administration across national and regional boundaries.

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