

# Causes of Big Bushfires in Australia: Higher Temperatures and Rainfall or More Fuel?

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## Abstract

The 2019-2020 bushfires in Australia caused the loss of 34 lives and an estimated 100 bn AU\$ damage. This has sharpened the apparent division between Australians who believe that the increasing number of bushfires is due to climate change, and those who suggest that fuel loads must be managed more carefully. Bushfires whose area equals or exceeds 1 mHa have been analysed in this paper. The results show that the number, duration, and size have increased over the period 1850-2020, but that since 1953, there has been a downward trend in the number of big bushfires. There is a range of temperatures of about 20°C that are associated with the fires, with a modal temperature of 30°C - 32.5°C. Using an analysis of the maximum temperatures for the period 1970-2020 as a standard for comparison with bushfires for the period 1850-2020, shows that during bushfire events the standardised temperatures have a downward trend. This is most clearly shown by the application of the Fisher Exact Test. This suggests that the fuel load in forests is a key factor for bushfires. The role of pre-bushfire rainfall shows a rapid rise in the area burnt when the rainfall exceeds 150 mm month<sup>-1</sup> which would lead to more plant growth and hence fuel load. The role of traditional burning over the whole of Australia is described based on documentary evidence. A tentative cost benefit analysis has shown that a comprehensive program of wildfire management is cost effective. The recommendations of previous research, National Inquiries and more recent management practices, have all failed to prevent the 2019-20 fire disaster in Australia.

## Keywords

Bushfires, Standardised Temperatures, Fishers Exact Test, Native Burning

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## 1. Introduction: A Dilemma for Australia

When the first English and Dutch explorers reached Australia in the late 17<sup>th</sup> and

18<sup>th</sup> century they were struck by the openness of the landscape, consistently describing it as a gentleman's park (Gammage, 2011). But the appearance of the "gentlemen" who created the attractive areas of grassland with open woodland parks gave the explorers a shock, and for over 200 years the first Australians were regarded as savage and ignorant: how could they have created such a beautiful landscape whilst having a primitive way of life as judged by European standards? Some early settlers did however appreciate their skilled use of fire (Bunbury & Morrell, 1930), but with the imposition of a European style of farming the role of fire in the national ecology and conservation was largely forgotten. Within a few decades large uncontrolled fires took place (Pyne, 1991), some of which resulted in vast destruction of property and the loss of about 800 lives over the next 150 years (Ellis, Kanowske, & Whelan, 2004). During the latter part of the 20<sup>th</sup> century concern had been widely raised about rising temperatures and the prediction of higher temperatures in the future. The result is that climate change is considered to be the main cause of bushfires in Australia and elsewhere (Bradstock et al., 2009; Lucas et al., 2007; Lucas, 2010; Climate Council, 2017, 2019; Keeley & Sypard, 2016; Harris et al., 2020). These studies fail to consider the whole record of serious bushfires with an area in excess of 1 M Ha, and the rainfall leading up to and during the events. Foresters take a more pragmatic view especially following the 1939 fire in Victoria (Ellis, Kanowski, & Whelan, 2004; Morgan et al., 2020). The latter authors highlight that since 1939 there have been over 50 public inquiries and reports yet devastating fires still take place. With the rise of environmentalism a negative perception of fire management has arisen with the view that "nature knows best" (Attiwill & Adams, 2013). This ignores over 30,000 years of landscape management that so impressed the first explorers (Gammage, 2011).

This paper seeks to resolve the dilemma by first describing the fire regime and history of big bushfires in Australia since 1850, including their number, duration and size. Second, an analysis is made of the temperatures during the bushfire events in order to detect the likely effect of climate change. Third the influence of pre-bushfire rainfall is analysed. Fourth, the qualitative evidence from early paintings and descriptions of the landscape are considered, especially in the light of a growing acceptance that some burning may be of benefit to the ecology and public safety. Fifth, a tentative cost benefit analysis is presented which may help to guide future policy. Finally, the discussion will acknowledge that conservation and preservation are mutually exclusive in a continent that has been described as Fire's lucky country (Pyne, 1991).

## 2. Data Sources

The main source of bushfire history is the Report of the Inquiry into the 2004 bushfires (Ellis, Kannowski, & Whelan, 2004). The bushfire of 2007 is fully described by Smith (2007) while details of the fire of 2019-2020 were obtained from press reports. The Australian Bureau of Meteorology (BoM) provided temperature

and rainfall data which can be downloaded from their website [www.Bom.gov.au](http://www.Bom.gov.au). Further data for the 1851 event were obtained from Ashcroft et al. (2014). All of this data has undergone quality control. However, very few sites have long term records that go back before 1950. **Figure 1** shows the location of the sites used in this study and their location is given in **Table 1**.



**Figure 1.** Location of the climatic stations.

**Table 1.** Location of the climate stations used in this study.

	Lon	Lat		Lon	Lat
Kerang VIC	143.92	-35.72	East Sale VIC	147.13	-38.12
Tennant Creek NT	134.18	-19.64	Maryborough VIC	143.73	-37.06
Noirtham WA	116.66	-31.65	Cape Otway VIC	143.51	-38.86
Menindee NSW	142.42	-32.39	Laverton RAF VIC	144.76	-37.86
Bathurst NSW	149.56	-33.43	Lake Eildon VIC	145.91	-37.23
Kyancutta SA	135.55	-33.13	Echuca VIC	144.76	-36.16
Cobar NSW	145.83	-31.48	Charleville QLD	146.26	-26.41
Maryborough QLD	152.72	-25.51	Gladstone radar QLD	151.26	-23.86
Sydney NSW	151.21	-33.86	Hughenden QLD	144.23	-20.85
Bridgetown WA	116.13	-33.95	Boulia Airport QLD	139.90	-22.91
Narogin WA	117.18	-32.93	Burketown QLD	139.55	-17.74
Adelaide SA	138.58	-34.93	Victoria R. Downs NT	132.97	-25.99
Richmond QLD	143.14	-20.73	Alice Springs NT	133.87	-23.71
Rotherglenn Res VIC	146.51	-36.10	Cunnamulla PO QLD	145.68	-28.07
Dwellingup WA	116.06	-32.71	Gunnedah Res. NSW	150.27	-31.03
Corrigin WA	117.87	-32.33	Kalgoorlie Boulder WA	121.45	-30.78
Cleve SA	136.49	-33.70	Katherine Council NT	132.26	-14.46
Yongala SA	138.76	-33.03	Quilpie Aero QLD	144.26	-26.61
Ballarat Aero VIC	143.79	-37.51	Wagga Wagga NSW	147.46	-35.16
Darwin NT	130.89	-12.42	Yamba Pilot NSW	153.36	-29.43
Brunette Downs NT	135.95	-18.64	Esperance WA	121.89	-33.83
Newcastle Sig.S.. NSW	151.80	-32.92	Halls Creek WA	127.66	-18.23
Taralga NSW	149.82	-34.40	Barrow Creek NT	133.89	-21.53
Bungaree VIC	143.93	-37.55			

### 3. Bushfire Regime and History

Bushfires are an integral part of the Australian environment (Cheney, 1995) and ecology (Russell-Smith, Whitehead, & Cooke, 2009). Australia is located over nearly 30° of latitude from 11°S - 39°S excluding Tasmania. Generally speaking the fire season starts during the late autumn to winter in the north and spreads southwards to affect Queensland in the spring and summer and then the south and west of Australia in the summer and autumn. A large number of causes have been put forward (Linacre & Hobbs, 1977), the chief ones being high temperatures, illegal burning of unwanted vegetation, deliberate action, lightning, and careless action of campers and others. These causes tend to lead to moderate sized fires, whereas this paper has its focus on those 1 MHa and above. This is because they can cause the most damage and have a reasonable chance of being associated with the major and therefore most important causes. However, there is a growing body of knowledge that places more importance on the fuel load of forests which has increased since the early European settlers went to Australia (Abbott & Burrows, 2003; Burrows & McCaw, 2013; Lullfitz et al., 2017; Morgan et al., 2020).

A total of 29 separate events since 1850 have been identified **Table 2**. Those of 1974, 2002, 2003, and 2020 are multiple events and so have been analysed either as a combined event taking into account their temporal dependency, or as spatially independent events.

### 4. Changes in Bushfire Number, Size, and Duration

**Figure 2** shows the changes in bushfire number the data for which has been binned into 10 groups of 17 years, since in many years there are no big bushfires. This gives fewer degrees of freedom but is more robust because of the use of binned data (Hoaglin, Mosteller, & Tukey, 1983). For the whole period there is a significant upward trend. Before 1939 there were only two big bushfires. After 1953 there is a significant downward trend in the number of fires.

**Figure 3** shows the changes in the area burnt from 1851-2020. The large number of relatively small fires is dwarfed by those in 1969, 1974 and 2002, so a trend analysis of both binned and discrete data show an excessively steep trend:  $Y = 0.4062T - 765.9055$  sig. 5%;  $Y = 0.3471T - 647.3829$  not sig. 5% respectively.

The changes in the duration of the fires is shown in **Figure 4** where the data for 19 independent events are shown, the median duration being used for 1974 and 2020 and the average duration for 2002 and 2003. There is an increase of duration from about 50 days in the first half of the 20<sup>th</sup> century to more than 100 days in the 21<sup>st</sup> century.

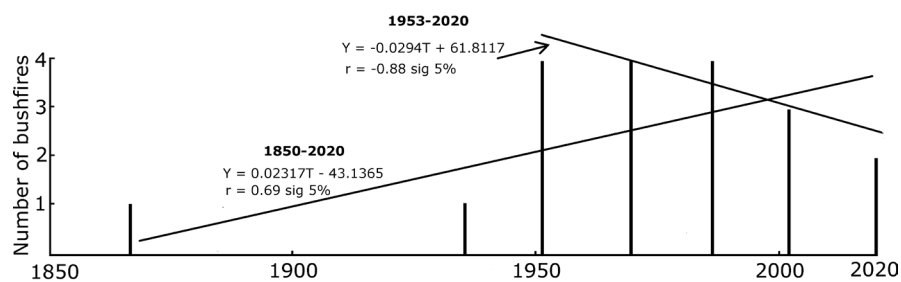
### 5. The Influence of Temperature and Rainfall

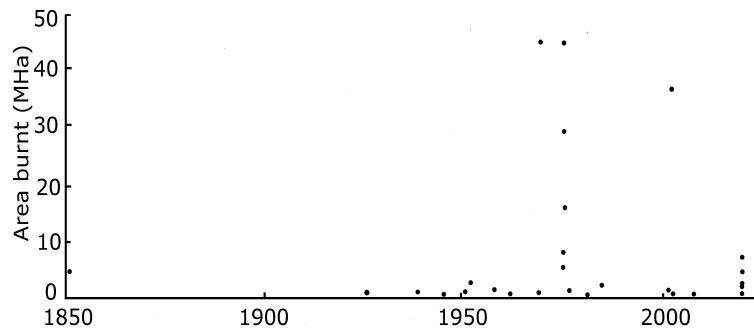
The fact that fires take place at different times of the year across Australia means that identifying the effect of temperature is not straightforward. The frequency distribution of the mean maximum temperature during the bushfires is shown in **Figure 5**.

**Table 2.** Bushfires 1 MHa or greater 1851-2020.

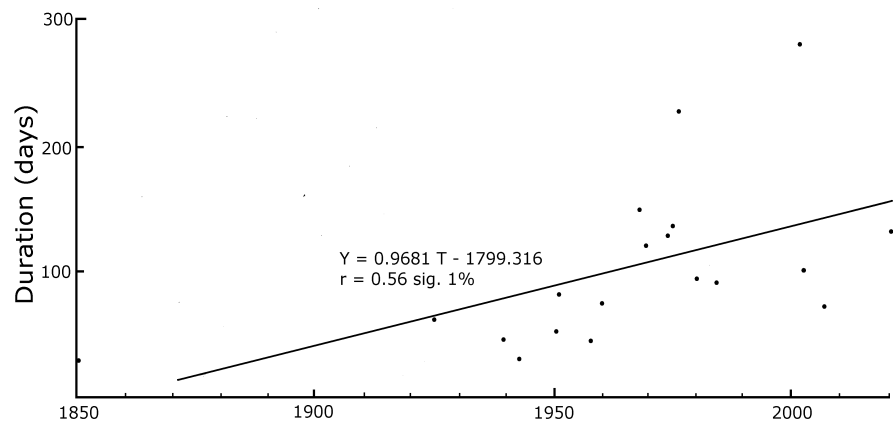
Year	State	Mean maximum temperature	Area burnt MHa	Median Z score	Estimated duration (days)
1851	VIC	31.3	5.0	1.63	30
1926	NSW	26.9	>2.0	1.33	60
1939	VIC	32.4	1.52	1.81	45
1944	VIC	30.9	1	0.88	30
1951	QLD	35.2	2.83	0.17	60
1952	VIC	33.1	>4.0	0.82	80
1957	NSW	25.7	>2.0	1.53	45
1961	WA	30.7	1.5	0.90	75
1968	NSW	21.9	>2.0	0.84	150
1969	NT	37.7	45	0.83	120
1974	QLD	35.0	7.3	-0.55	140
1974	NSW	24.1	4.5	-0.51	140
1974	SA	26.7	16	-0.58	120
1974	NT	34.4	45	-0.76	150
1974	WA	30.2	29	-0.50	140
1974	Nation	30.2	101.8	-0.55	-
1976	QLD	31.1	1.89	0.30	230
1980	NSW	30.0	>1	0.94	90
1985	NSW	33.7	3.5	0.25	90
2001	QLD	31.1	1.6	-0.02	120
2002	NT	33.3	38	0.39	285
2002	NSW	24.7	1.46	0.84	220
2003	VIC	29.8	1.1	0.36	80
2003	WA	31.1	2.1	0.14	120
2007	VIC	30.3	1.1	1.12	69
2020	NSW	25.0	5.4	1.28	215
2020	NT	35.7	6.8	1.19	185
2020	VIC	30.9	1.5	0.30	125
2020	WA	31.7	2.2	0.88	130
2020	QLD	33.7	2.5	0.71	125
2020	Nation	31.7	18.4	0.88	-

NB. For 2002 and 2003 the median temperature and Z score are equal to the average.

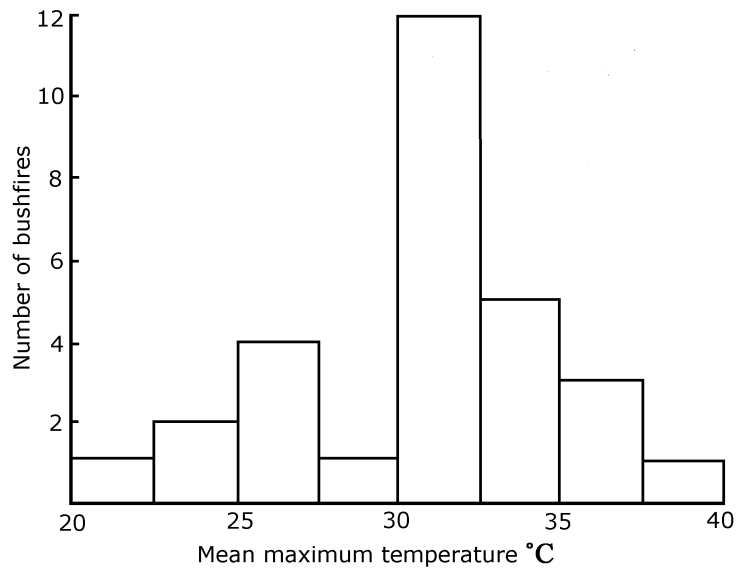
**Figure 2.** Changes in the number of big bushfires based on 17 year totals.



**Figure 3.** Changes in the area burnt during big bushfires.



**Figure 4.** Changes in the duration of big bushfires since 1850.



**Figure 5.** Frequency distribution of mean maximum temperature during big bushfires.

There is a range of nearly 20°C in temperature that is associated with big bushfires. The modal value is 30°C - 32.5°C, above which the frequency declines rapidly. The likely effect of temperature on the area burnt is shown in **Figure 6** where the envelope curve is well described by a logistic fit to the data.

The biggest three events took place in the Northern Territory and which also

has the highest mean maximum temperatures. The group of events which have high temperatures but are well below the envelope curve took place in the other five States.

Since there is a wide variety of temperature associated with bushfires, in order to compare any changes in temperature that may have affected their occurrence it is necessary to standardise the temperature during each event. This is achieved by calculating Z scores for each event. This will be based on stations which are in the same area as the fire, where the standardised temperature:

$$Z \text{ score} = (\text{variate} - \text{mean}) / \sigma$$

where  $\sigma$  = standard deviation. If this process is not carried out then any trend in temperature could be strongly affected by the temporal distribution of the events. For example a small cluster of fires in the Northern Territories will have higher temperatures than a fire taking place in Western or Southern Australia. This would lead to the spurious conclusion that temperatures are getting hotter or cooler if they took place near the end or start of the study period. A further point is that the period of record for calculating average temperature may need to be longer than the standard WMO (2007) 30 year time period when the events under study are themselves rare, such as in an analysis of severe hailstorms (Clark, 2020). In the present study the period used to calculate the average temperatures at each site was 1970-2020. There are 19 independent events. Figure 7 shows that there is a significant downward trend in the standardised

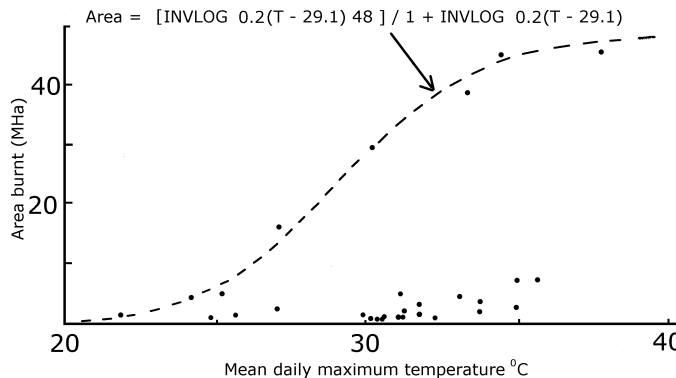


Figure 6. Relationship between mean daily maximum temperature and the area burnt.

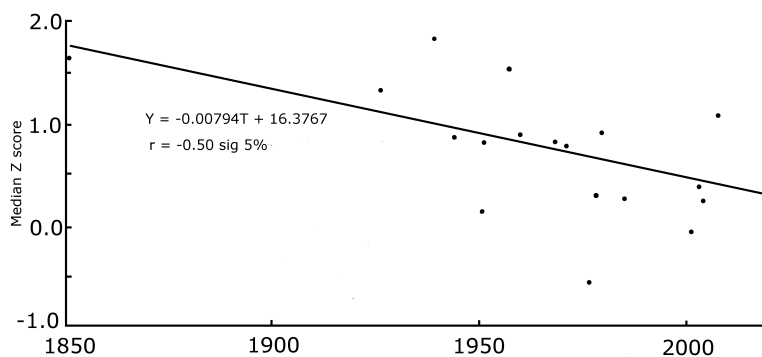


Figure 7. Changes in Z scores for big fires since 1850.

mean maximum temperature for the bushfires over the whole study period. Using the actual temperatures, the result not shown here, shows no correlation.

The downward trend in Z scores is further investigated in this case using the Fisher Exact Test. This uses the frequency of occurrence of two independent samples that fall into one of two mutually exclusive classes (Siegel, 1956), and has been in use in a wide variety of situations from medicine (Riffenburgh, 2005), biology (van Nood et al., 2013) and geology (Butler et al., 2010). The method calculates the probability that the two samples are different, in this case a decline in the Z value. This means the null hypothesis is in one direction and is therefore a one tailed test. The sample of bushfires is divided into the periods 1850-1970 and 1971-2020. The frequencies of Z scores of +0.8 or less than 0.8 is determined directly from the data. The null hypothesis is that there is no significant difference between the Z scores of the first and second time periods. The Fisher exact Test is calculated:

$$F = \text{row} \times \text{column factorials} / \text{cell} \times \text{grand total factorials}$$

For all fire events:

	Z > 0.8	<0.8	Total
1850-1970	9	1	10
1971-2020	6	13	19
Total	15	14	29 (Grand total)

$$F = (10! 19! 15! 14!) / (9! 1! 6! 13! 29!)$$

$$F = 0.00349$$

The probability of a more extreme situation is calculated viz:

	Z >0.8	<0.8	Total
1950-1970	10	0	10
1971-2020	5	14	19
Total	15	14	29

$$F = (10! 19! 15! 14!) / (10! 0! 5! 14! 29!)$$

$$F = 0.000149$$

$$\text{The total probability} = 0.00349 + 0.000149 = 0.0036$$

The null hypothesis is rejected at the 0.4% level.

The test was performed again under different criteria:

	Z Threshold	
	0.8	0.7
Spatially independent fires n = 25	0.016	0.007
Spatially and temporally independent events n = 19	0.009	0.017

All these results are significant well below the 5% probability level. This shows even more clearly that the Z scores in the first time period are different (higher) than in the second time period.

Rainfall preceding a fire may have a significant effect on the size and duration of a fire. This was noted by Pyne (1991) for the 1974 bushfires in Northern Territory, following considerable rainfall during late winter and spring. A total of 24 spatially independent events were assessed for their antecedent rainfall. This



rainfall took place over different time periods so the average rainfall per month was chosen as the explanatory variable and then related to the area burnt. **Figure 8** shows the result wherein a logistic curve best describes the data shown.

A maximum burnt area of 50 MHa was assumed in the analysis. For events that have rainfall less than 125 mm per month the area burnt is restricted to less than 10 MHa.

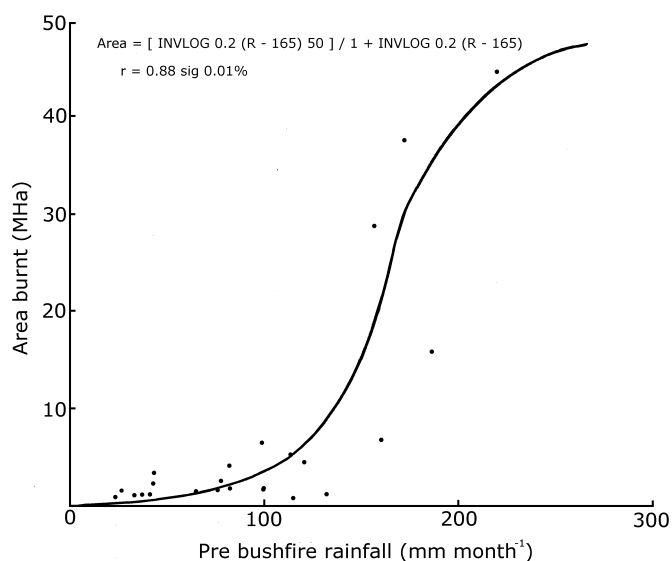
## 6. Fuel Load and Big Bushfires

The importance of reducing the quantity of combustible material to help prevent fires is no where better stated than by the Health and Safety Executive in the UK: [www.hse.gov.uk/construction/safetytopics/processfire.htm](http://www.hse.gov.uk/construction/safetytopics/processfire.htm)

“the quantity of combustible materials on site should be kept to the minimum and all such materials safely stored and used”

Given that big bushfires have caused so much death and destruction in modern day Australia it is legitimate to ask the question how the oldest civilisation in the world (Malaspina et al., 2016) managed the problem of fire in the biggest single nation island in the world? Although the native population of Australia has probably been there for at least 40,000 years, no written records have so far been found that describe the bushfire situation before the arrival of Europeans in the 18<sup>th</sup> century. After arrival in eastern Australia, Captain Cook on 1<sup>st</sup> May 1770 wrote in his journal:

“we made an Excursion into the Country, which we found diversified with Woods, Lawns, and Marsh. The woods are free from underwood of every kind, and the trees are at such a distance from one another that the whole Country, or at least greater part of it, might be Cultivated without being obliged to cut down a single tree.”



**Figure 8.** Relationship between pre-bushfire rainfall and the subsequent area burnt.

Time and again the journals of Dawson (1830), Haydon (1846), Mossman & Bannister (1853), and others wrote of the “park like” scenery, “truly beautiful: studded with single trees, as if planted for ornament” (Dawson, 1830).

Even more telling are the observations made by Henry Bunbury. The manuscript extract shown in **Figure 9** speaks for itself.

If these writings were not enough evidence of the way in which the native people managed the land, the paintings of 13 independent artists between 1770 and 1872 and reproduced in Gammage (2011) confirm the park like appearance and the way in which the natural resources of the land are being harvested for food. Perhaps the best known of these is the painting by Joseph Lycett, an artist turned forger and then on parole as an official artist. This is reproduced here as **Figure 10**.

*labor & cost of clearing would be so greatly increased as to take away all the profits, & it would change the very nature of the country by depriving it of the grazing & pastoral advantages it now possesses. This has been already proved in the case of Van Diemens land, where in consequence of the transportation of the natives to Great or Flinders Island & the consequent absence of extensive periodical fires the bush has grown up thick to a most incalculable degree, spoiled the sheep runs & open pastures & afforded harbor to snakes & other reptiles which are becoming yearly more numerous. It is true we might ourselves burn the Bush but we could never do it with the judgment & the same good effect that the natives do, who keep the fire within due bounds, only burning those parts they wish when the scrub becomes too thick or they have any other object to gain by it. Upon the burnt ground they can easily track the Opusians Kangaroo Rats, & the diabolical Iguanas, snakes &c which can elude their search in the thick scrub which moreover is very painful to walk through, being*

**Figure 9.** Extract from the Journal of Henry Bunbury in 1849. The writer remarks that since the native population had been taken away from their land the bush vegetation had grown up with a change in the animal life, and comments about their skilful use of fire.



**Figure 10.** A native hunting scene painted by Joseph Lycett circa 1820. Copyright National Library of Australia.

It shows the presence of open grassland as a result of clearing part of the forest; the use of fire to move kangaroos out of hiding, and the natives hunting them for food. Since the civilisation has lasted over 30,000 years it is very unlikely that they have over exploited the land.

More recently considerable interest has been taken in native fire activity (Jones, 1969; Kimber, 1983; Preece, 2002; Abbott, 2003; McCaw et al., 2005; Burrows et al., 2006; Bird et al., 2009; Boer et al., 2009; Gammage, 2011; Burrows & McCaw, 2013; Lullifitz et al., 2017). In particular to use indigenous knowledge for better management (Ansell et al., 2020). There is now greater recognition that this knowledge, which had been gathered over many thousands of years, is invaluable for the reduction in wildfires, and could also be used to enhance landscape value and ecology (Russell-Smith et al., 2009, 2020).

## 7. Cost Benefit Analysis for Big Bushfires

Although cost benefit analysis has a long history when it comes to the assessment of bushfires there is still much disagreement about methodology (Ladds et al., 2017), and with the effects on ecosystems and tourism not included in the thesis by Florec (2016), there is considerable scope for improvement. In 2018 tourism was valued at just under 150 bn AU\$ (Tourism Research Australia, 2019), and following the 2019-2020 bushfires the Government has pledged 4.5 bn AU\$ to help the industry by the end of 2020

<https://www.abc.net.au/news/2020-01-19/federal-government-announces-bushfire-recovery-tourism-package>. After the 2009 bushfire tourism declined by about 12% based on long term arrivals into the country. One of the chief effects of bushfires is that of smoke inhalation (Johnston et al., 2002; Yu et al., 2020). The same concerns relate to prescribed burning (Ravi et al., 2019). The present study has not included the smaller bushfires, some of which like the Black Friday 2009 event caused losses estimated at 11.8 bn AU\$ (Ladds et al., 2017). This estimate did not include loss of ecosystem value or long term health effects.

The 2019-2020 bushfires in Australia are the most serious in recent decades and the estimated costs, both tangible and intangible may be around 100bn AU\$ <https://theconversation.com/with-costs-approaching-100-billion-the-fires-are-australias-costliest-national-disaster> although no detailed analysis has yet been published.

In a national assessment of the cost and benefits of fires in Australia, Ashe et al. (2010) estimated, at 2005 prices that the total cost of fire fighting was 11,990 MAU\$, with losses totalling 1755 M AU\$. In view of this unfavourable result a brief estimate of the cost of reducing the fuel load is now presented.

**Table 2** shows that there have been 27 big bushfires in about 80 years. Thus the annual frequency is 0.33 fires per year. If the true cost of the damage during one of these fires is 100 bn AU\$ then the annual cost is  $0.33 \times 100 = 33$  bnAU\$. Allowing for some overestimate this could be reduced to 30 bnAU\$. If a forest worker has a 35 hour week and is paid 15 AU\$ per hour then the annual cost in

wages alone for a two man team would be  $35 \times 52 \times 15 \times 2 = 54,600$  AU\$. With a potential benefit of 30 bnAU\$ per year a cost of 54,600 AU\$ would pay for 549,000 two men teams. If on average they were able to clear 1Ha per week then in a year about 27.4 MHa would be maintained. If a firebreak 200 m wide and 1 km long for each km<sup>2</sup> were produced by clearing and later maintained by controlled burning, then in a year an area of 0.686 Mkm<sup>2</sup> would be covered. If continued for 11 years this would result in the whole of mainland Australia being treated. However, the area covered by all forests and woodlands is about 4.16 Mkm<sup>2</sup> (Department of Environment and water resources, 2007) thereby reducing the time to just over six years. If the cost of damage was reduced to 20 bn AU\$ year<sup>-1</sup> the completion time would increase to nine years. The position of new firebreaks could be carried out by experiment, with due regard to topographic, hydrological and edaphic factors taken into account with the aim of producing the kind of mosaic of habitats that was described by Bowman (2003). The felled timber could be sold for a variety of purposes (FAO, 2009) and not necessarily burnt on site.

This analysis does not take into account the damage caused by smaller fires. The most tragic was Black Saturday in Victoria in 2009 when 173 people were killed. A more comprehensive study is called for, which will include the cost of the potential rise in prevalence of chronic diseases due to air, land and water pollution, leading to increased mortality (Yu et al., 2020).

## 8. Discussion

The historic record of big bushfires shows that during the 19<sup>th</sup> century only one was recorded. It is unlikely that others have been missed. During the 20<sup>th</sup> century the number and size of bushfires increased and it has been logical to suggest that rising temperatures have been the cause (Climate Council, 2019; Keeley & Sypard, 2016), and by Dutta et al. (2014) where the data set used is only seven years long. But temperatures in excess of 40°C have occurred many times in the past, while the range of bushfire temperatures is considerable as shown in **Figure 5**. What has prevented a clearer understanding of the role of maximum temperatures on big bushfires is to neglect an analysis of the temperatures during the events. This leads to a dilemma regarding cause and effect, and fails to address the problem of fuel load since the decline of the practice of native burning. In Europe fire was seen as a menace, but in Australia many plant species depend upon fire for habitat, germination and distribution (Bowman, 1998; Bird et al., 2009). Furthermore, some struggle with the idea that humans are part of the natural environment and disagree about whether humans or the environment are at risk, and why, (Altangerel & Kull, 2013), or as Attiwill & Adams (2013) summed up the politics of bushfires, even in the presence of evidence to the contrary many still believe that “nature knows best”. But the nature they refer to excludes traditional burning which produced the landscape so admired by the early settlers.

This paper has shown that although big bushfires have increased in size, number and duration the deviation of temperature from the mean, expressed in units of standard deviation or Z scores, has declined over the past 170 years. Furthermore, that extra rainfall when it occurs before the bushfire season, can lead to bigger bushfires. Although factors such as the deliberate starting of fires plays a part, the main reason for the changes in their frequency, size and duration has been the great increase in the fuel load in most parts of Australia. The temporal distribution of rainfall complicates the picture in that it promotes plant growth and available material for burning. When followed by a prolonged period of hot weather conditions are ripe for extensive fires. When placed in a global context (Meyn et al., 2007; Bowman et al., 2014) the climate of Northern Territory, with a mean annual rainfall of around 1000 mm can be expected to have the most extensive fires, which is apparent from **Figure 8** of this paper. The continued use of fire by Aboriginal Natives was, by all accounts, so well informed that their language developed words to describe the fire situation, conditions, and purpose of the fire.

The year 2020 witnessed one of the worst fires in many parts of Australia. It is hard to understand that with the longest experience of fires in the whole world the traditional knowledge and practice of fire management, hunting, and landscape creation and maintenance has been largely ignored, with the proliferation of studies designed to find out what has been known for thousands of years. The implications of this and other studies should be quite clear: manage the land as it was for millennia or face more destructive fires in the future. In the words of Bill Gammage (2011): “If we are to survive, let alone feel at home, we must begin to understand our country. If we succeed, one day we might become Australian”.

### Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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