Causes of bushfire is Australia – A response

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Preamble

A recent video shared on Facebook (https://www.facebook.com/watch/?v=837989649986602) is symbolic of a broader meme that has emerged in political, media, and social media circles regarding the role of arson in the current bushfire season. The above clip states that: "The popular narrative is that Australia's fires are caused by climate change but the facts say otherwise". It goes onto say that "since November 8, 2019 nearly 200 arsonists have been arrested for starting brush fires in Australia". It then forwards "the arsonists were responsible for about 50% of the brushfires[1]", before concluding that it is not climate change but arsonists that are responsible for Australia recent bushfires.

The above statistic of 50% reportedly derives from an article published in "The Australian" newspaper (Ross & Reid, 2020) which states "Swinbourne University Professor James Ogloff said about 50 per cent of bushfire were lit by firebugs and impending seasons excited them." The figure he quoted reportedly came from a study a fire statistics released 12 years ago, which would imply that that the professor was not speaking about the 2019-20 season specifically. Articles similarly highlighting the role of arson have emerged in the Spectator (Chrenkoff, 2020) and Sydney Morning Herald (Rawsthorne, 2020).

However, the above narrative is countered by a recent article published by Nguyen et al. (2020) for the ABC (Australian Broadcasting Commission), which examined the cause of many of the large fires on a state-by-state basis. Ultimately they concluded that deliberate fire-setting did not play a significant role in the recent bushfires in New South Wales, Victoria, South Australia, or even Queensland. They indicated that as little as 1% of the land (approximately 5 million hectares) burned in NSW can officially be attributed to "arson", and that of the 1.2 million hectares burned in Victoria, only 385 hectares (0.03 per cent) had a fire origin that was suspicious. This interpretation is seemingly supported by statements by fire agency personnel, presumably interviewed for that story. Ben Shepherd, the acting media manager at the Rural Fire Service [agency responsible for attending fires in rural and remote NSW] was quoted as saying "I can confidently say the majority of the larger fires that we have been dealing with have been a result of fires coming out of remote areas as a result of dry lightning storms". Brett Mitchell, incident controller for the Country Fire Authority in Bairnsdale, East Gippsland, Victoria, was similarly quoted as stating that most of the fires have been caused by lightning (Nguyen et al., 2020). Fires on Kangaroo Island are similarly attributed to lightning strikes.

To my knowledge there has not been a formal, systematic, nationwide analysis of the "cause" of the 2019-20 Australia's bushfires, although Nguyen et al.'s (2020) rudimentary

[1] Note that brushfire is not a term used in Australia, and therefore this particular clip likely originated in the US.

analysis makes a start. The true picture will only likely emerge after the smoke has settled, so-to-speak, and all the investigations and data have been finalised.

The contrasting pictures painted above reflect the fact that even Australia's most recent tragic events are not immune from becoming embroiled in a partisan political discourse regarding the perceived need to, or lack thereof, to address the issue of climate change. Notably, the emergence of these different narratives will likely be seen by all to reflect the perceived biases in Australia media and politics, and ultimately will likely be interpreted through the "appropriate" lens according. Notably, The Australian newspaper is widely regarded as being supportive of conservative, more right wing politics, whilst the ABC is argued by many on the right to be supportive of the left.

Thus far (since August, 2019), I have declined to publicly comment to popular media on this subject of "bushfire arson". However, given the statistic that 50% of all bushfires in Australia are caused by "bushfire arson" reportedly derives from a paper I wrote on the causes of bushfires in Australia (Bryant, 2008a), I have in this instance responded to a request by Saranac Spencer's, a reporter from FactCheck.org, request for comment.

The following is an attempt to clarify the essence and meaning of the fire statistics presented in Bryant (2008a, b), to provide some guidance regarding the complexities involved in the interpretation of fires statistics, but also demonstrate how this out-of-date analysis of vegetation fires may yet still provide some important insights regarding the likely future fire patterns in the face of ongoing climate change.

What exactly did Bryant (2008a, b) say?

Bryant (2008a) stated that "on average across the country, approximately 13 percent of vegetation fires are recorded as being deliberate and another 37 percent as suspicious. That is, for all vegetation fires for which there is a cause recorded, 50 percent may be lit deliberately…" and "Some caution should be taken when considering these figures. Just over 40 percent of vegetation fires across Australia do not have a cause assigned by the responding fire agency."

That one-page briefing is based on an extensive several hundred page review (Bryant, 2008b) of ~280,000 vegetation fire incidents collected by 18 separate agencies responsible for fire management across Australia. These agencies include urban brigades (personnel typically paid), fire agencies in rural and remote regions (fire-fighters are primarily volunteers), as well as various land management agencies (conservation and forestry). Most critically, that study typically only examined fire incident data over a 4–5 year interval, for fires that occur during the late 1990s–early 2000s (the exactly range of years varied subtly across agencies).

It is critical to note that Bryant (2008a, b,) is not a report on "bushfire arson". It is a report examining the causes (ignitions) of, and spatial and temporal distribution of fire incidents involving vegetation fires. That language is intentionally precise; the meanings of each of the underlined words are relevant to this debate.

Bushfire versus vegetation fire

What is a bushfire? The term bushfire is used in Australia probably in a similar way to the word wildfire is used in North America. It is a wildfire that occurs "in the bush", that is in forest, scrub, woodland or grassland.

What is a vegetation fire? A vegetation fire is any fire that occurs within vegetation. All bushfires are vegetation fire but few vegetation fires are bushfires.

Why did Bryant (2008a, b) report on vegetation fires rather than bushfires? There are inherent difficulties in precisely defining which of the 50,000 vegetation fire incidents attended by fire agencies each year were or had the capacity to become a bushfire. This results from imprecision in the definition of the term bushfire, difficulties integrating land use patterns with individual fire incidents at the precise time of those fires, and ultimately because of the often complex relationship between the Australian residential living and the natural environments (some would argue dangerously so). Commensurately, a fire started in the vegetation in someone's backyard in an urban centre may have exactly the same code as one started in the neighbouring state forest or national park, within a fire agency database. Any attempt to differentiate between the two is fraught.

Both the nature and causes (ignition) of vegetation fires vary markedly between urban landscapes and remote wilderness areas. Therefore, it is not valid to directly compare statistics for vegetation fires (e.g., Bryant 2008a, b) and bushfires.

Fire incidents versus fire incidence

Bryant (2008a, b) provided an analysis of all vegetation fires attended by various State and Territory fire agencies within a given period, as recorded in their incident databases. Importantly, the latter is not a record of all incidents attended by Australian fire agencies. At the time of writing, many of the fires attended by volunteers in regional Queensland and Western Australia were not included in those jurisdictions databases. It is my understanding that this has subsequently changed to some extent in Queensland.

Nor is the report based on all vegetation fires in Australia. The overwhelming majority of fires that occur across the deserts and savannah of Australia's top end, many of which are exceptionally large (largest fires in the Northern Territory burned 40-45 million hectares) are not attended by fire agencies unless they pose risk to life or property, and the overwhelming majority are not recorded at all (except perhaps on Geoscience Australia's hot spots maps).

If we are to include all instances of vegetation fires within the Australian landscape by rights we would also need to include all back-burns, and all fires lit by Indigenous Australia, as a means of ecosystems management. Neither of these is recorded within the available incident databases unless fire agencies have been requested to attend (e.g., fire escape, fire monitoring).

The significance of the above is that fire incidents attended by fire agencies are biased towards human-caused ignitions (including deliberately lit) whereas many fires that occur in remote areas that are not attended by fire agencies are likely started by natural causes.

Fire cause

Inherent limitations of assigning the cause (ignition) or fires

There are inherent difficulties in determining the causes (ignition) of vegetation fires, and commensurately considerable uncertainty in the reported statistics. This reflects the facts that:

- very few of the vegetation fire incidents attended are scientifically investigated (*cf.* building fires), although this increases during periods of adverse bushfire weather.
- it can be difficult to establish the exact point of origin
- very little of the evidence relating to ignition may be preserved following the fire
- fires often occur in more remote locations that are not readily observed
- the nomination of a cause as "deliberate" or "suspicious" is commonly achieved through elimination of all other likely factors.

Therefore, there is considerable uncertainty surrounding the assignation of the causes of fire ignitions. In a high proportion of instances the cause of a vegetation fire is documented as unknown.

Bushfire arson versus deliberately lit vegetation fires

Importantly, Bryant (2008a, b) does not report on rates of "bushfire arson", it is a report on the rates of deliberately lit vegetation fires. How do those two things differ?

For an act to be classified as arson it must be established, by a court, that a series of criteria have been met. These can be basically summarised as; that a fire was lit, there was intention or wilfulness, the fire was lit with malice, and there was some kind of property or object burned (Willis, 2008).

"Bushfire arson" is a colloquial term applied to describe the criminal act of "deliberately setting fire to the bush". Each state and territory has its own specific law pertaining to such an offence. In most jurisdictions the appropriate legislation makes it an offence to cause a fire intentionally, and be reckless as to its spread to vegetation on any public land or on land belonging to another (or something similar).

Critically, for an act to labelled "bushfire arson", the responsible person must be convicted of the appropriate offence. A study of "bushfire arson" would examine all the criminal justice statistics pertaining to the relevant offences, and more specifically, the number of persons ultimately convicted of those offences (not simply arrested for). Such an analysis would be of limited value, because it would tell us very little about how many fires were possibly lit deliberately. Moreover, it would tell us absolutely nothing about any of the other causes of ignitions.

Given the considerable uncertainty with respect to assigned cause, Bryant (2008a, b) attempted to establish possible rates of deliberate fire-setting. Those works used the term "deliberate" to collectively refer to all fires that reported as either incendiary (or deliberate, malicious etc.) or suspicious, within the available fire incident databases. However, even the use of deliberate is less than ideal, as the fire incident database reveals nothing about intent. For example, someone can deliberately light a fire that is not a potentially[2] criminal act (e.g., barbeque, campfire, back-burn). These types of fires were classified as "accidental" in Bryant (2008a, b).

What do Bryant's (2008a, b) results tell us about the "causes" of bushfires, and how can this inform the current debate?

Two factors are required to "cause" a bushfire; a source of ignition, and agents that facilitate its spread (e.g., suitable fuels, wind, low fuel moisture, low relative humidity, etc.). Notably, we can have a point of ignition but a bushfire will not eventuate if there is no agent to facilitate its spread. A bushfire cannot occur in the absence of a source of ignition.

Source of ignition – Number of fires

Bryant (2008a) results highlight that over 90% of vegetation fires were caused by people, with deliberately lit fires accounting for approximately half (49.5%) of all vegetation fires attended by fire agencies in Australia, where the cause (ignition) was "known".

The latter qualifier is significant. Notably, the cause (ignition) of fires was denoted unknown in at least one-third of vegetation fires, but comprised as much as 79% for one urban-based agency (likely reflects differences in how agencies treat uncertainty). In reality, only 9% of all vegetation fires were actually identified as incendiary (13.3 % of vegetation fires with a cause assigned), but a further 24.3 % were identified as suspicious (36.2 % of vegetation fires with a cause assigned). In reaching the figure of 50% we assume that all suspicious fires were in fact incendiary, and that the likely distribution of fire causes (ignitions) is similar for the knowns and unknowns, neither of which may be valid.

The vast bulk of all vegetation fires occur within, or within close proximity to, major population centres. This is seen irrespective of whether the fire agency is urban-based, rural, or a land management agency. If we use the statistics for NSW (Table 1) as an example, it is evident that high rates (incidence of) incendiary and suspicious fires are evident for all fire agencies, although in general, deliberate causes (including suspicious) account for a slightly higher proportion of fires attended by urban based brigades as compared with land management services (e.g., National Parks and Wildlife, State Forests, Table 1). So, if we do "a back of the envelope" calculation, using average vegetation fire statistics, approximately 110 of vegetation fires in State Forests and 190 vegetation fires in National Parks, in any given year in NSW were – at that time – likely incendiary or suspicious.

[2] Whether or not it is an offence depends if that act is prohibited on a Total Fire Ban day.

The most profound difference evident in fire cause (ignitions) across agencies with a given jurisdictions relates to the proportion of natural fires (primarily lightning). For example, in NSW, during the aforementioned interval, natural fires accounted for 1.5% of vegetation fires of known cause attended by urban-based brigades as compared with 29% and 20% of vegetation fires of known cause attended by National Parks and Wildlife and State Forests, respectively. These rates are likely substantially higher for genuine bushfires (see below).

Table 1: Summary of fires statistics for vegetation fires attended by fire agencies across New South Wales in the later 1990's-early 2000's.

	No. per annum (approx.)[#]	%Incendiary (%Known)	%Suspicious (%Known)	%Natural (%Known)	%Unknown (%Known)	% Deliberate (%Known)
NSW Fire Brigades (urban)	~11,000	14.6 (21.7)	22.6 (33.5)	1 (1.5)	32.6	37.2 (55.2)
NSW Rural Fires Service (Regional, rural)	~ 7,000*	2.6 (5.4)	15.9 (33.0)	8.8 (18.3)	51.8	18.5 (38.4)
NSW Forests (forestry)	~270	38.5 (40.2)		19.5 (20.4)	4.4 (4.6)	38.5 (40.3)
NSW National Parks and Wildlife	~400	21.2 (25.0)	19.7 (23.3)	24.7 (29.2)	15.3	40.9 (48.3)

*Based on three years for which the data is considered to be complete.
[#] Note that the same fire (particularly bushfires) may be reported in the statistics of more than one agency.

(Statistics sourced from Bryant, 2008b)

Relationship with adverse fire weather

Daily variations

It is exceptionally difficult to correlate specific fire incidents with fire weather because the relevant agencies in Australia (e.g., Bureau of Meteorology) did not maintain historical records of the fire danger conditions for individual regions. A limited number of fire agencies have independently chosen to record the fire danger rating within their fire statistics, albeit inconsistently.

Although a precise quantitative analysis is not possible, the available evidence indicates that fire ignitions in general, and deliberate fires in particular, occur under a very broad range of weather conditions ranging from low to extreme[3]. The distribution of the fire conditions under which vegetation fires occur is strongly linked to the distribution of fire weather conditions at that locality more generally. This means, that if one locality experiences a high

[3] Note that the severe and catastrophic categories were implemented after the observation period covered in Bryant (2008a, b).

proportion of very high or extreme fire danger days then a high proportion of all deliberate fires will occur under those conditions.

Historically, the media, and commensurately parts of the broader population, have been deeply concerned that "bushfire arsonists" deliberately target adverse fire weather. Again, a quantitative analysis was not possible in the absence of complete historical records. However, contrary to existing fears, available evidence indicates that the proportion of incendiary and suspicious fires actually decreases under extreme weather conditions, being significantly outstripped by an increasing numbers of accidental and natural fires.

Seasonal (yearly) variations

Bryant (2008b) typically only analysed the number of fires over a comparatively short interval (generally five years). Commensurately, longer term variations of fire ignitions as a function of seasonal variations in fire weather (and climate) are sometimes difficult to trace within that data, particularly as not all fire data cover the same interval.

The general observations are:

- Most vegetation fire statistics occur within, or close proximity to, urban environments. Commensurately, the data are dominated by incidents from urban and rural fire agencies (e.g., NSW RFS, Victorian CFA are commonly attend fires in regional urban centres).
- The numbers of vegetation fires that occur in urban areas do not fluctuate substantially across seasons, irrespective of fire weather. That observation is supported by longer term fire statistics recorded by the Australian Productivity Commission (https://www.pc.gov.au/)
- Nevertheless, there is a small increase evident in the number of vegetation fires attended by fire agencies in years in which there were more adverse bushfire weather conditions (e.g., 1997-98. 2002-03).
- A comparatively high proportion (varies with location) of all vegetation fires were likely deliberately lit, irrespective of the fire weather.

The most profound effect of seasonal (annual) variations in adverse fire conditions is evident for land management agencies. This is significant to this discussion, because this is the environment in which most bushfires occur. Figure 1 presents a summary of vegetation fires attended annually by the NSW Parks and Wildlife Service for the period from 1995-96 to 2003-04. This period overlaps with the first part of the Millennium Drought, a period of rainfall deficit in south-eastern Australia that extended from late 1996 to mid-2010. However, it is noted that 1997-98 and 2002-03 were also associated with El Niño events, and commensurately were associated with particularly adverse fire weather.

In 1997-98 and 2002-03, the NSW Parks and Wildlife attended significantly higher numbers of vegetation fires. This increase in numbers was primarily due to the considerably higher number of natural fires; natural fires accounted for 41 and 50 percent of vegetation fires attended in 1997–98 and 2002–03, respectively. Ultimately, fires started by lightning, burned most of the highlands of Victoria and southern New South Wales. Fires started by

lightning strikes in the forests to the west of Canberra, on January 17, under what arguably were catastrophic conditions, impacted western Canberra killing four (435 injured), and destroying 488 buildings (mostly homes).

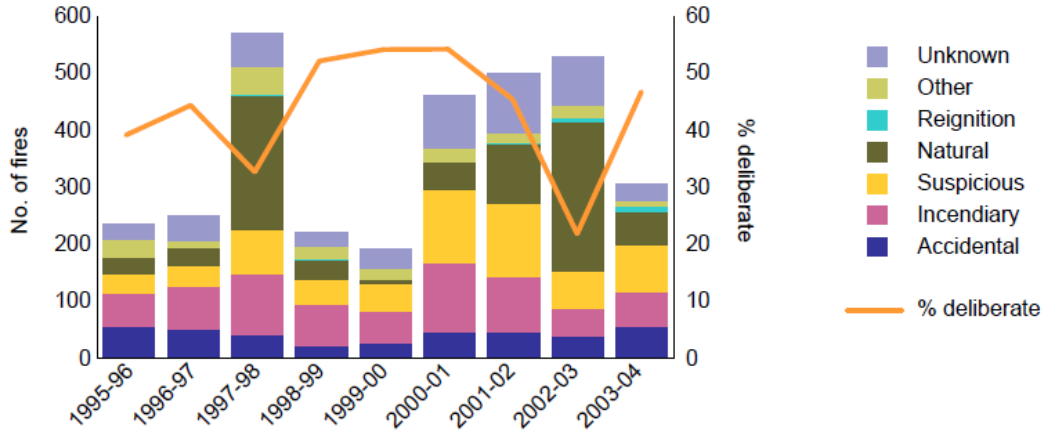


Figure 1: Number of, and percentage of deliberately lit vegetation fires attended by NSW Parks and Wildlife from 1996-96 to 2003-04 (Sourced from Bryant, 2008b).

However, it is also noteworthy that high numbers of vegetation fires were also documented in 2000-01 and 2001-02. Whilst increased numbers played a role, in both years there were particularly high numbers of incendiary and suspicious fires. The role of "arson" was widely reported in the media during the summer of 2001-02, prompting, subsequently, a concerted effort to address the issue of the deliberate lighting of vegetation fires.

Fire incident statistics from the then Department of Sustainability and Environment yield a similar trend with regard to the causes (ignitions) and particular adverse bushfire seasons. Notably, the highest numbers of fires were recorded in 1997-98, followed by 2002-03, and 1994-95, three years associated with a negative oscillation index (El Nino events). The numbers of fires started by lightning were distinctly higher in 1997–98, and to a lesser extent 2002–03. In these years, the absolute numbers of incendiary and suspicious fires remained comparatively unchanged, but comprised a lower proportion of all vegetation.

Fire spread

The above information regarding the number and distribution of fire incidents is useful but it tells nothing, in and of itself, about the spread of a fire. The latter in large part determines which vegetation fires (presuming there is access to vegetation), can be considered a bushfires (or potential bushfire) and which are not, although in reality, the line between the two is arguably ill-defined.

The overwhelming majority of all vegetation fires are small, and the frequency of fires decreases with increasing magnitude. This is observed irrespective of the cause (ignition) and across both volunteer fire brigades that cover rural and regional centres as well as land management agencies (i.e., agencies managing conservation areas, and state forests),

across all years. Nevertheless, differences is size distribution are evident across these categories.

For example, 59% of fires attended by Victoria Department of Sustainability and Environment from 1995-96 to 2003-04 were less than 1 ha, and 86% were less than 10 ha. The proportion of all fires that were deliberately lit remained approximately stable across most fire size categories but comprised a markedly lower proportion of fires burning in excess of 1,000 hectares. Natural fires accounted for a substantially higher proportion of very large fires (>1,000 ha). Departmental burns also contributed to an increasing proportion of larger scale fires categories.

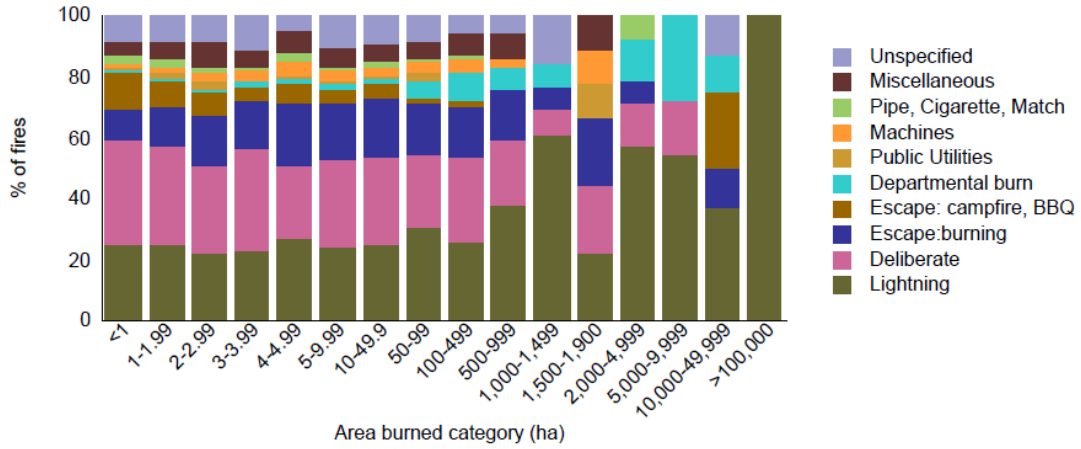
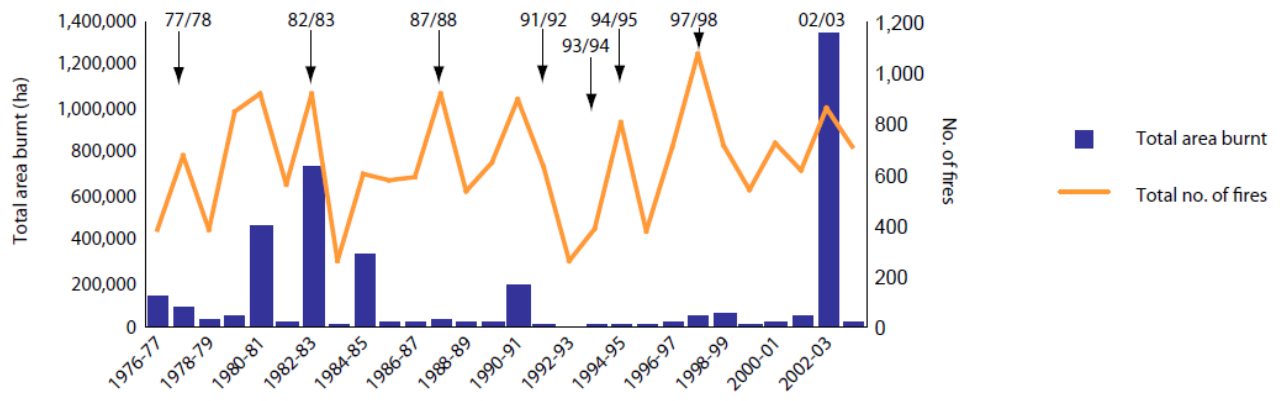


Figure 2: Area burn by category (ha), by cause for vegetation fires attended by the Victoria Department of Sustainability and the Environment, 1993-94-2003-04 (Sourced from Bryant, 2008b).

A broadly similar trend is evident for NSW National Parks and Wildlife, and NSW RFS data, although in these two instances, suspicious and to a lesser extent incendiary fires accounted for a higher proportion of larger fires. Notably, the marked increase in the proportion of natural fires is only evident in fires greater than 5,000 (NSW RFS) to 10,000 (NSW NPWS).

It is critical to observe that several large fire events may dominate any statistics pertaining to the total area burned. In Victoria, 91.9 per cent of all land burned in Victorian DSE fires (land mangaement agency), from 1993-94 to 2003-04 resulted from natural causes. These statistics are dominated by the expansive fires of 2003-03 (Figure 3). Deliberate fires burned 0.5 per cent of the area during the same interval.

The statistics for NSW are slightly different. Notably, deliberate fires accounted for 21 percent of the total 3.5 million hectares burned in NSW NPWS vegetation fires from 1995-96 to 2003-04, primarily in 2000-01 and 2001-02 (Figure 4). As noted previously, measures were subsequently enacted to address deliberate fires in NSW.



a: annotated numbers refers to years in which the average Southern Oscillation Index was less than –10, classified as an El Niño event by the Australian Bureau of Meteorology

Source: DSE 1993–94 to 2003–04 [computer file]; Davies 1997

Figure 3: Number of fires and total area burned y vegetation fires each year from 1977-78 to 2003-04 with additional data from Davies (1997).

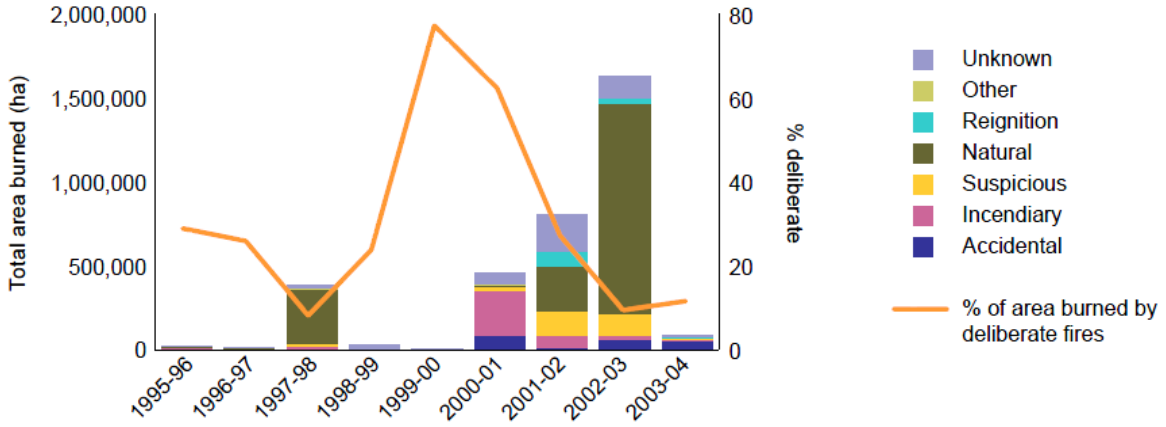


Figure 4: Total area burned, by cause, NSW National Parks and Wildlife 1995-06 to 2003-04 (Sourced from Bryant, 2008b).

It is an indisputable fact that natural fires account for the greatest total area burned in Australia, particularly during years of drought and adverse fire weather.

As documented in the biennial State of the Climate report (http://www.bom.gov.au/state-of-the-climate/), Australia's rainfall is highly variable, being strongly influenced by phenomena like El Niño, La Niña, and the Indian Ocean Dipole. The years in which the greatest total area is burned tends to be associated with years of drought, and commonly El Niño events. Large areas have not always been burned in ever year in which an El Niño is recorded (Figure 3), the reasons for which likely reflect the differential rainfall patterns of individual El Niño, the role of Indian Ocean Dipole effects, and a variety of other reasons,

some of which likely remain to be fully quantified. Significantly, the largest areas tend to be burned in years of extreme weather conditions that come on top of a period of prolonged drought. This is documented more specifically below.

The Ash Wednesday bushfire which burned through 210,000 hectares in Victoria and 208,000 hectares in South Australia, mostly in one day, killed 75 people, and destroyed 3,700 homes and buildings. The Ash Wednesday occurred on a day of catastrophic fire conditions, within a year associated with El Niño event, which occurred on the back of one of the worst droughts in Australian history that began in 1979 (https://en.wikipedia.org/wiki/1979%E2%80%9383_Eastern_Australian_drought).

Particularly large areas of land were burned in 2002-03 (Figure 3), a year in which an El Niño event was experienced mid-way through the Millennium Drought (late 1996 to mid-2010). Reports on the Eastern Victorian Alpine bushfires indicate that initially there were 87 fires started by lightning strikes. Eight of those fires could not be contained, eventuallly merging togother to burn over 13,000 km² over a period of 59 days (https://en.wikipedia.org/wiki/2003_Eastern_Victorian_alpine_bushfires). Lightning triggered by the same weather event trigged bushfires in southern NSW, some of which culminated with the Canberra fires of 17 January 2003 (see above).

Forebodingly, the Millennium drought was associated with another two particularly bad fire seasons. The year of 2006-07 is not well remembered as being particularly disastrous, within the annals of Australia's collective bushfire memory. It is however, significant because it included the Victorian Alpine Complex which commenced with lightning strikes on 1 December 2006. That fire burned 1,048,000 ha (almost two thirds of the amount burned during Victoria's current fire season) and resulted in the loss of 51 homes. This fire was significant because it represents Victoria's longest running fire in (recorded) history. Severe bushfires were experienced in New South Wales, South Australia, Tasmania and Western Australia during the same year. It is debated by some (e.g., Su et al., 2018) that 2006-07 was also associated with an El Niño event.

However, the 2006-07 fires pale into insignificance (at least from a human perspective), with the Black Saturday fires of 2009-10 during which fires that started as a result of powerlines, deliberate fire-setting, lightning and machinery burned 450,000 hectares, killing 173 people, destroying 3,500 building (2,029 houses). The year 2009-10 again was associated with an El Niño event that occurred at the very end of the Millennium drought.

The current 2019-20 is associated with a severe drought, which has been widespread across much of Australia since 2017.

Climate change

The fifth, biennial *State of the Climate* report (https://www.csiro.au/en/Showcase/state-of-the-climate), based on the latest monitoring, science and projection information, highlights the following points:

Temperature

- The seasonal (year to year) natural variably in temperature induced by El Niño and La Niña in the tropical Pacific Ocean and phases of the Indian Ocean Dipole in the Indian Ocean, is now superimposed on a trend of increased warming.
- Australia's climate has warmed just over 1°C since 1910 leading to an increase in the frequency of extreme heat events.
- Increased temperatures are observed across both day and night-time temperatures, in all seasons.
- The number of more extreme daily heat events (those above the 99th percentile of each month from the years 1910–2017) has also increased.

Addendum: It is noteworthy that that the Australia Bureau of Meteorology has identified the last seven years have been among the top 10 warmest on record for Australia. 2019 is officially Australia's hottest year on record.

Rainfall

- Despite the natural variability in rainfall, which is strongly influenced by El Niño, La Niña, and the Indian Ocean Dipole phenomena, there has been a shift towards drier conditions across southwestern and south-eastern Australia during April to October, with a decline of around 11 per cent in April–October rainfall in the southeast of Australia since the late 1990s.
- Streamflow has decreased across southern Australia.

Fire weather

- There has been a long-term increase in extreme fire weather and in the length of the fire season across large parts of Australia. Notably, there is a clear trend in more recent decades towards of a greater number of very high fire weather days in spring[4].

The prediction is that future climate change will bring us more of the same.

Conclusion

Bryant (2008a) did conclude that as much as 50 percent of vegetation fires in Australia may be deliberately lit. However, that statistic is not, and should not be used as, an assessment of the likely causes (ignition) of Australia's 2019-2020 bushfires, as it is not an accurate reporting of what has occurred, and it is unlikely representative of the actual picture.

What the larger report of Bryant (2008b) ultimately demonstrates is how the distribution of vegetation fires is dominantly a reflection of patterns of human activity and behaviour, and reflects their interaction with the landscape in which they live. Humans are likely responsible for 90 per cent of all vegetation fire ignitions, and commensurately there is a

[4] Absent from this report, and issue of critical importance with regard bushfire is the potential impacts of changes in wind strength, velocity and variability as a function of climate change.

strong correlation the distribution of people and the distribution of vegetation fires across the landscape.

Deliberate fires account for approximately 60 percent of human-caused ignition, the remaining 40% being accidental in origin. High rates of deliberate fire-setting appear to occur across all environments in which human interact, irrespective of the fire-weather. In fact, the proportion of deliberate fires decreases on extreme fire weather days, owing to the much greater increases in natural and accidental fires.

A higher proportion of deliberately lit vegetation fires occur in areas of greater social disadvantage. This reflects the fact that deliberate fire-setting, like any other problematic behaviour, is a reflection of societal functioning. There is much focus on "arsonists". However, the distribution of deliberately lit vegetation fires is not simply a reflection of the distribution of the "arsonists"; it captures and reveals the intersection between human society and the environment.

A critical observation is that natural causes, principally lightning, commonly account for approximately 20-25 per cent of fires in conservation areas and state forests, but more significantly, this may increase to as much as 50 per cent during particularly adverse fire seasons. It is emphasised that the majority of very large bushfires have a natural origin, and such fires account for the overwhelming majority of all land burned, particularly during particularly adverse bushfire seasons.

There is a clear link between adverse bushfire outcomes and adverse bushfire weather, at both smaller and larger scales. Large areas of land are commonly burned in years associated with climatic "anomalies", during which there is more extreme weather. Catastrophic fire events like Ash Wednesday, Canberra fires, and Black Saturday are clearly associated with catastrophic bushfire weather conditions. The worst outcomes (considering life, property and the environment combined) occur in years where a climatic phenomenon like El Nino and Indian Ocean Dipole follow a period of sustained and widespread drought.

The evidence is that climate change seasonal (year to year) natural variably in temperature are now superimposed on a trend of increased warming, south-eastern Australia is becoming drier, and consequently that there is a long-term increase in extreme fire weather. A critical point is that human-induced climate change appears to be driving not only a trend of increased warming but likely also the frequency at which we experience climatic phenomenon like El Nino (e.g., Cai et al., 2014) and Indian Ocean Dipole (Wang et al. 2017) effects.

The framing of this issue as an arsonist versus climate change debate reflects a failure to accurately understand the nature of the issues involved, but also a failure to capture the essence of the problem that needs to be resolved. People do what people do. They have barbeques, they mow the lawn, they harvest some grain, they cut up some steel with an angle grinder in their back yard, they light a campfire, they burn some rubbish, they ride a motorbike through a paddock, and some even light up some the grass in the local neighbourhood. Whilst only one of these is probably perceived as being illegal or problematic all have the potential to create a disastrous bushfire if they are undertaken

during more adverse bushfire weather. The evidence is that climate change is increasing the likelihood that such adverse bushfire weather will take place. So when people do what people do, for whatever reason they do it, there is an increasing likelihood that it will coincide with more adverse fire conditions. That means without any change in human behaviour, the potential for more adverse outcomes will increase. So, ultimately, into the a future there will be an ever increasing need to address all actions and behaviours that contribute to human-related fire ignitions be they perceived as deliberate or accidental in origin. However, even if by some miracle (because that it was it would require) we were able to eliminate all such instances, we would not eliminate the ever-increasing threat posed by bushfires started by lightning, that will arise with a warming, drying landscape.

While there has been a tendency for arson to be pitted against climate change in this debate, there is a common theme. All human beings must become conscious of the potential consequences of their actions, and adjust their thinking and behaviours accordingly, if adverse outcomes are to be avoided.

References

Bryant, C.J. 2008a. *Proportion of deliberate bushfires in Australia*. Bushfire arson bulletin no. 51. Canberra: Australian Institute of Criminology. https://aic.gov.au/publications/bfab/bfab051.

Bryant, C.J. 2008b. Understanding bushfire: trends in deliberate vegetation fires in Australia. *Technical and background paper* No. 27. Canberra: Australian Institute of Criminology.

Cai, W., Borlace S., Lengaingne, M., van Rensch, P., Collins, M., Vecchi, G., Timmermann, A., Santoso, A., McPhaden, M.J., Wu, L., England, M.H., Wang, E., Guilyardi, E., & Jin, F.-F. 2014. Increasing frequency of extreme El Niño events due to greenhouse warming. Nature Climate Change 4: 111-116.

Chrenkoff A. 2020. We don't just have a bushfire crisis. We have an arson crisis, too. https://www.spectator.com.au/2020/01/we-dont-just-have-a-bushfire-crisis-we-have-an-arson-crisis-too/ (accessed 16 Jan 2020)

Nguyen, K., Brunero, T., Thomas, S., & Keane D. 2020. The truth about Australia's fires — arsonists aren't responsible for many this season. https://www.abc.net.au/news/2020-01-11/australias-fires-reveal-arson-not-a-major-cause/11855022 (accessed 16 Jan 2020)

Rawsthorne, S. 2020. Legal action taken against 183 people this bushfire season. https://www.smh.com.au/national/nsw-fires-legal-action-taken-against-183-people-this-bushfire-season-20200106-p53p97.html (accessed 16 Jan 2020)

Ross, D. & Reid, E. 2020. Firebugs fuelling crisis as arson arrest toll hits 183. The Australian, 7 Jan 2020. https://amp.theaustralian.com.au/nation/bushfires-firebugs-fuelling-crisis-asarson-arresttollhits183/news-story/52536dc9ca9bb87b7c76d36ed1acf53f?__twitter_impression=true

Su, J., Lian, T., Zhang, R., & Chen, D. 2018. Monitoring the pendulum between El Niño and La Niña events. Environmental Research Letters, Volume 13, Number 7

Wang, G., Cai, W., & Santoso, A. 2017. Assessing the Impact of Model Biases on the Projected Increase in Frequency of Extreme Positive Indian Ocean Dipole Events, *Journal of Climate,* doi: 1175/JCLI-D-16-0509.1

Willis, M. 2004. *What is arson?*. Bushfire arson bulletin no. 1. Canberra: Australian Institute of Criminology. https://aic.gov.au/publications/bfab/bfab001