



Emergency Leaders for Climate Action

Submission to:

Finance and Public Administration References Committee

Inquiry: Lessons to be learned in relation to the preparation and planning for, response to and recovery efforts following the 2019-20 Australian bushfire season

Addressed to:

Senate Finance and Public Administration Committees
PO Box 6100
Parliament House
Canberra ACT 2600

Submission from:

Emergency Leaders for Climate Action
<https://emergencyleadersforclimateaction.org.au/>

Prepared on behalf of ELCA by:
Greg Mullins AO, AFSM; Commissioner, Fire & Rescue NSW (ret)

18 April 2020.

Introduction

Irrefutable empirical scientific data, reinforced by observations of veteran firefighters and people on the land, confirm that a warming climate, proven to be caused by the burning of coal, oil and gas, is resulting in worsening and more frequent extreme weather events such as those that spawned the 2019-20 bushfires in NSW, Qld, SA, Victoria, WA and Tasmania. It is not possible to “adapt” to such catastrophic and escalating conditions, and they can only be partially mitigated.

The failure of successive governments at all levels to show leadership and take credible, urgent action on the basic causal factor: greenhouse gas emissions from the burning of coal, oil and gas, will lead to further escalation in natural disaster risks.

Emergency Leaders for Climate Action (ELCA) was formed in April 2019 due to deep shared concerns about the potential of the 2019-20 bushfire season, and unequivocal scientific evidence that climate change, driven mainly by the burning of coal, oil and gas, is worsening these extreme weather events, including hot days, heatwaves, heavy rainfall, coastal flooding, catastrophic bushfire weather and overlapping bushfire seasons..

In April and May 2019 ELCA corresponded with the Prime Minister and sought opportunities to brief him on the alarming potential of the looming bushfire season, then again later in 2019 when the catastrophic fire season, as warned, started to rapidly deteriorate. Ultimately after significant efforts to establish dialogue, a short meeting was held with Ministers Littleproud and Taylor on 4 December. By then hundreds of homes and a number of lives had already been lost in NSW and Queensland. No tangible changes or actions resulted from the December meeting, and further lives, together with hundreds of homes, were subsequently lost to the flames in NSW, Victoria and South Australia.

ELCA recommended a number of significant measures that would have aided state and territory firefighting efforts, including approval of additional funding previously requested by fire chiefs for additional large firefighting aircraft, and mobilisation of elements of the Australian Defence Force to logistically support emergency services and aid in initial recovery. The recommendations were initially ridiculed by government politicians, then ignored, then belatedly implemented after public, political and media pressure, but not until after the worst damage and most deaths had already occurred. The sluggish response detracted from its effectiveness.

It could be argued that the measures recommended by ELCA, if implemented, could have helped to reduce losses. If this proposition is accepted, it may also then be inferred that the Australian Government was negligent and abrogated its responsibility to protect Australians by failing to listen to and act on information and advice offered by experts concerning an imminent emerging national disaster.

ELCA hopes that following this latest disaster, and given the inevitability of future escalating and catastrophic natural disasters because of past emissions, the Australian Government will learn from some state and territory governments, start to urgently develop and deploy meaningful climate change policies aimed at drastically and deeply reducing emissions, and in so doing, provide future generations with some prospect of withstanding or avoiding what is currently a likely nightmare scenario of natural disasters with consequences of such a scale that they will not be able to be effectively mitigated against, adapted to, or responded to.

The ultimate costs of the current weak climate change policies and lack of sufficient action on emissions (in Australia and internationally) are becoming increasingly clear, and the moral culpability of this generation to future generations should also now be abundantly clear. Strong leadership on climate action is more necessary than ever before, because climate change is creating the conditions for more frequent and deadly natural disasters.

ELCA has been heartened by the Australian Government's response to the COVID-19 pandemic: in contrast to the bushfires, the Government listened to scientists and experts, consulted widely, communicated clearly, and acted quickly in the best interests of the country, coordinating actions with other nations. *This needs to be the model for immediate action to start to stabilise, then ultimately reduce, unprecedented bushfire and natural disaster risks driven by out-of-control emissions and climate change.* A national pivot to sustainability and renewable energy as part of an economic "reset" after COVID-19 is a good place to start.

Emergency Leaders for Climate Action

ELCA comprises thirty-three (33) former fire and emergency service leaders from every state and territory, representing every fire service in Australia, several State Emergency Service agencies, several forestry and national parks agencies, and Emergency Management Australia. ELCA represents about 1,000 years of cumulative experience.

Current members of ELCA are:

John Anderson AFSM; *Former Deputy Commissioner, NSW Fire Brigades; former Chair, NSW State Emergency Management Committee; former NSW Representative, Australia / New Zealand Emergency Management Committee.*

Mary Barry; *Former CEO, Victoria State Emergency Service; former Board Member, Australasian Fire & Emergency Service Authorities Council; former Chair, Australian Council of State Emergency Services.*

Tony Blanks AFSM; *Former Fire Manager Tasmania Parks & Wildlife Service; former Fire Manager, Forestry Tasmania.*

Neil Bibby AFSM; *Former CEO, Country Fire Authority Victoria; former Deputy Chief Fire Officer, Melbourne Metropolitan Fire Brigade.*

Naomi Brown; *Former CEO, Australasian Fire Authorities Council.*

Mike Brown AM, AFSM; *Former Chief Fire Officer, Tasmania Fire Service; former Chair, National Aerial Firefighting Centre.*

Bob Conroy; *Former Fire Manager, NSW National Parks & Wildlife Service; member, NSW Bush Fire Coordinating Committee (representing Minister for Environment); volunteer firefighter NSW RFS.*

Malcolm Connellan AFSM; *Former Deputy Commissioner Fire & Rescue NSW.*

Campbell Darby DSC, AM; *Former Director General, Emergency Management Australia.*

Major General Peter Dunn AO (ret); *Former Commissioner, ACT Emergency Services Authority. Bushfire Recovery Coordinator, Lake Conjola NSW*

Brian Gilligan; *Former Director General, NSW National Parks & Wildlife Service.*

John Gledhill AFSM; *Former Chief Officer, Tasmania Fire Service. Former President, Australasian Fire Authorities Council.*

Dr Jeff Godfredson AFSM; *Former Chief Fire Officer, Melbourne Metropolitan Fire Brigade.*

Dr Wayne Gregson APM, OAM; *Former Commissioner, Western Australia Department of Fire & Emergency Services; former Board Member, Australasian Fire & Emergency Service Authorities Council; former Assistant Commissioner, WA Police.*

Craig Hynes AFSM; *Former Chief Operating Officer, Western Australia Fire & Emergency Services Authority.*

Lee Johnson AFSM; *Former Commissioner Queensland Fire & Emergency Services; former President, Australasian Fire & Emergency Service Authorities Council; Board Member, Bushfire & Natural Hazards Cooperative Research Centre.*

Murray Kear AFSM; *Former Commissioner NSW State Emergency Service; former Chair, Australian Council of State Emergency Services; former Assistant Commissioner, NSW Fire Brigades.*

Phil Koperberg AO, AFSM, BEM; *Former Commissioner, NSW Rural Fire Service; former NSW Minister for the Environment.*

Craig Lapsely PSM; *Former Emergency Management Commissioner, Victoria; former Chair, Chief Officers and Commissioners Strategic Committee (Australia); former Fire Services Commissioner, Victoria; former Deputy Chief Officer, Country Fire Authority Victoria.*

Andrew Lawson AFSM; *Former Deputy Chief Officer, SA Country Fire Service.*

Grant Lupton AFSM; *Former Chief Officer and CEO, SA Metropolitan Fire Service; former Board Member, Australasian Fire Authorities Council; former Deputy Fire Commissioner and Director of Fire Safety, Province of British Columbia, Canada; International Board Chair, Institution of Fire Engineers.*

Greg Mullins AO, AFSM; *Former Commissioner Fire & Rescue NSW; former President and Board Chair, Australasian Fire & Emergency Service Authorities Council; former Deputy Chair and Acting Chair, NSW State Emergency Management Committee; former NSW representative, Australian Emergency Management Committee; former member, NSW Government Climate Change Council; former Member, NSW Bush Fire Coordinating Committee; former Country Director, International Fire Chiefs' Association of Asia; Chair, NSW Ambulance Service Advisory Board. Climate Councilor. Volunteer firefighter, NSW RFS.*

Greg Newton; *Former Deputy Commissioner, NSW State Emergency Service.*

Frank Pagano AFSM, ESM; *Former CEO, Emergency Management Queensland; Former Deputy Commissioner, Queensland Fire & Rescue Service.*

Darryl Pepper AFSM; *Former Director (Chief Officer), Northern Territory Fire & Emergency Services; former Assistant Commissioner, Queensland Fire & Rescue Service.*

David Prince AFSM; *Former Chief Fire Officer, Australian Capital Territory Fire Brigade.*

Russell Rees AFSM; *Former Chief Fire Officer, Country Fire Authority Victoria.*

Steve Rothwell AFSM; *Former Chief Officer, Northern Territory Fire & Rescue, and NT Emergency Service; former Assistant Commissioner, Queensland Fire & Rescue Service.*

Steve Sutton; *Former Chief Fire Control Officer, Bushfires NT.*

Jim Smith AFSM; *Former Acting Commissioner NSW State Emergency Service, former Deputy Commissioner, Fire & Rescue NSW; Volunteer firefighter, NSW RFS.*

David Templeman; *Former Director General, Emergency Management Australia.*

Ken Thompson AFSM; *Former Deputy Commissioner, NSW Fire Brigades.*

Ewan Waller AFSM; *Former Chief Officer, Forest Fire Management Victoria.*

Table of Contents

<i>Introduction.....</i>	<i>2</i>
<i>Emergency Leaders for Climate Action</i>	<i>3</i>
<i>Recommendations</i>	<i>10</i>
<i>1. Background - NSW and ACT fire history</i>	<i>17</i>
<i>2. Background - Victorian & South Australian fire history.....</i>	<i>18</i>
<i>3. The bushfire & climate change challenge.....</i>	<i>20</i>
3.1 New South Wales & Queensland.....	20
3.2 Victoria and South Australia.....	23
3.3 The core problem and what must be done	23
<i>4. How climate change aggravated the 2019-20 bushfire crisis.....</i>	<i>24</i>
4.1 Unprecedented weather, fires, and broken records	24
4.2 Drought and long term drying.....	25
4.3 Rising temperatures	27
4.4 El Niño no longer coupled with serious fire seasons	28
4.5 Longer fire seasons	28
4.6 Overlapping fire seasons.....	29
4.7 More days of serious fire weather each year	29
4.8 Fire weather worsening.....	30
4.9 More extreme bushfire events	31
4.10 Increase in fire-generated storms.....	31
4.11 Increasing smoke impacts and deaths.....	32
4.12 Increasing environmental impacts	32
4.13 Increasing economic impacts.....	33
4.14. Fire and disaster risks will continue to escalate without genuine and sustained efforts to tackle climate change.....	33
<i>5. How climate change has forced operational practices to change.....</i>	<i>35</i>
5.1 Historical paradigm shifts in Australian firefighting doctrine.....	35

5.2 New fire danger ratings	36
5.3 New aerial firefighting strategies introduced	37
5.4 Large-scale international assistance	37
5.5 New approach to public safety: leave early	37
5.6 Emergency warnings introduced	38
6. Research and information capability in a rapidly changing climate	39
6.1 Dedicated research capability required	39
6.2 Australian Government research agencies	39
6.3 Emergency information	40
7. Fuel management and prescribed burning	41
7.1 Weather conditions defining factor in extreme 2019-20 fires.....	41
7.2 Misinformation during the 2019-20 fires	42
7.3 Hazard reduction	43
7.4 Increased, targeted burning needed.....	44
7.5 Cultural burning practices.....	45
7.6 Windows for burning reducing due to climate change	46
7.7 Mechanical thinning of forest has protection benefits.....	46
7.8 Management of fuel on private lands	47
7.9 Grazing does not reduce fuel loads and fire risk.....	47
7.10 Understanding the risks with burning	48
8. Strategies to deal with very large fires.....	49
8.1 Lightning-caused fires.....	49
8.2 Backburning.....	50
8.3 Proven control strategies.....	51
8.4 Early detection and initial attack.....	52
9. Firefighting aircraft	53
9.1 Firefighting aircraft a tool, not a solution	53
9.2 National arrangements for firefighting aircraft	54
9.3 Funding	55
9.4 Strategic and tactical use of aircraft.....	57
9.5 Research into the use of firefighting aircraft.....	58

9.6 Water-scooping aircraft as an additional resource.....	59
9.7 Military Strategic Lift (cargo) aircraft as firefighting backup	62
10. Building standards in bushfire-prone areas	64
10.1 Construction standard a key resilience measure	64
11. National Support Coordination	67
11.1 Military support crucial, but not to take over	67
11.2 No need to duplicate state and territory capabilities	67
11.3 The role of Emergency Management Australia	68
11.4 Catastrophic disaster planning and coordination.....	70
11.5 Lessons learned from counter terrorism planning.....	71
12. Use of Australian Defence Force capabilities	74
12.1 Climate change impacting ADF	74
12.2 Utilise existing ADF capabilities for support roles.....	75
12.3 DACC arrangements need to be reviewed and simplified	75
13. Other matters pertaining to emergency management.....	77
13.1 Alignment of emergency warnings nationally	77
13.2 Radio communication and interoperability	77
13.3 Common operating picture and national situational awareness.....	78
13.4 Community resilience – electricity and mobile telephony.....	78
References	81

Recommendations

1. The Senate Inquiry should find that the 2019-20 bushfires were unprecedented and detail how they were driven by extreme weather conditions, by elevated fire danger indices on multiple days, and by cascading events including drought, heatwaves, dry thunderstorms causing lightning ignitions, and an unprecedented number of pyroconvective events influencing extreme fire behaviour. In doing so, the Senate Inquiry should detail and explain for the historical record the irrefutable fact, based on a large body of scientific data and research over decades, that the extreme weather experienced in 2019-20 was outside previously expected natural variation, and was clearly driven by anthropogenic climate change.
2. The Senate Inquiry should detail how anthropogenic climate change has resulted in Australian bushfire seasons lengthening, worsening, and overlapping between states and territories, limiting the ability of Australian firefighting agencies to assist each other, while also overlapping with northern hemisphere fire seasons, limiting the availability of large firefighting aircraft, particularly between August and November each year.
3. The Senate Inquiry should detail how the long term and continuing climate change-driven increase in bushfire and other natural disaster risks in Australia is harming the economy, the environment, and costing people their lives and livelihoods. For the sake of historical accuracy and to underline the magnitude of the 2019-20 fires and upward trajectory of future risk, the Senate Inquiry should include the number of deaths from smoke impacts as being directly caused by the bushfires, resulting in a final death toll of at least 450.
4. The Senate Inquiry should detail how strong climate mitigation and adaptation policies are required from all levels of government in order to start to address the escalating extreme weather, bushfire and natural disaster risks driven by climate change. The Federal Government should coordinate all levels of government in accelerating and increasing measures to tackle climate change. More substantial action is required to reduce Australia's emissions, including accelerating the transition to renewables and storage technologies, non-polluting transport, infrastructure, food production and the phase out of fossil fuel projects. The Federal Government must strengthen its current suite of ineffective climate policies and commit to meeting and beating emission reduction goals and renewable energy targets. Because many climate impacts are already locked in, all levels of government will play a critical role in building community preparedness and resilience.
5. The Senate Inquiry should detail how anthropogenic climate change has resulted in Australian emergency services radically and by necessity changing long-standing

operational paradigms so that they can better meet critical needs of communities threatened by escalating bushfire risks.

6. The Senate Inquiry should recommend that there be ongoing funding and support for a dedicated independent research capability given the imminent cessation of funding in 2021 for the Bushfire & Natural Hazards Cooperative Research Centre. Research is crucial to understanding and tracking escalating natural disaster risks and enabling fire and emergency services to plan and prepare for worsening conditions. An evidence-based ability to track and predict escalating risks driven by climate change must underpin the development of national and state resilience, adaptation and mitigation strategies, as well as informing funding needs for community education and engagement, and enhanced resourcing of emergency services.
7. The Senate Inquiry should recommend that critical government research agencies, such as the Bureau of Meteorology and the Commonwealth Scientific and Industrial Research Organisation have funding for research into climate change and natural disasters restored and enhanced. These agencies need to be sufficiently resourced to improve predictive capabilities, understand effects of climate change on natural disasters now and into the future, and have capabilities to warn and alert communities and emergency services in a timely, comprehensive manner.
8. The Senate Inquiry should recommend that the role of ABC local radio as the national emergency broadcaster be recognised and enshrined in the remit of the Australian Broadcasting Commission. Further, that it be recognised as an essential service, and have adequate funding assured into the future.
9. The Senate Inquiry should find that fuel reduction is one of the only ways to reduce fire intensity and therefore must be a major part of any mitigation strategy. It should recommend that research underpin the development of new policies that recognise the need for better asset protection strategies, shrinking windows available for controlled burning due to a warming climate, the need to fund and research cultural burning practices, and the need to avoid perverse outcomes, such as burning large tracts of land remote from assets in order to meet arbitrary percentage or hectare targets.
10. The Senate Inquiry should find that due to the impacts of climate change, existing hazard reduction approaches could become less effective at mitigating and controlling fires during extreme weather events that result in long distance spotting, intense and sustained ember attack, and pyroconvective fires. As a result, fuel reduction approaches will need to be better integrated with overall mitigation

strategies including fire detection and suppression, community education, hardening of infrastructure, warnings, evacuation, and other measures.

11. The Senate Inquiry should find that a number of land management agencies nationally have suffered real cuts in funding and staff numbers, some at the same time as the amount of land under management has increased. Benchmarks should be developed to ensure that agencies are properly resourced to manage lands under their control, and that both urban and rural fire services have sufficient resources to participate in prescribed burning operations on a regular, planned basis.
12. The Senate Inquiry should find that more attention and resourcing need to be applied to rapid detection of and response to new fire outbreaks during periods of serious fire weather. A range of new rapid fire-detection technologies should be trialed. Together with rapid detection, new fast attack strategies for new outbreaks, particularly remote fires caused by lightning, need to be introduced with clear objectives, e.g. putting fires out within 24 hours and before they exceed ten hectares. Fast attack should involve rapid dispatch of a suitable number of water bombing aircraft to achieve rapid turnaround and constant direct attack on fire fronts, complemented, as soon as possible by aerial insertion (where practicable) or ground insertion of remote area fire teams to complete extinguishment.
13. The Senate Inquiry should recommend that, as a condition of receiving a portion of Australian Government annual funding support, the National Aerial Firefighting Centre be required to conduct a trial, in consultation with the Royal Australian Air Force and Australasian Council of Fire and Emergency Service Authorities Council, of CL415 amphibious water-scooping aircraft in a first attack / direct attack firefighting role. Australian fire services at present use small and large fixed wing water bombers, but not medium sized, a clear gap in capabilities. Given the success of 3,200 litre water scooping single engine air tankers (SEAT), a twin engined purpose-built aircraft with significantly greater air speed, range, flexibility and twice the payload would be a logical and useful addition to current arrangements. The only purpose-built firefighting aircraft in the world, they are used extensively and successfully in most other fire-prone countries.
14. The Senate Inquiry should recommend that the Federal Government require, as a condition of receiving a portion of annual funding advances, that the National Aerial Firefighting Centre vary tender requirements for large firefighting aircraft to remove payload requirements that expressly exclude consideration of CL415 water-scooping aircraft in Australia, given the strong evidence that due to shorter refill

and cycle times they can outperform large aerial tankers in terms of total volumes able to be dropped on fires.

15. The Senate Inquiry should recommend that the Federal Government and RAAF conduct a trial of the feasibility of fitting one or more RAAF C130 Hercules aircraft with Modular Airborne Fire Fighting Systems (MAFFSII) to evaluate introduction of a capability within the ADF to augment aerial firefighting capabilities during major disasters.
16. The Senate Inquiry should recommend that in the wake of the devastating 2019-20 fires, and recognising that climate change continues to drive an increase in Australia's bushfire threat, it is critical that building and planning regulations and standards be reviewed, particularly Australian Standard 3959.
17. The Senate Inquiry should recommend that roof design and strength is included as a critical factor in future bushfire design of homes and other buildings. Requirements need to be increased to reflect increasing wind velocities fuelled by climate change, and fire storms and fire tornadoes caused by pyroconvective events that damage and remove roofs. If a roof is damaged or destroyed survivability of the structure and its ability to act as a refuge are diminished or eliminated.
18. The Senate Inquiry should note the variation in legislation and bushfire planning and building standards across states and territories. A more integrated approach to planning for fire risk, which better connects planners with emergency management, will be critical as bushfire threats continue to escalate in a warming, drying climate. As fire danger indices and fire paths from 2019-20 are analysed, locations might be identified where rebuilding should not occur due to excessive levels of fire and life risk.
19. The Senate Inquiry should recommend that states and territories provide, in remote communities or communities deemed to be at extreme risk and with limited safe egress, dual-purpose community buildings capable of providing all community members with refuge in an extreme bushfire, flood or storm emergency.
20. The Senate Inquiry should detail why the military is not in a position to, nor should it, take over from state and territory emergency services during natural disasters, but instead work in close collaboration. In its Findings, the Senate Inquiry should recognise the strong leadership and achievements of state and territory emergency service leaders, and particularly of the many emergency workers, career and

volunteer, who worked on the front lines for months, mostly without pay, and in some cases, ultimately without homes to return to.

21. The Senate Inquiry should find that significant additional expenditure on the ADF to build a new disaster response capability is not necessary and would be an expensive duplication of existing state and territory capabilities. The focus should be on complementarity and support, not taking over or creating expensive new structures.
22. The Senate Inquiry should note the deficiencies that occurred at the national political level during the fires for the official record, so that it will hopefully not be repeated in future. Despite expert warnings, it appears that the Federal Government was seriously unprepared for the fires, but it was promising to see stronger leadership during the subsequent COVID-19 pandemic. An apparent failing during the fires was the lack of engagement of expert officials to underpin well-informed and evidence-based decision-making by politicians.
23. The Senate Inquiry should recommend that the role of Emergency Management Australia be revitalised and strengthened. EMA is currently subsumed in the large Home Affairs bureaucracy, but should have direct access to the Prime Minister and Secretary of the Department of Prime Minister and Cabinet. It should continue to work closely and collaboratively with the peak council for fire and emergency services, the Australasian Fire and Emergency Service Authorities Council.
24. The Senate Inquiry should recommend that Emergency Management Australia be given legislative power to coordinate Commonwealth assets in support of states and territories when required, rather than the current arrangements that are reliant on goodwill. Goodwill is insufficient in disaster situations where clear lines of authority, command, control and firm decision-making based on evidence, are required.
25. The Senate Inquiry should recommend that EMA lead a collaborative project to develop detailed plans and arrangements to deal with catastrophic disasters that remove the ability of states and territories to respond and to govern. By necessity this will involve a range of stakeholders including but not limited to: state and territory governments, emergency services and their peak council, and the Australian Defence Forces. Australia must not wait for such a disaster to occur before working out how to deal with it.
26. The Senate Inquiry should recommend that Australia's National Security Strategy needs to embrace wider and deeper concepts of security, including a consideration

of climate change, natural disasters driven by extreme weather, and their impacts, as well as the possibility of compound events (where two or more extreme weather events combine to produce impacts that are worse than the effects of each event independently). The Australian Defence Force has comprehensive logistics, engineering and heavy lift capabilities that can be applied to assist emergency services and communities in the response and recovery phases.

27. The Senate Inquiry should recommend that key Defence policy papers, such as the next Defence White Paper, should incorporate a clear forward plan for how the ADF will support emergency services and recovery agencies in the future, as climate change drives an increased number of extreme fire danger days and other natural disasters in Australia and regionally.
28. The Senate Inquiry should recommend that the Australian Government conduct a fundamental review of longstanding Defence Assistance to the Civil Community (DACC) arrangements. The arrangements can be cumbersome and slow, and levels of understanding between the ADF and emergency services about respective capabilities, needs, and arrangements can be improved.
29. The Senate Inquiry should recommend that the ADF further develop its capability to assist states and territories during disasters, with a focus on utilisation of existing capabilities for civil defence roles under the control of emergency services and state and territory governments, rather than developing new capabilities that might serve to duplicate state and territory capabilities and ultimately cause confusion and inefficiencies.
30. The Senate Inquiry should strongly recommend that state and territory governments agree on and then align how they promulgate emergency warning information in order to avoid confusion as people cross borders. As a minimum, there needs to be alignment of colours used in threat maps, and the level of information provided by agencies to the public in emergency warnings.
31. The Senate Inquiry should recommend that states and territories, coordinated by the Australasian Fire and Emergency Service Authorities Council, develop protocols and arrangements, backed by appropriate technologies, to enable direct tactical radio communications between all emergency services operating at the same major incident. Work around solutions such as additional inter-agency talk groups should be eliminated as they can reduce overall situational awareness.

32. The Senate Inquiry should recommend that a technological solution to implement a shared situational awareness tool, or National Common Operating Picture (COP), be developed by Emergency Management Australia and shared with all state and territory emergency services. The COP would enable all agencies in real time to monitor current incidents, deployments and emerging needs, as well as the ability to flag emerging local requirements. AFAC should partner with EMA to deliver the project.
33. The Senate Inquiry should find that loss of electricity through inevitable damage to overhead powerline infrastructure during fires, storms and cyclones has immediate, cascading and profound effects that impact on response, recovery and community resilience. Community lifelines including all forms of electronic communication, drinking and firefighting water, sewerage and hygiene, refrigeration and food, can all be impacted. The Senate Inquiry should recommend that new electrical supply installations in future be required to be underground, and that the Council of Australian Governments should develop a long term nationwide program prioritised to high risk areas, to eventually place the majority of electrical distribution lines underground.

1. Background - NSW and ACT fire history

The forested coastal fringe and rangelands of eastern NSW, including areas surrounding Canberra in the Australian Capital Territory (ACT) are fire-prone and have periodically experienced serious bushfire seasons based on cycles of hot, dry weather accompanied by strong winds. Western areas have also experienced serious fires, but less frequently due to the sparsely populated, semi-arid nature of the landscape resulting in low fuel levels during most seasons. An exception to this was the exceptional bushfire season of 1974-75 following unprecedented rainfall and growth of grasslands. Though large areas were burned, that season cannot be meaningfully compared to the 2019-20 bushfire season due to completely different fuel types, terrain, sparse population, and nature of the fires.

NSW and the ACT experienced serious bushfires with property, stock and life losses in:

- 1915
- 1925-26
- 1926-27
- 1936
- 1938-39 (about 174 homes destroyed)
- 1944 (150 homes destroyed in Blue Mountains, Gosford and Sydney)
- 1951-52
- 1957-58 (158 homes destroyed in Blue Mountains)
- 1968 (123 homes destroyed in Blue Mountains, 33 in the Illawarra)
- 1977 (49 homes destroyed in the Blue Mountains)
- 1979 (14 homes destroyed in Warringah; 6 in Hawkesbury)
- 1994 (206 homes destroyed)
- 2001-02 (109 homes destroyed)
- 2002-03 (86 homes destroyed)
- 2003 (487 homes destroyed in the ACT)
- 2013 (57 homes destroyed in Coonabarabran)
- 2013 (222 homes destroyed in Blue Mountains and Central Coast)
- 2018 (69 homes destroyed at Tathra)
- 2019-20 (2,486 homes destroyed).

(Luke & McArthur 1978; Doogan, 2006; NSW Parliament 2014; NSW RFS 2020b)

Historically, large property loss fires normally involved one or two days of serious fire weather where the McArthur Forest Fire Danger Index was over 50, accompanied by an El

Niño event and often also by drought, where multiple properties were impacted at the same time in an urban fringe setting.

The 2019-20 bushfire season was remarkable in that there were multiple days of Severe, Extreme and even Catastrophic fire danger over several months, there was no underlying El Niño event, and urban areas were not impacted. It is extraordinary and indicative of the size and extent of the fires that most property losses occurred on remote rural properties, in small villages, and on the outskirts of regional towns where properties were not as close together as, for example, suburbs in the Blue Mountains.

NSW experienced 21 days of Very High fire danger and above during the spring of 2019, eclipsing the previous record of 11 days recorded in spring 2002, and a long-term average of just 2 days going back to 1950 (BoM 2020d). There were 59 Total Fire Ban declarations, 11 statewide total fire bans, and 44 bushfire emergencies declared under s.44 of the Rural Fires Act (NSW RFS, 2020b).

2. Background - Victorian & South Australian fire history

Although Victoria comprises just 3% of Australia's land mass, 67 percent of all known civilian fatalities since the beginning of the 20th century (Blanchi et al. 2014), and around 50 percent of the economic losses due to bushfires have occurred in the state (Buxton et al. 2011). Nearly 80 percent of Australians were affected either directly or indirectly by the 2019-20 bushfires. Tragically, five Victorians lost their lives during the 2019-20 bushfires (Victorian Government 2020). More than 300 homes were destroyed in Victoria. The 2019-20 bushfire season has been Australia's most destructive fire season on record, with previous major bushfire events - Ash Wednesday (1983) destroying 2,000 homes in Victoria and 383 in South Australia, and Black Saturday (2009) destroying 2,029 homes in Victoria (AIDR 2020; Victorian Government 2020).

Victoria and South Australia experienced serious bushfires with life, stock and property losses in:

- 1851 Victoria (Widespread damage. 12 lives, about 5M ha, 1M sheep, and thousands of cattle lost)
- 1898 Victoria (2,000 buildings and 12 lives lost)

- 1926 Victoria (widespread damage and 60 lives lost)
- 1931-32 Victoria (20 lives lost)
- 1938-39 South Australia (90 homes lost)
- 1939 Victoria (650 buildings, the town of Narbethong and 71 lives lost)
- 1942 Victoria (20 homes and 1 life lost)
- 1943-44 Victoria (550 homes and 20 lives lost)
- 1952 Victoria (no information)
- 1955 Adelaide Hills SA (8 lives lost)
- 1961-62 Victoria (454 homes and 32 lives lost)
- 1965 Victoria (66 homes, 7 lives and 4,000 stock lost)
- 1967/68 Victoria (53 homes lost)
- 1969 Victoria (230 houses, 23 lives and 12,000 stock lost)
- 1977 Victoria (116 houses, 4 lives and 198,500 stock lost)
- 1980 SA. Adelaide Hills (35 homes lost)
- 1983 Victoria. Mt Macedon 1 February (50 houses lost)
- 1983 Victoria. Ash Wednesday 16 February (2000 homes, 73 lives and 270,000 stock lost)
- 1983 SA. Ash Wednesday 16 February (383 homes, 28 lives lost)
- 1985 Victoria (185 homes, 3 lives and 46,000 stock lost)
- 1997 Victoria (41 homes and 3 lives lost)
- 2001 SA. Eyre Peninsula (11 homes lost)
- 2003 Victoria (41 homes and 1.2M hectares lost)
- 2005 SA. Eyre Peninsula and Adelaide Hills (93 homes, 9 lives, 47,000 stock lost)
- 2005-06 Victoria (57 homes, 4 lives and 64,000 stock lost)
- 2006-07 Victoria (51 homes, 1 life and 1,741 stock lost)
- 2009 SA. Port Lincoln (10 homes lost)
- 2009 Victoria (2029 homes and 173 lives lost)
- 2011-12 SA (5.58M ha burned after rains stimulated grass growth)
- 2013 Victoria (5 lives lost)
- 2014 SA (10 homes lost)
- 2015 SA. Sampson Flat & Pinery (115 homes and 2 lives lost)

(Luke & McCarthur 1978; FFMV 2019; University of Adelaide 2020; CFS 2020)

It needs to be noted that previous serious bushfire seasons in Victoria and South Australia with extensive losses of life and property generally saw the most significant losses on 1 or 2 days of what would today be termed Extreme and Catastrophic (“Code Red” in Victoria) fire danger. The trend worldwide, including in Tasmania, Queensland, NSW and California

over the last 5 years, has been for there to be *multiple* days of very serious fire weather over longer, more extended fire seasons (Wallace-Wells 2019. BoM 2020d).

The fact that this fire season in NSW, compared to the previous worst fire season on record in 2013 where 222 homes were lost, resulted in losses more than 10 times greater (2,486 homes lost), should be deeply concerning to all Victorians and South Australians. If Victoria and South Australia suffered a similar increase in losses, more than 23,000 homes could be lost in a single fire season (using Ash Wednesday 1983 as a baseline). Similarly, in 1967 Tasmania experienced the loss of more than 1,293 homes and 62 lives in a single afternoon (AIDR 2020a).

It is not far-fetched to extrapolate and multiply historical property and life losses by a significant factor, particularly given the NSW and Queensland experience during the last fire season. California, which is similar in terms of bushfire risk to Victoria and South Australia, suffered losses of 10,000 homes in 2017, then about 20,000 homes with nearly 100 people killed in 2018, marking a 5-fold increase on previous heaviest losses during a single fire season (CalFire 2020a). California's escalating fire problem, also fuelled by climate change, shares features that are also challenging Australian firefighters: temperature extremes, extreme wind velocities and low humidity, drought, longer fire seasons, and more days of serious fire weather (CalFire 2020b).

As noted above, Victoria and South Australia have historically suffered their greatest losses on just one or two days of extreme or catastrophic fire weather. If, like NSW and Queensland in 2019-20, the whole of Victoria, South Australia and Tasmania experienced multiple days of Severe, Extreme and Catastrophic fire danger over an extended fire season, the types of losses being experienced in California could easily be imagined in Australia. This is the type of threat, driven by worsening climate change, that authorities must now consider and plan for.

3. The bushfire & climate change challenge

3.1 New South Wales & Queensland

The 2019-20 season's fires were incredibly extensive, even compared to recent severe fires elsewhere in the world. Around 21 percent of Australian temperate broadleaf and mixed forests was burnt, compared to the average annual area burnt for most continents, including Australia, which is generally below 5 percent, with the exceptions of Africa and Asia, which have average annual areas burnt of 8-9 percent (Boer et al. 2020).

It is well established that the bushfire season was “the most devastating in NSW history” (NSW RFS 2020a):

- More lives lost than in any previous bushfire season (25)
- 1000% more homes destroyed than in the previous worst bushfire seasons in NSW; 222 homes in 2013; 206 homes in 1994. *2,448 homes lost in 2019-20*
- More forested areas burned than in any previous NSW bushfire season; e.g. 800,000 ha in 1994; 744,000 ha in 2001/02; 118,000ha in 2013. *5.52 million hectares burnt in 2019-20.*

(NSW RFS 2020b)

Not every year produces serious fire weather and fuel conditions. NSW has experienced periodic serious bushfire seasons, linked to weather patterns, for thousands of years according to carbon records. Since European habitation, there have been serious, damaging bushfires in NSW approximately once every decade, or slightly longer (Luke & McArthur 1978).

Climate change has changed weather patterns and, in many areas, increased the frequency of serious bushfire seasons (BoM 2018c). For example, the Blue Mountains west of Sydney, an area that has been subjected to significant property loss and sometimes loss of lives due to bushfires, experienced serious bushfire seasons in 1925-26, 1936, 1944, 1957, 1968, 1977, 1994, 2001-02, 2007, 2013, and 2019-20 (Luke & McArthur 1978; NSW Parliament 2014; NSW RFS 2020a). For decades the frequency of large fires was consistently around a decade apart. This changed after the 1994 fires with the return period since then being around six (6) years; a consistent observable change that can be explained by changing weather patterns driven by climate change.

Queensland experienced its two most damaging bushfire seasons in 2018 and 2019. Many homes and other buildings were lost, and extensive areas burned including areas of sub-tropical and temperate rainforest formerly not considered prone to fire (BoM 2019b; Queensland Government 2020). In 2019, Queensland experienced almost a third of all homes lost to bushfire since records began, and more than in any previous bushfire season (Hannan 2019b). Queensland has been experiencing an ongoing trend of longer, hotter bushfire seasons, and more days of Very High fire danger and above (Climate Council 2018a; BoM 2019a).

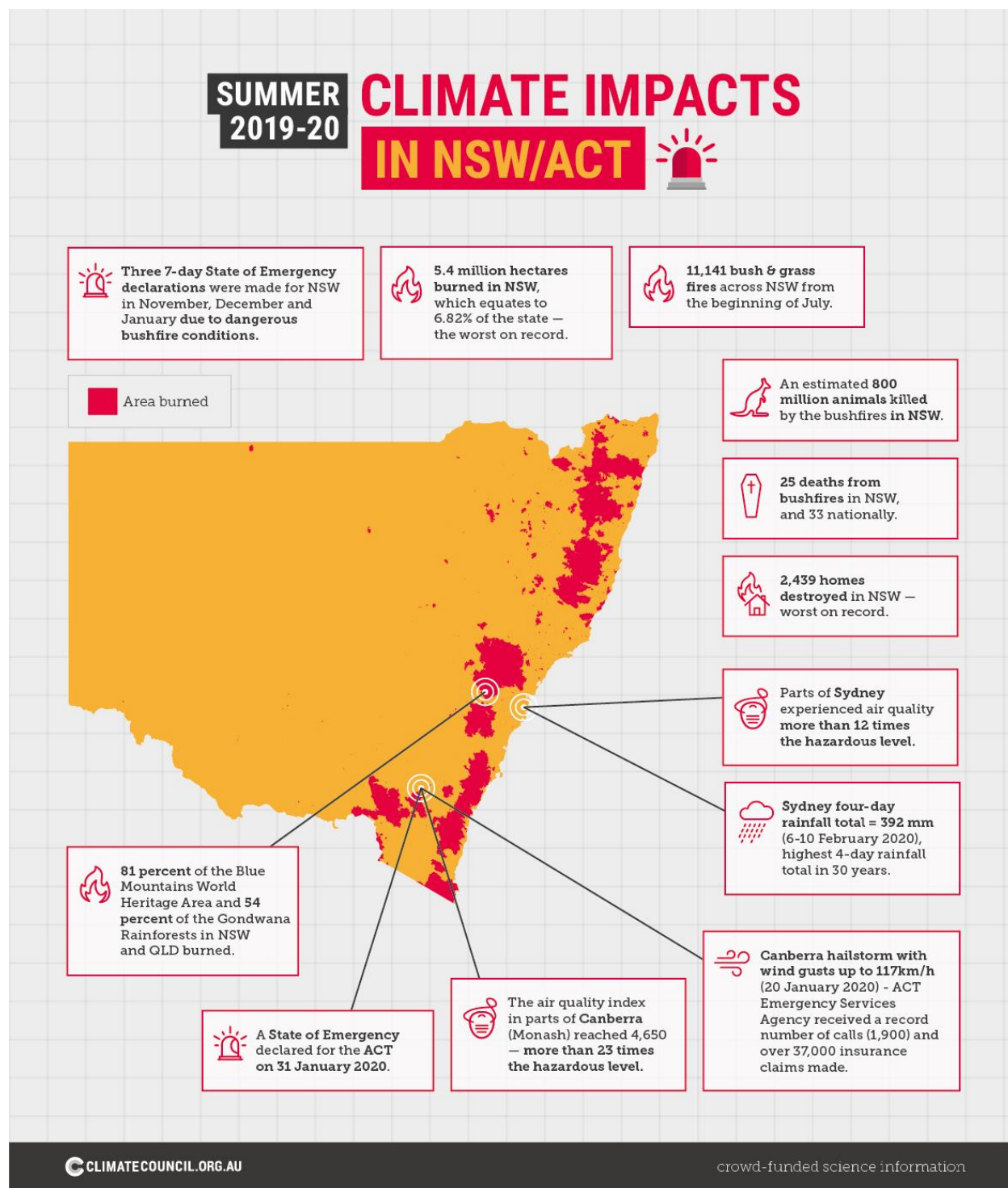


Figure 1: Summer 2019-20 climate impacts in NSW. Source: Climate Council (2020a).

3.2 Victoria and South Australia

According to the Victorian Department of Environment, Land, Water and Planning (DELWP) preliminary bushfire report summary, the fires (as at 11 January 2020) had impacted at least 60 percent of over 50 national parks and nature reserves in Victoria (DELWP 2020). The report states that “given that a significant area of habitat across Victoria has now burnt multiple times since 2000, this could result in regeneration failure for Alpine Ash” (DELWP 2020, p 24). In addition, the Warm Temperate Rainforest in Victoria are of “immediate concern”, with 70 percent within bushfire affected areas in 2019-20 (DELWP 2020, p 42).

South Australia also experienced extensive property losses, particularly due to fires that broke out on Kangaroo Island where up to 48% (210,000 ha) of the island was burned and two lives were lost, and at Cuddlee Creek. Across SA a total of 188 homes were destroyed, another 33 were seriously damaged, and 3 lives were tragically lost (SA DHS 2020).

Bushfire conditions are now more dangerous than in the past, and the risk to life, property and the environment has increased. Fire seasons have lengthened in Victoria and South Australia, and the number of days of Very High Fire Danger and above have increased, reducing windows of opportunity for land managers and fire services to conduct hazard reduction burns (Climate Council 2014a; 2020b).

3.3 The core problem and what must be done

ELCA contends that we are now experiencing the real and rapidly escalating costs of failing to act on the underlying causal factor of escalating bushfire and natural disaster hazards: climate change driven mainly by greenhouse gas emissions from the burning of coal, oil and gas.

During the bushfire season diversionary tactics appear to have been used extensively to take attention away from governmental inaction on emission reductions and climate change. These included falsely blaming the Australian Greens and their supporters for alleged reductions in hazard reduction burning, falsely blaming “arsonists” for starting most of the fires, and false assertions like “we’ve had bad fires like this before”. Basic research quickly refutes such myths and assertions; they are irresponsible and misrepresent the factual basis upon which action must be taken to safeguard life, property and the environment, and the safety of future generations. They therefore need to be comprehensively refuted on the basis of evidence in the Senate Inquiry report so that no further time or resources are needlessly wasted.

A simple analogy: when a pot on the stove boils over, there is no point trying to continually mop up boiling water: obviously, the cause of the problem – the heat source, must be dealt with. In relation to bushfires and climate change: the worldwide fire problem has reached a point where fire services can no longer cope. The pot (warming climate) is boiling over, but governments around the world, with the Australian Government being a significantly culpable party, are resisting efforts to reform economies and deeply and rapidly reduce greenhouse gas emissions.

The Senate Inquiry has a duty to help protect our firefighters and the communities who rely upon them, by dealing with the core problem that is driving disastrous bushfire seasons: by rapidly and deeply cutting greenhouse emissions, eventually enabling the risk to be reduced back to manageable levels.

4. How climate change aggravated the 2019-20 bushfire crisis

4.1 Unprecedented weather, fires, and broken records

After suffering significant property losses through winter and spring, NSW in particular was primed for the worst bushfire conditions ever experienced by humans in Australia. In December 2019, more than 2000 bush and grass fires burned throughout the month in NSW, and other significant fires broke out in South Australia, Tasmania and Victoria. From 12 December, a slow-moving hot air mass developed over Western Australia and started to move from west to east across the country. This resulted in a series of days above 40°C in Perth from 13-15 December and then a swathe of broken records for daily December maximum temperatures in locations across South Australia, Victoria, ACT and NSW, southeast Queensland, Central Australia, and much of Tasmania. For a number of locations, records were set for the warmest day for any time of the year, and on two consecutive days (17 and 18 December) records were broken for the national area-averaged maximum temperature (40.9°C and 41.9°C respectively) (BoM 2020b). Heavy smoke blanketed Sydney, especially throughout December, as the Gospers Mountain Fire burned out of control.

As the heatwave arrived on the east coast, catastrophic conditions were again forecast for the Greater Sydney Region (the second time this has ever occurred), marking the beginning of another seven-day State of Emergency for New South Wales from 19 December. The week ending 24 December 2019 was Australia's hottest week on record, and the month as a whole was Australia's hottest December on record (3.21°C above average, surpassing the previous December record set in 2018 by more than a full degree). It was also the hottest month on record for minimum and maximum temperatures, with the national maximum

temperature an astounding 4.15°C above average. The monthly accumulated FFDI was also the highest on record for any month since records began in 1950 (BoM 2020a).

The end of 2019 and the first days of 2020 brought particularly extreme fire weather to southeastern NSW and eastern Victoria, with numerous locations recording their hottest January day on record on 4 or 5 January across southeastern Australia. Bushfires flared on New Year's Eve 2019, hitting many small towns on the south coast of New South Wales, destroying hundreds of homes including around Batemans Bay, Mogo, Lake Conjola and Cobargo and tragically killing nine people. In an unprecedented move, the New South Wales Government issued evacuation orders for the south coast prior to New Year's Eve, a commendable decision that almost certainly saved many lives.

Another seven-day State of Emergency was declared from 3 January 2020 for NSW. From 27 January until the end of the month, a very hot air mass brought high temperatures to southern Australia. On 31 January, as temperature records were broken in locations across NSW, Victoria and Tasmania, a State of Emergency was declared in the Australian Capital Territory as the Ororral bushfire grew to eight percent of the territory's land area, threatening homes and properties there and in New South Wales (ACT Government 2020).

ELCA submits that the evidence is irrefutable – climate change caused by the burning of coal, oil and gas super-charged the 2019-20 bushfire season. It is not possible to “adapt” to such catastrophic conditions and they can only be partially mitigated. There needs to be a clear understanding within the community, media and all levels of government that the base cause of extreme weather leading to natural disasters must be addressed through rapid and deep cuts to greenhouse gas emissions, for the sake of future generations.

4.2 Drought and long term drying

The ongoing drought coupled with increasing periods of extreme heat, both aggravated by climate change, set the scene for the catastrophic fires in the summer of 2019-20. The bushfire season started in winter and was the worst on record for NSW and Queensland in terms of intensity, area burned, and the number of lives and properties lost. The season was very significant in Victoria and South Australia, and fires also affected Tasmania and Western Australia.

Bushfires rely on five main factors to take hold and spread: high temperatures, low rainfall, low humidity, strong winds and a suitable fuel source. 2019 was the hottest year on record across Australia with the mean temperature 1.52°C above average and mean maximum temperature 2.09°C above average (BoM 2020b) (see Figure 2 below).

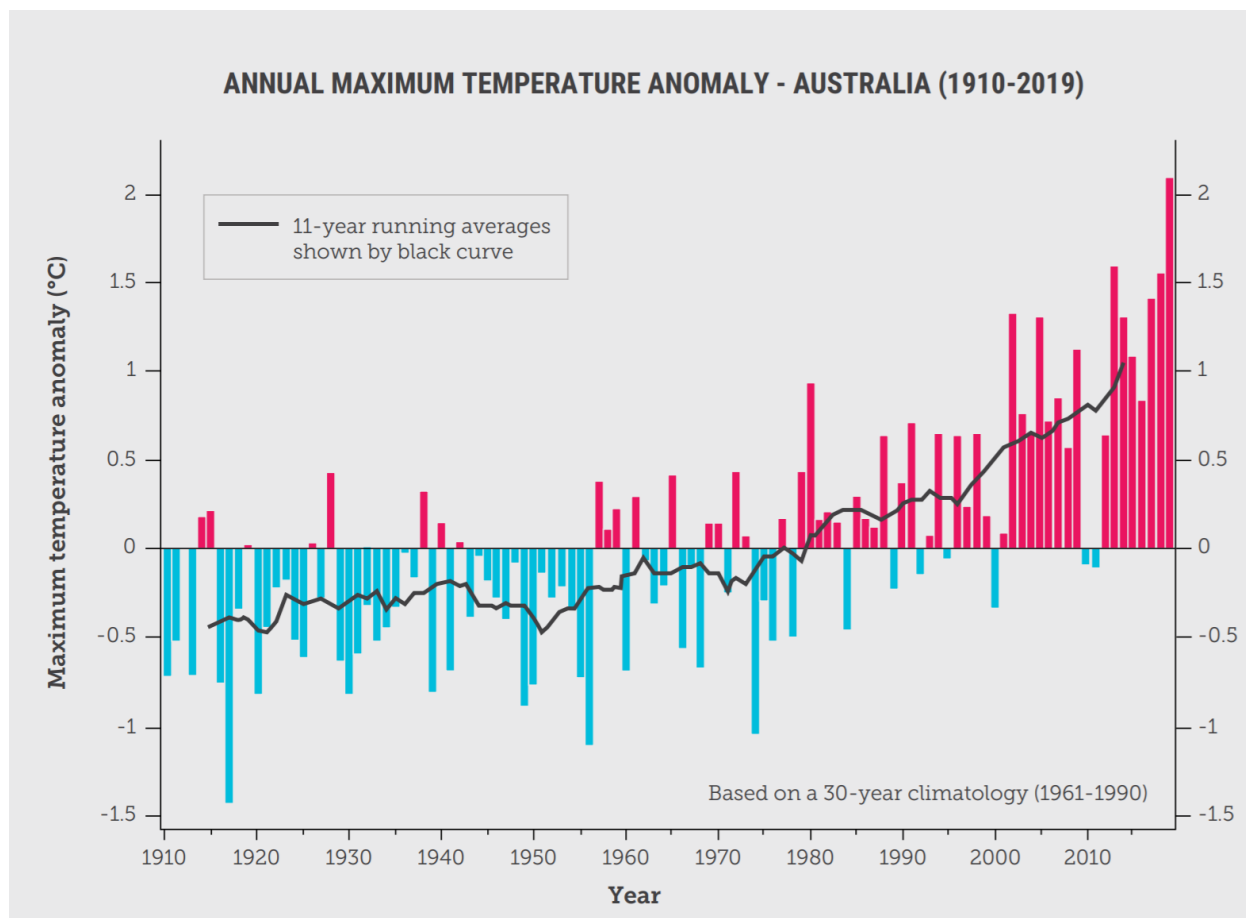


Figure 2: Annual maximum temperature anomaly Australia (1910 to 2019). Source: BoM (2020a).

It was also the driest year on record across Australia with rainfall 40 percent below average (BoM 2020b). For the January to October period, rainfall was 70 to 80 percent below average in some locations in northern New South Wales (BoM 2019a). The dry conditions throughout the year came on the back of prolonged rainfall deficiencies across most of southeastern Australia since the beginning of 2017, underpinning one of the worst droughts on record. Victoria's rainfall in 2019 was about 28% below average, and most of Gippsland, the Mallee, northern and northeastern districts, and parts of the Wimmera and central districts had annual rainfall totals in the driest 10 per cent of records (decile 1) (BoM 2019b). The dry conditions throughout the year came on the back of prolonged rainfall deficiencies across most of southeastern Australia since the beginning of 2017, underpinning one of the worst droughts on record (Figure 3 below shows the 2018 to 2019 rainfall trends).

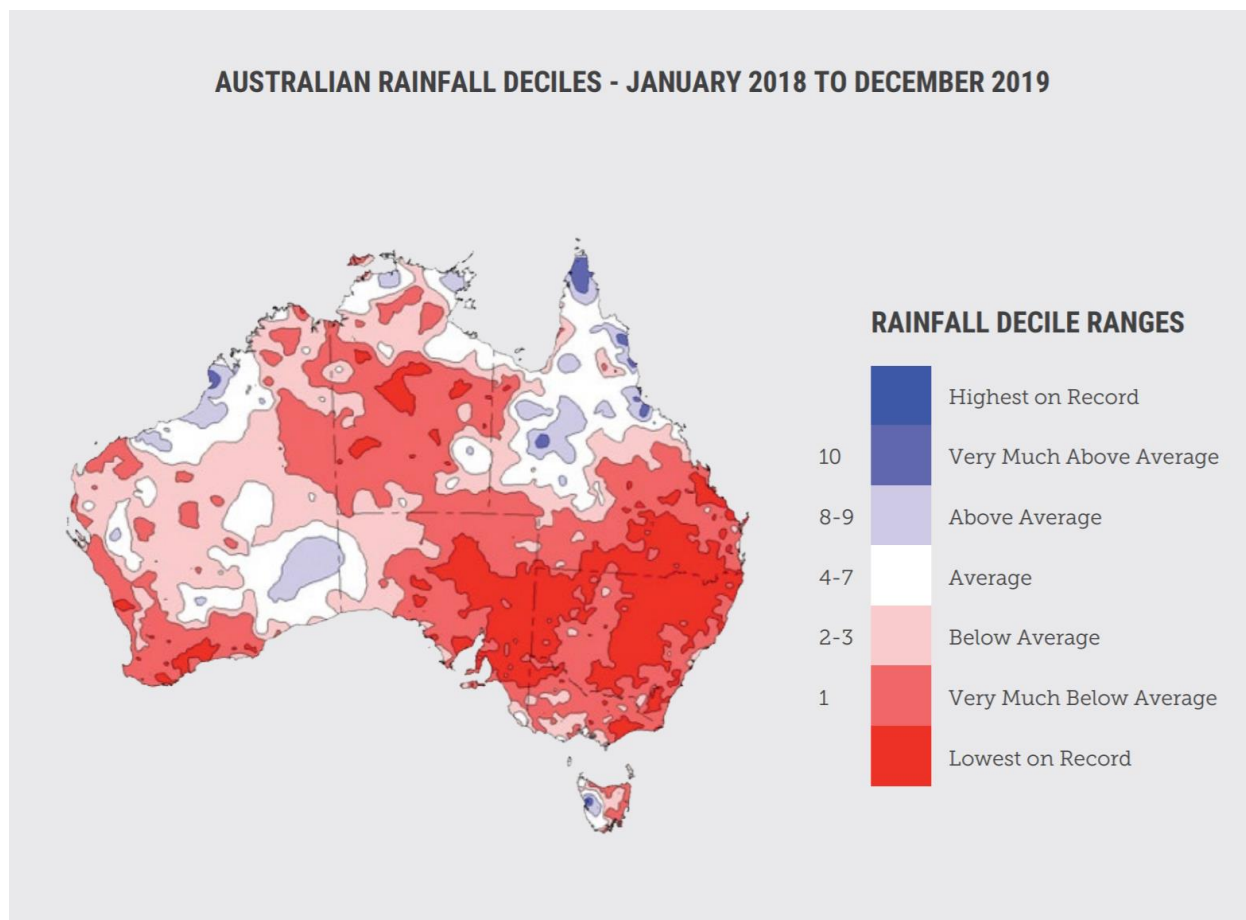


Figure 3: Australian rainfall deciles – 1 January 2018 to 31 December 2019. Source: BoM (2020b)

In eastern Australia the prolonged dry conditions over the year contributed to the drying of vegetation, making bushfire fuels more flammable, and creating the perfect conditions for fires to take hold and spread quickly, given a source of ignition and the right weather. Prolonged heat also increased evaporative demand, further exacerbating soil and vegetation dryness and increasing the amount of “available fuel” which in turn added to fire intensity, convection, spotting distances, and intensity of ember attack. Unsurprisingly, the annual accumulated McArthur Forest Fire Danger Index (FFDI) was the highest on record in 2019 (measured since 1950) (BOM 2020e).

4.3 Rising temperatures

Australia’s climate has warmed by more than 1°C since 1910 (CSIRO and BoM 2018). Every year since 2013 has been amongst the ten hottest years on record for Australia, with only one of the ten hottest years (1998) occurring before 2005 (BoM 2020c). Cool season rainfall has also been declining across southern Australia over recent decades. In the

southwest of Australia, May-July rainfall has decreased by around 20 percent since 1970 and in the southeast, April-October rainfall has decreased by around 11 percent since the 1990s (CSIRO and BoM 2018). These trends have contributed to an increase in the length of fire seasons and to the severity of dangerous fire weather across large parts of the continent (CSIRO and BoM 2018).

4.4 El Niño no longer coupled with serious fire seasons

Although the El Niño–Southern Oscillation (ENSO), commonly a driver of serious bushfire seasons in eastern Australia remained neutral throughout 2019, a very strong positive Indian Ocean Dipole also contributed to low rainfall across Australia over the past year, building upon longer-term rainfall deficiencies in eastern Australia since the beginning of 2017. Apart from NSW in 2013, all previous major bushfire seasons with heavy losses of property in NSW occurred during El Niño events, but climate change is increasingly swamping the influence of natural variability (Gergis and Carey 2020). This should be of significant concern – when an El Niño inevitably returns, it is likely to result in elevated temperatures and reduced rainfall, so the prospect of an even more disastrous bushfire season at some time in the future is likely.

4.5 Longer fire seasons

As the climate continues to change, bushfire seasons are starting earlier and lasting longer. The length of bushfire seasons has been shown to have increased markedly (Clarke et al 2013; Climate Council 2015; BoM 2018c). Commonly, for practical purposes, the NSW bushfire season now commences in early August each year rather than October as enshrined in the Bush Fires Act 1949 and its successor, the NSW Rural Fires Act 1997. Fire seasons now sometimes extend further than 31 March which is also enshrined in the aforementioned Acts. Longer fire seasons have been accompanied by record-setting periods of serious bushfire danger very early in the bushfire season (Hannan 2019a).

Major fires burned across Queensland and northern New South Wales from July 2019. Fires ignited in the Northern Territory and Western Australia in September, and across Tasmania and South Australia by late October. By late November, every state was alight when fires broke out in Victoria following lightning strikes in East Gippsland (Canberra Times 2020; Victorian Government 2020).

Twenty-one local government areas in New South Wales commenced their Bushfire Danger Period in August 2019, and a further 53 local government areas commenced their Bushfire Danger Period in September (NSW RFS 2019a). These declarations were in contrast to the statutory Bushfire Danger Period in New South Wales, which officially spans from 1 October to 31 March. Commencement of serious bushfire weather and outbreaks of serious fires from August in New South Wales has become common in recent years.

In April 2018 a major fire threatened hundreds of properties in south and south west Sydney when hot and dry conditions were accompanied by very strong westerly winds over a number of days (BOM 2018a). Just prior to this, 69 homes were lost in late March at Tathra on the NSW Far South Coast. The Bureau of Meteorology found that fire danger indices experienced on the South Coast and other parts of NSW were unprecedented at that location at that time of year (BoM 2018b). Further fires broke out in south west Sydney in July, and properties were lost when major fires broke out at Bega, Ulladulla and Port Stephens in August 2018.

4.6 Overlapping fire seasons

Longer fire seasons in each state and territory, previously sequential, are increasingly *overlapping*. Australian fire seasons are increasingly overlapping with those in the northern hemisphere (Climate Council 2019a). Over the previous century it had been well established that fire seasons started in the north and moved south, consecutively affecting different jurisdictions, thereby enabling the sharing of firefighting plant, equipment and firefighters (Luke & McArthur 1978). This was the basis of fire service operational paradigms for decades but can no longer be relied upon.

Overlapping fire seasons reduce the ability of Australian fire services to defend life and property and contain major fires now and into the future, because they limit the sharing of vital personnel and equipment. The basic issue facing all fire services now is that jurisdictions cannot release resources to assist others when their own state or territory is burning – an increasingly common occurrence that reduces overall firefighting capacity when it is needed most.

Increasing overlap with northern hemisphere fire seasons is well documented (Wallace-Wells 2019). A major problem is limited access to large firefighting aircraft at the start of Australian fire seasons, because they are still being used in places like California during its extended fire season (i.e. we rely on the same pool of firefighting equipment). This has significant relevance to how the relatively small fleet of leased large firefighting aircraft (fixed and rotary wing) are shared during a crisis – reinforcing the fact that there are simply not enough to go around.

4.7 More days of serious fire weather each year

The 2019-20 bushfire season was remarkable in that there were multiple days of Severe, Extreme and even Catastrophic fire danger over several months, there was no underlying El Niño event, and urban areas were not impacted.

It is extraordinary and indicative of the size and extent of the fires that most property losses occurred on remote rural properties, in small villages, and on the outskirts of regional towns where homes were not in close proximity to each other.

Based on records going back to 1950, NSW experienced 21 days of Very High fire danger and above during the spring of 2019, eclipsing the previous record of 11 days recorded in spring 2002, and a long-term average of just 2 days (BoM 2020d). There were 59 Total Fire Ban declarations, 11 statewide total fire bans, and 44 bushfire emergencies declared under s.44 of the Rural Fires Act (NSW RFS, 2020).

4.8 Fire weather worsening

Data gathered and analysed by the Bureau of Meteorology has established that fire weather across many regions of Australia, and in particular southern and eastern Australia, is worsening as a direct result of increasing temperatures and less reliable cool season rainfall, a trend that is “consistent with human induced climate change (anthropogenic global warming)” (BoM 2018a; Dowdy 2017).

The 2019-20 fire season was an extreme example of this. In most districts of northeast New South Wales, 6 September 2019 had the highest regionally averaged daily Forest Fire Danger Index (FFDI) for September, based on all years since 1950 (BoM 2019a). Numerous bushfires burned across southern Queensland and northern New South Wales over the 5-9 September period, destroying many homes.

On October 26, the Gospers Mountain fire was ignited by lightning in the Wollemi National Park. The fire burned through more than 512,000 hectares throughout November, December and January, making it the largest forest fire ever recorded in Australia. It was eventually extinguished by heavy rains in February.

In late spring, catastrophic fire danger ratings were again experienced at locations and times of the year never before recorded. From 8 November, fire conditions flared in the Clarence Valley in New South Wales, destroying hundreds of homes across the region. For the first time since the catastrophic fire danger rating was introduced in 2009, it was forecast for Greater Sydney on 12 November 2019 (NSW RFS 2019b). A seven-day State of Emergency was declared for New South Wales. A number of fires started in Lane Cove National Park and quickly reached emergency warning level, threatening homes in Turramurra.

Despite atmospheric stability readings (cHaines index¹) indicating that it would be very unlikely, several fires created their own weather systems and *pyrocumulous* clouds on that day, leading to very rapid fire spread, long-distance spotting, and intense fire conditions. Catastrophic fire conditions were also forecast in numerous places in South Australia on 20 November and parts of Victoria on 21 November 2019 (catastrophic conditions are known as Code Red in Victoria).

¹ The Continuous Haines (C-Haines) index can be used to predict unstable atmospheric conditions that can contribute to the development of pyrocumulonimbus (pyroCb) events (fire-caused storms). The C-Haines Index combines measures of the vertical rate of change in air temperature and the change in moisture content of the lower atmosphere to provide a score out of 13. A high C-Haines index value indicates an unstable atmosphere that may favour pyroCb formation.

4.9 More extreme bushfire events

Climate change could be driving an increase in the occurrence of extreme bushfires in Australia (Dowdy & Pepler 2018; Dowdy et al. 2019; Climate Council 2019c). Bushfires can transition to more extreme events such as pyroconvective interactions (when fires burn in close proximity and influence each other, spreading faster and in unpredictable ways) and pyrocumulonimbus events (fire-generated storms). Extreme bushfires have a high level of energy, and exhibit chaotic and unpredictable behaviour, which are often harder or impossible to control and more dangerous to both firefighters and communities (Sharples et al. 2019).

Fires that burn in close proximity can influence each other due to pyroconvective interactions between individual fires. Commonly this is seen when intense spotting (when embers from a primary fire are blown downwind and ignite new spot fires) causes multiple fires to form and coalesce. As the primary fire and spot fires interact, local rates of spread can increase, sometimes in unexpected directions. This can result in broad “flaming zones” which can entrap firefighters and increase the likelihood of extreme bushfires (Sharples et al. 2019). Pyroconvective conditions are more likely to occur when atmospheric instability is high, combined with dangerous near-surface conditions (e.g. low humidity, strong winds and high temperatures) (Dowdy & Pepler 2018; Climate Council 2019c). Modelling suggests that the increased risk of extreme fire weather events under the influence of climate change may lead to increased incidence of pyro-convective fire behaviour. Australia has already seen an increase in these events with the 2003 Canberra bushfires, 2009 Black Saturday bushfires in Victoria, and the 2019-20 fire season in Queensland, NSW and Victoria, all examples of pyroconvective events (Dowdy & Pepler 2018; Dowdy et al. 2019; Climate Council 2020a).

4.10 Increase in fire-generated storms

Pyroconvective events (fire-generated storms) occur when bushfires couple with the atmosphere, generating explosive thunderstorms that can include strong downdrafts, gusting winds and lightning, making bushfire behaviour very dangerous and unpredictable. These storms do not produce any useful rain, therefore serving to increase rather than decrease fire activity. One of the features of the extreme 2019-20 bushfire season has been a very significant increase in the number of fire-generated storms.

Pyroconvective events were previously considered rare, with Australia experiencing only two confirmed and two possible fire-caused storms between 1978 and 2001 (McRae et al. 2015). Since 2001, 78 fire-caused storms have been recorded, including a staggering 33 percent increase in 2019 (with around 15 fire-caused storms in the Victorian high country in March 2019 alone).

Fire researchers estimate that an additional 30 fire-caused storms have occurred since September 2019, with a further 15 possible fire-caused storms being investigated (The Guardian 2019). This represents an astounding and deeply concerning shift in the frequency of these events. Veteran firefighters, including members of ELCA have limited experience of such conditions, and established firefighting doctrine does not adequately consider the dangers and variables associated with pyroconvective activity. In other words, fire-generated can cause the death of firefighters, as evidenced during this fire season.

4.11 Increasing smoke impacts and deaths

Heavy smoke blanketed Sydney and other capital cities, especially throughout December, as the Gospers Mountain Fire burned out of control. A recent report estimates that up to 417 early deaths occurred as a result of particulates contained in bushfire smoke over the summer (Arriagada et al. 2020). This figure could be higher, as the long-term contribution to morbidity and mortality from the intense and chronic exposure over summer is not yet known.

4.12 Increasing environmental impacts

The significant extent of the fires resulted in serious ecological damage. An estimated one billion animals perished in the fires (University of Sydney 2020). Vast, silent stretches of skeletal forests where everything, including tree canopies, were consumed by fire are testament to the ecological disaster that has occurred. As previously outlined, it is estimated that 21% of Australia's south eastern broadleaf forests have been burned, compared to an average of 3% in any given fire season. Because of the number of days of Very High fire danger and above leading to extreme fire behaviour on multiple days, there are few unburned patches left in many areas to provide refuge for wildlife. Many of the few animals that survived the most severe fires have likely since succumbed to starvation, injuries and predation by feral animals.

It is estimated in Victoria alone that 170 species were affected, including 19 mammal species, 13 frog species, ten reptile species, nine bird species, 29 aquatic species and 38 plant species (Andrews 2020). There were stark media images showing the devastation caused to sensitive koala habitats on Kangaroo Island.

4.13 Increasing economic impacts

Economic costs have been very high with an estimated \$4.5 billion lost in tourism due to bushfires. The bushfire smoke that blanketed Greater Sydney is estimated to have reduced the city's gross domestic product by around \$12-50 million per day (SMH 2019). About 23,000 fire-related insurance claims were lodged between November and February in NSW, Queensland, Victoria and South Australia, totalling about \$1.9 billion (ICA 2020).

4.14. Fire and disaster risks will continue to escalate without genuine and sustained efforts to tackle climate change.

The previous sections detailed settled, irrefutable science: that climate change fueled the extreme weather experienced during the 2019-20 bushfire season, which in turn resulted in fires that could not be controlled by humans.

The severity and frequency of extreme weather-driven events – including bushfires and smoke – will continue to increase in coming decades, with commensurate increases in costs. This is due to greenhouse gases that have already been, and continue to be, emitted. If Australia fails to take strong action to rapidly phase out coal, oil and gas as part of a global effort, the impacts of climate change, including worsening bushfire and natural disaster conditions, will continue to escalate.

Australia urgently needs a plan to cut domestic greenhouse gas emissions to net zero and to phase out fossil fuel exports, because we are one of the world's largest polluters. Australia is the 14th largest emitter of greenhouse gases globally and we emit more per person than any other developed country. We are also the third largest exporter of fossil fuels (The Australia Institute 2019).

What we as Australians do, matters. The longer we delay, the harder the problem will be to solve. We do not have the moral authority to call on other countries to take action on emissions if we fail to do so, or continue to use questionable accounting to erroneously claim that we are “doing our bit”. It is unethical and morally repugnant to leave this escalating, slow moving disaster for our children and grandchildren to try to fix.

As Australia continues to face a worsening bushfire threat, it will be critical that a clear forward plan is in place for all Australian governments to support emergency services and fire management agencies, coupled with strong federal policy to rapidly tackle the root cause of the problem – emissions and climate change. The ongoing threat from uncontrolled bushfires effects confidence to invest in fire-prone areas in rural Australia.

There is also the time taken to do prevention works and the time away from work when fighting fires that is now often for extended periods.

Recommendation 1: The Senate Inquiry should find that the 2019-20 bushfires were unprecedented and detail how they were driven by extreme weather conditions, by elevated fire danger indices on multiple days, and by cascading events including drought, heatwaves, dry thunderstorms causing lightning ignitions, and an unprecedented number of pyroconvective events influencing extreme fire behaviour. In doing so, the Senate Inquiry should detail and explain for the historical record the irrefutable fact, based on a large body of scientific data and research over decades, that the extreme weather experienced in 2019-20 was outside previously expected natural variation, and was clearly driven by anthropogenic climate change.

Recommendation 2: The Senate Inquiry should detail how anthropogenic climate change has resulted in Australian bushfire seasons lengthening, worsening, and overlapping between states and territories, limiting the ability of Australian firefighting agencies to assist each other, while also overlapping with northern hemisphere fire seasons, limiting the availability of large firefighting aircraft, particularly between August and November each year.

Recommendation 3: The Senate Inquiry should detail how the long term and continuing climate change-driven increase in bushfire and other natural disaster risks in Australia is harming the economy, the environment, and costing people their lives and livelihoods. For the sake of historical accuracy and to underline the magnitude of the 2019-20 fires and upward trajectory of future risk, the Senate Inquiry should include the number of deaths from smoke impacts as being directly caused by the bushfires, resulting in a final death toll of at least 450.

Recommendation 4: The Senate Inquiry should detail how strong climate mitigation and adaptation policies are required from all levels of government in order to start to address the escalating extreme weather, bushfire and natural disaster risks driven by climate change. The Federal Government should coordinate all levels of government in accelerating and increasing measures to tackle climate change. More substantial action is required to reduce Australia's emissions, including accelerating the transition to renewables and storage technologies, non-polluting transport, infrastructure, food production and the phase out of fossil fuel projects. The Federal Government must strengthen its current suite of ineffective climate policies and commit to meeting and beating emission reduction goals and renewable energy targets. Because many climate impacts are already locked in, all levels of government will play a critical role in building community preparedness and resilience.

5. How climate change has forced operational practices to change

5.1 Historical paradigm shifts in Australian firefighting doctrine

Australia has experienced many serious bushfires in the past, as detailed earlier in this submission. As a result, there have been many significant changes to firefighting practices and doctrine drawing upon lessons that have been hard-learned, often at the cost of lives, property, the economy and the environment.

Significant historical changes include:

- Formation of volunteer bushfire brigades in response to major bushfires such as those in 1851, 1898 and the early 20th century.
- Creation of modern fire prevention practices and legislation following the fires of 1939.
- Establishment of the long-standing doctrine of “stay and defend”, a reluctance to force evacuations, and public education detailing how suitable preparation and precautions can make bushfires a survivable phenomena, after the fires of 1939.

- Commencement of broad-scale burning programs by land management agencies to manage forest fuels in the 1960s and 70s, particularly in Western Australia following the Dwellingup fire disaster of 1961.
- Establishment of new firefighting command and control systems (Australasian Inter-service Incident Management System – AIIMS), better approaches to firefighter protection (uniforms and vehicles), and work on standards to make the built environment more resilient following the Ash Wednesday fires of 1983.
- Recognition of a greater need for national coordination and funding for firefighting aircraft following the 2003 Canberra bushfires.
- Recognition of the need for national research and information capability to front line land management and emergency services to adapt following the 2003 Canberra bushfires.
- Fundamental shift in fire service doctrine from “stay and defend” to “leave early”, and “primacy of life” following Black Saturday 2009.
- Fundamental shift in the focus of fire agencies during catastrophic fires, to information gathering and dissemination to the public, recognising that fire suppression efforts are sometimes futile, following Black Saturday 2009.

It is notable that the most significant shifts in firefighting doctrine in Australia have been driven by Senate Inquiry s; notably the Stretton Senate Inquiry into the 1939 bushfires, and the Teague Senate Inquiry into the 2009 Black Saturday bushfires.

The 2019-20 fires were larger and more destructive than any previous bushfires in Australia, with tragic loss of life, including of firefighters. It is hoped that the Binskin Senate Inquiry will also enter the history books – as the commencement of a national acknowledgement that the fight against bushfires and natural disasters must be underpinned by a concerted effort to stabilise, then reduce emissions, eventually reducing global temperatures that are driving worsening and more dangerous extreme weather.

5.2 New fire danger ratings

Worsening fire weather and fire danger patterns driven by climate change forced Australia to change the long-standing fire danger rating system in order to reflect unprecedented conditions.

Following the 2009 Black Saturday fires in Victoria, the Australasian Fire Authorities Council (AFAC) and the Bushfire Cooperative Research Centre (CRC) worked with state, territory and federal governments to change the fire danger rating and warning framework that had been in place in Australia for decades.

A new rating, Catastrophic, known as Code Red in Victoria, was introduced (FFDI off the McCarthur scale, above 100), and a new rating of Severe was introduced in between Very High and Extreme, reflecting the very different fire behaviours experienced when the Fire Danger Index measured on the McCarthur Forest Fire Danger Index reaches 75.

Catastrophic fire danger or indices above 100, were formerly rare. As previously detailed, they were recorded in multiple locations and on multiple days in Queensland, NSW, Victoria and South Australia in 2019-20.

5.3 New aerial firefighting strategies introduced

Following the 2009 Black Saturday bushfires, fire agencies in Victoria and NSW trialed large and very large aerial water bombers, which had not been used extensively before in Australia. The trials were deemed successful, and they were adopted as part of the standard firefighting approach in Australia. Up to 11 large and very large air tankers were deployed in 2019-20.

5.4 Large-scale international assistance

The use of firefighters from other countries, other than New Zealand, has been rare in Australia and generally not necessary due to the ability of fire authorities in the different states and territories to share firefighting personnel and equipment due to the sequential onset of dangerous fire weather each summer and spring. Changed weather patterns resulting in lengthening fire seasons and significant overlap between states and territories as a result of climate change is now restricting the sharing of firefighting resources.

In 2019-20 more than 1,000 firefighting personnel from countries including NZ, the USA and Canada were utilised in Australia – the largest contingent in history. And it wasn't without sacrifice too, with three US personnel tragically killed. This highlights how the Australian bushfire problem is changing and worsening under the influence of climate change.

5.5 New approach to public safety: leave early

Fires that occur in catastrophic conditions cannot be fought safely, and lives and homes are put at great risk. Fire authorities now recommend that people “leave early” when such conditions are forecast.

Following the 2009 Victorian fires, and with the 2003 Canberra fires freshly in mind, fire services abandoned the operational doctrine that can be summarised as “stay and defend”,

developed following the Stretton Senate Inquiry into the 1939 bushfires. The Teague Senate Inquiry into the 2009 fires found deficiencies in the former doctrine of fire services, based as it was on an assumption that residents had a bushfire plan and knew how to prepare: something that proved incorrect (Teague 2010).

Research findings from the Bushfire CRC showed that when fire danger indices pass 100 on the McArthur scale, fires may not be survivable. “Stay and Defend” was replaced with a policy of “primacy of life”, and new national public education campaigns based on “Stay or Go” and “Leave Early”.

The changed paradigm was the direct result of the worsening of bushfire conditions in Australia, driven by climate change.

5.6 Emergency warnings introduced

Following Black Saturday, the Teague Senate Inquiry established that fire services did not provide adequate verified intelligence or advice to the public about what was happening, what to do and where to go in order to find safe refuge (Teague 2010).

Fire services realised following the 2009 fires that due to climate change, on the worst days, direct firefighting would often become secondary to providing information so that people could be warned and have a better chance of survival. This again is a major operational paradigm shift for fire services based on more intense fires being experienced as a result of ongoing and worsening climate change.

This significant paradigm shift resulted in establishment of a national early warning framework with 3 fire statuses: *Advice*; *Watch and Act*; and *Emergency Warning*. Publicly available telephone Apps were also introduced, such as Fires Near Me.

Recommendation 5: The Senate Inquiry should detail how anthropogenic climate change has resulted in Australian emergency services radically and by necessity changing long-standing operational paradigms so that they can better meet critical needs of communities threatened by escalating bushfire risks.

6. Research and information capability in a rapidly changing climate

6.1 Dedicated research capability required

Given worsening extreme weather caused by climate change, sustaining, and in some cases improving research capability will be critical to ensuring that fire and emergency services are properly informed, protected, and resourced into the future. Fire and emergency services, just like the military, need to know the strategic environment in which they will be operating now, and in 30 years, so that they can adequately prepare. To do this adequately, they need access to a significant research capability and verified intelligence.

Over the last decade or more, the Bushfire Cooperative Research Centre, then the Bushfire & Natural Hazards Cooperative Research Centre (CRC) have each driven, in consultation with fire and emergency services and their peak council, AFAC, ground-breaking research into bushfires and natural disasters. The research has enhanced understanding of the effects of climate change and changing risk patterns, informing development of strategies to adapt to and mitigate risks as far as possible. Practical applications of the research extend to areas as diverse as cabin protection systems for fire trucks, personal protective uniforms, and decision-making strategies for command staff.

The Federal Government recently confirmed during Senate Estimates in Canberra that the Bushfire & Natural Hazards CRC would not be funded past 2021 (SBS 2020). This potentially removes critical research capabilities at a time of accelerating change and could leave fire and emergency services without the necessary knowledge and evidence base to develop fire prevention and suppression capabilities and strategies, or to prepare and inform communities.

6.2 Australian Government research agencies

Withdrawal of federal funding is not confined to the CRC. The CSIRO and Bureau of Meteorology (BoM) each play very significant roles in determining current and future impacts of climate change – something which has obviously not been appreciated by some Australian Government politicians, who at times have been outspoken about the agencies and their research findings.

Both BoM and the CSIRO have had funding for climate change research reduced. BoM plays a critical operational role in helping emergency services prepare for floods, cyclones, heatwaves, storms, and fires. Their suite of predictive capabilities requires ongoing

investment as does their organisational capability to deliver prompt expert advice. Their special reports and explanation of climate trends is invaluable to emergency services agencies. The CSIRO's work on annual climate statements is also invaluable. Their roles are critical to understanding Australia's future environment, and informing policy on the consequences of continuing failure to develop credible climate policies. They and their budgets need to be protected to underpin evidence-based policy by all levels of government. .

6.3 Emergency information

ABC local radio has adopted the role of National Emergency Broadcaster and plays an invaluable role throughout Australia by disseminating timely, verified information and advice during bushfires and other natural disasters. ABC local radio suspends normal programming during local emergencies so that it can disseminate information on road closures, fire locations, emergency warnings, evacuation centers, and other vital information. They complement and enhance information able to be provided by the emergency services.

Unfortunately, the Australian Broadcasting Commission has been subjected to year on year budget cuts. These cuts have a direct impact on the people and communities, and ABC local radio should be recognised as an essential service, funded accordingly.

Recommendation 6: The Senate Inquiry should recommend that there be ongoing funding and support for a dedicated independent research capability given the imminent cessation of funding in 2021 for the Bushfire & Natural Hazards Cooperative Research Centre. Research is crucial to understanding and tracking escalating natural disaster risks and enabling fire and emergency services to plan and prepare for worsening conditions. An evidence-based ability to track and predict escalating risks driven by climate change must underpin the development of national and state resilience, adaptation and mitigation strategies, as well as informing funding needs for community education and engagement, and enhanced resourcing of emergency services.

Recommendation 7: The Senate Inquiry should recommend that critical government research agencies such as the Bureau of Meteorology and the Commonwealth Scientific and Industrial Research Organisation have funding for research into climate change and

natural disasters restored and enhanced. These agencies need to be sufficiently resourced to improve predictive capabilities, understand effects of climate change on natural disasters now and into the future, and have capabilities to warn and alert communities and emergency services in a timely, comprehensive manner.

Recommendation 8: The Senate Inquiry should recommend that the role of ABC local radio as the national emergency broadcaster be recognised and enshrined in the remit of the Australian Broadcasting Commission. Further, that it be recognised as an essential service, and have adequate funding assured into the future.

7. Fuel management and prescribed burning

7.1 Weather conditions defining factor in extreme 2019-20 fires

It is abundantly clear that the destructiveness of the 2019-20 bushfires' was driven more by extreme weather than by fuel. Australia has suffered serious bushfires before, but nothing on this scale. There was no appreciable, provable difference in overall fuel levels between these fires and the many previous fires – yet the 2019-20 fires burned 10 times more homes in NSW than ever before, and burned more forested land than ever before. Significantly, there were more days of Total Fire Ban and Severe, Extreme and Catastrophic fire danger than ever before, and all of these factors are determined on the basis of forecast and actual weather conditions. Fires burned over a variety of land tenures, including public and private land, and through a variety of fuel types. They burned through rainforests previously considered immune to intense fires, through eucalypt forest, scrubland, grassland, crops, pasture, recently burned areas, and back yards. Assertions that failure to act on fuel reduction was the reason for the fires cannot withstand scrutiny. Notwithstanding, hazard reduction burning will need to play larger role in fire management under a changing climate, although its effectiveness may reduce under the current trajectory of worsening extreme weather driven by climate change. Current strategies could prove to be increasingly ineffective as windows to conduct prescribed burning reduce due to hotter, drier weather extending into the cooler seasons, again as a direct result of climate change.

It is very clear that the 2019-20 bushfires' destructive capabilities particularly in NSW and Queensland were driven more by extreme weather on multiple days of Severe, Extreme and Catastrophic fire danger, than by fuel loads (BoM 2020b, 2020d. Climate Council 2020a). On the worst days, when pyrocumulonimbus clouds formed above fires, long distance spotting and intense ember attack occurred, reducing the effectiveness of hazard reduced areas and the effectiveness of fire breaks (Climate Council 2020b).

Logically, one might expect, with better home construction, better planning standards, better water supplies, and fire agencies resourced to unprecedented levels including an array of aerial firefighting assets, that no fire could surpass the size and destructive potential of fires in the past. However, this view fails to consider the unprecedented fire weather experienced, in all its facets, in 2019-20.

Unfortunately, current firefighting arrangements are no match for nature in all its fury; especially in a rapidly warming and drying climate with more frequent and severe extreme weather events, and longer, more intense bushfire seasons. This has also been the case in California, which has a significantly larger firefighting resource base than Australia. As previously noted, in 2017 around 10,000 homes were lost in California, with nearly 20,000 homes lost in 2018 together with almost 100 lives (CalFire 2020b).

7.2 Misinformation during the 2019-20 fires

During the 2019-20 fires, and previous fire seasons in Australia, there has been considerable misinformation circulated in all forms of media and sometimes even by ill-informed politicians, strongly asserting that hazard reduction burning is a "silver bullet" capable of preventing massive losses even during the most extreme conditions. Further, allegations by politicians responsible for resourcing of government agencies, that some agencies, such as National Parks services, resisted or failed to carry out sufficient burning resulting in the scale and ferocity of the fires (Canberra Times 2019).

Such claims unfortunately clouded informed debate, serving to misrepresent reliable data that showed the worst damage caused by the fires was on days of Severe, Extreme and Catastrophic fire danger ratings – i.e, due to extreme weather (BoM 2020b, 2020d. Climate Council 2020a. NSW RFS 2020b).

Fuel loadings are the most significant factor following weather and climate. However the defining difference of the 2019-20 fires was the clearly identified, unprecedented weather conditions, not a difference in fuel levels compared to previous fire events (BoM 2020b, 2020d. Climate Council 2020a). Arguably it would be impossible, with current resource

levels, to increase the amount of burning to a level where it could mitigate fires on such a scale (over 12 million hectares). Even though prescribed burning is becoming more difficult to carry out safely, the rate of burning in New South Wales – where the recent bushfires have been most destructive – has actually increased, rather than decreased as falsely reported (Broome et al. 2016). The lack of any appreciable effect of the level of burning on the massive 2019-20 fires shows two things: (1) that more burning is required, and (2) that on the worst days of fire weather even an increase in burning may not mitigate major fires significantly.

Unsupported assertions that the Australian Greens and their supporters stopped hazard reduction burning are ludicrous as the Greens are not in Government in any jurisdiction and cannot enact legislation. Greens policies are in fact pro-burning provided practices are ecologically sustainable (Greens 2020). The NSW Nature Conservation Council also overtly supports prescribed burning, and works with the NSW RFS, farmers and community groups through the Hot Shots Program to educate people about ecologically sustainable burning (NCC, 2020).

During the bushfires, Victorian Country Fire Authority (CFA) Chief Officer Steve Warrington, NSW Rural Fire Service (RFS) Commissioner Shane Fitzsimmons, and Queensland Fire & Emergency Services acting Commissioner Mike Wassing all responded to statements by some politicians and in media reports explaining that they were ill-informed and that burning on its own is not a panacea for uncontrolled fires (The Guardian 2020a. ABC 2020). Notwithstanding, they also support a thoughtful and evidence-based approach to increased, targeted burning.

7.3 Hazard reduction

Hazard reduction involves controlled application of fire or other means, such as mechanical clearing or thinning, for the reduction or modification of available fuels within a predetermined area in order to mitigate against the future spread of an uncontrolled bushfire. The most common approach is prescribed burning, or the application of fire under controlled conditions.

Different vegetation types in different locations and geographies respond to fires differently, and prescribed burns need to take into account not just flammability but ecological impacts of burning frequency, intensity and timing. Hazard reduction can involve other methods such as mechanical clearing of fire breaks or thinning of vegetation, which is labour-intensive and cannot be practically carried out over large areas. The goal of hazard reduction is not to produce areas that will not burn, but areas that will burn at a

lower intensity and therefore be controlled more easily by firefighters (Climate Council 2020b).

Of all the factors that contribute to the intensity of a fire (temperature, wind speed, humidity, topography, fuel moisture and fuel load), only fuel load can be easily modified by human effort (but bearing in mind that since the industrial revolution it is now clear that humans have also modified the world's temperature, and action on emissions may eventually assist to bring this down).

Because of the temperature, wind velocities, low humidity and fuel dryness in 2019-20, on days of Very High fire danger and above areas of lower fuel loads were unlikely to significantly slow the progress of fires, although it must be noted that lower fuel loads do lead to reduced fire intensity, a critical factor close to assets and people.

7.4 Increased, targeted burning needed

ELCA holds the view that a renewed focus on, and funding for, thoughtful and evidence-based approaches to significantly increased hazard reduction burning must be a key outcome of the unprecedented fire season.

As extreme weather and number of days of elevated fire danger continue to increase, hazard reduction (prescribed burning) may have to be prioritised close to communities, assets and critical infrastructure with a focus on more frequent burning close to settlements and assets in order to create permanent fuel-reduced zones. There may also be a need for more focus on increased use of “cool burns” or more frequent “light burning”, as recently suggested in Gippsland, over larger areas.

Different vegetation types in different geographies have adapted to differing fire regimes, so a ‘one size fits all’ approach is unlikely to be ecologically sustainable or lead to desired outcomes in all locations. Jarrah forest in WA is quite different from dry *sclerophyll* forest in Hawkesbury sandstone, or remnant Gondwana forest in Tasmania or SE Queensland. Nuanced, appropriate approaches are needed.

There are insufficient resources within fire and land management agencies to simply dictate an increase in burning, particularly in states and territories where the majority of personnel engaged in prescribed burning operations are volunteers who may not be able to commit to arbitrarily increased burning targets.

As a key element in mitigating the effects of future fires, benchmarks need to be developed for funding requirements of fire, emergency and land management agencies so that they can conduct increased, targeted fuel reduction works, and have operational capabilities (people, equipment, infrastructure) commensurate with increasing risks and strategic fuel management requirements. A suitable reporting and auditing framework will be integral to this work, but will be pointless unless there is a significant increase in budgets, resources and training to enable a significantly increased burning program to be implemented and achieved.

7.5 Cultural burning practices

Cultural burning practices can no longer be ignored. Traditional owners in some areas still conduct cultural burning, and in others, attempts are being made to re-learn and resurrect former practices. This is highly worthy of support, research, and necessary funding.

Concepts surrounding cultural burning are complex and inter-related. People who live on and have a deep connection with Country develop knowledge of the interactions of weather, fuel types, topography, animals and people. They generally light “cool” fires when they can be easily controlled.

It is simplistic to conceive of cultural burning as simply an alternative burning technique that can be taught to firefighters and land managers – it involves a deep, spiritual connection to Country and deep understanding of the interactions of ecosystems. According to cultural burning expert, Victor Steffensen, “Maintaining the health and diversity of all the ecosystems with and without fire is key to protecting and serving our animals into the future. Burning the country to look after it this way takes more time and effort than any other modern fire management techniques” (Steffensen 2020). The techniques are very sophisticated and present not only an opportunity to heal the land, but to engage and respect Traditional Owners by assisting them to apply and further develop their knowledge.

In reviewing hazard reduction treatments, an excellent opportunity exists to better engage and support regional Aboriginal organisations and businesses in fire management and reforestation projects to achieve both social justice, regional economic impacts and climate change mitigation and adaptation outcomes. There are already some good examples of Aboriginal organisations (eg Muru Mittigar in Western Sydney) which could benefit from greater Government support through the adoption of preferential procurement policies for bushfire risk reduction on government tenures.

7.6 Windows for burning reducing due to climate change

Windows of opportunity to conduct safe burns have become much shorter due to higher temperatures, drier conditions, and fewer days of low/moderate fire danger outside the bushfire season as a result of climate change (Earth Systems and Climate Change Hub 2019).

This is significant because the largest workforce engaged in hazard reduction burning in some states and territories comes from volunteer rural fire services, the bulk of whom are only available on weekends. Thus, in those areas reliant on volunteers, the reducing windows of weather suitable for burning also need to coincide with weekends.

Workforces of forestry and national parks services have in many cases suffered cuts in real terms, if not in gross numbers. Changes in land tenure such as private land being incorporated into new or existing national parks without a corresponding increase in staff numbers to effectively manage those estates can further limit the proportion of burning able to be conducted. Significant frustration has been experienced in some regional areas in Queensland and NSW where grazing lands have been transferred to national parks over the years without a commensurate increase in resources for national parks agencies to manage fuel loads.

Urban fire services in some states and territories carry out a significant amount of hazard reduction burning at the urban / bushland interface. However they are limited in their ability to participate in controlled burns because of the requirement to provide standards of response coverage across their areas of responsibility, further limiting opportunities to burn at times that volunteers are not available. Like forestry and national parks agencies, urban fire services will need staff and budget increases into the future if there is going to be a substantial increase in fuel reduction burning.

7.7 Mechanical thinning of forest has protection benefits

Reducing biomass close to settlements and assets has the potential to lower fire intensity and reduce crowning and spotting. It can also provide areas of tactical advantage from which to conduct hazard reduction burns, and backburns during fires. Mechanical clearing of fire breaks close to assets should be investigated further however it has always proven to be a difficult, expensive and sometimes impractical approach. It is not possible to mechanically clear large areas, particularly in rugged terrain where the worst fires often occur.

Given the intensifying bushfire threat driven by climate change, mechanical clearing and maintenance of fire breaks close to vulnerable communities should be increased where practical.

7.8 Management of fuel on private lands

There was much speculation and debate during the recent fires about fuel loads on publicly managed lands (that comprise about 15% of NSW and 30% of Victoria). However, the greatest impact on fire intensity and ember load immediately adjacent to a structure can be directly proportional to the amount of effort put into managing fuel loads between the back door and back fence line.

A well-known adage in the fire services is: “If you own the land, you own the fuel.” Despite the NSW Rural Fires Act having provisions to enforce reduction of bushfire fuels on private land (S.66), in practice it appears that this is not now widely enforced. Arguably, before the onset of each bushfire season, there should be a concerted effort to ensure the proper management of bushfire fuels on private land.

A cross-tenure approach to bushfire risk reduction is critical. A greater focus on reducing risk on private property seems appropriate given the high number of confirmed bushfire hazard complaints that are lodged with the RFS against private property holders in NSW.

7.9 Grazing does not reduce fuel loads and fire risk

Assertions made during the fires that grazing of national parks should be reintroduced as it leads to a reduction in bushfire fuel levels have been proven to be false. Grazing instead leads to serious environmental and ecological damage, particularly in fragile alpine environments, with no reduction in bushfire risk or fire intensity where it is applied.

The Victorian Alpine Grazing Taskforce found that “the scientific research is adequate and consistently reveals that grazing has a deleterious effect on biodiversity”, leading to a ban on grazing in Victoria’s alpine parks (DSE, 2005). It also concluded that “the most flammable fuel types in the park, which contribute virtually the entire available fuel load to wildfires, are branches, twigs, bark, eucalyptus leaves and shrubs. With the exception of some shrubs, cattle do not eat these fuels”, and further, “It was also pointed out that cattle eat the new green shoots and not the dead, dry grass that constitutes the more flammable component of the fine fuel”, concluding that: “cattle grazing does not make an effective contribution to fuel reduction and wildfire behaviour in the Alpine National Park” (DSE, 2005, pp 39, 40 and 43).

The suggestion that grazing be re-introduced to publicly owned land should be summarily discarded as it has no foundation in fact.

7.10 Understanding the risks with burning

If the community and governments determine that more burning is desirable, then there will also be a need for acceptance of the associated inevitable risks. Some burns will escape, and there will be unwelcome smoke impacts. In the past this resulted in a reluctance to continue burning programs and a risk averse approach, arguably resulting in increased fuel loads. If increased burning becomes a requirement, then there will be a need for governments to accommodate increased complaints against the inevitable by-products – increased smoke impacts and escaped burnoffs. Increased burning is necessary and needs to be strongly supported by governments at all levels, and the many benefits explained to communities. Above all, the practitioners carrying out this difficult and sometimes risky operation on behalf of us must be fully supported, including legally and morally, if something does go wrong.

Recommendation 9: The Senate Inquiry should find that fuel reduction is one of the only ways to reduce fire intensity and therefore must be a major part of any mitigation strategy. It should recommend that research underpin the development of new policies that recognise the need for better asset protection strategies, shrinking windows available for controlled burning due to a warming climate, the need to fund and research cultural burning practices, and the need to avoid perverse outcomes, such as burning large tracts of land remote from assets in order to meet arbitrary percentage or hectare targets.

Recommendation 10: The Senate Inquiry should find that due to the impacts of climate change, existing hazard reduction approaches could become less effective at mitigating and controlling fires during extreme weather events that result in long distance spotting, intense and sustained ember attack, and pyroconvective fires. As a result, fuel reduction approaches will need to be better integrated with overall mitigation strategies including fire detection and suppression, community education, hardening of infrastructure, warnings, evacuation, and other measures.

Recommendation 11: The Senate Inquiry should find that a number of land management agencies nationally have suffered real cuts in funding and staff numbers, some at the same time as the amount of land under management has increased. Benchmarks should be developed to ensure that agencies are properly resourced to manage lands under their control, and that both urban and rural fire services have sufficient resources to participate in prescribed burning operations on a regular, planned basis.

8. Strategies to deal with very large fires

8.1 Lightning-caused fires

The Gospers Mountain fire north west of Sydney started as a result of a lightning strike on 22 October 2019. It was in a remote area with no vehicular access, and efforts to control the fire quickly by ground crews using hand tools were unsuccessful. Eventually it grew to 512,000 ha, becoming the largest forest fire in Australia's recorded history (SMH, 2020).

Many fires during the 2019-20 fire season exceeded 100,000ha in size. According to the NSW RFS, the majority of the large fires were started by dry lightning storms, and then burned into populated areas (News.com.au 2019).

It is likely that the potential for lightning-ignited bushfires will increase in the future, as lightning occurs more frequently under warmer conditions (Williams 2005; Romps et al. 2014; Abatzoglou et al. 2016). There is a strong positive association between temperatures and fire occurrence in the Southern Hemisphere, with a tight coupling between lightning-ignited fire occurrences and the upward trend in the Southern Annular Mode (Mariani et al. 2018).

Fires ignited by lightning can be difficult to suppress as they often occur in inaccessible remote areas. Lightning storms also often result in multiple simultaneous ignitions. In 2016, thousands of dry lightning strikes caused multiple intense bushfires in Tasmania, burning over 120,000 hectares, including nearly 20,000 hectares in the Tasmanian Wilderness World Heritage Area (Styger et al 2018; Earl et al 2019).

The likelihood of sustained ignition of vegetation following a lightning strike is largely dependent on fuel moisture content (Dowdy 2015). The warming, drying climate is projected to produce drier, more flammable fuel (Mathews et al. 2012). Since the mid-1990s, southeast Australia has experienced a 15% decline in late autumn and early winter rainfall, and a 25% decline in average rainfall in April and May (CSIRO and BoM 2016). April to October rainfall has also decreased in southwest Australia, with May-July rainfall seeing the largest decrease of around 20% since 1970 (CSIRO and BoM 2018). The shift in rainfall patterns can make a difference to the dryness of fuel and soil conditions, even if total seasonal or annual rainfall remains stable. For example, in the Tasmanian Wilderness World Heritage Area there has been an observed increase in the incidence of fires associated with lightning since the late 20th Century. This is thought to be due to a shift in rainfall patterns, with less frequent but more intense rainfall during the summer months resulting in drier fuels (Styger et al. 2018).

The 2019-20 fire season in Victoria highlighted the problems associated with clusters of lightning-caused fires in remote areas. They are a significant drain on specialised resources such as aircraft and remote area fire teams (RAFT). Many fires were started by lightning in northern NSW, the Hunter region, the Blue Mountains, the southern ranges, and southern alpine region. Coupled with multiple days of Severe, Extreme and Catastrophic fire danger, despite many of the fires being controlled in the early stages, many grew to mammoth proportions and resulted in significant losses.

8.2 Backburning

Backburning is often one of the only strategies that can be implemented with any hope of success once fires escape containment in conditions of Very High fire danger and above. It is inherently risky as it involves new fire being introduced into a landscape, which, in the case of the 2019-20 bushfire season, was extremely dry having been primed by years of drought. As previously explained, intense weather conditions exacerbated by climate change resulted in many days of elevated bushfire danger where established fires were able to spread almost unimpeded. This resulted in thousands of kilometres of active fire edges, often in remote, inaccessible areas, that could not be attacked directly except with limited air attack. It was often too dangerous to insert ground crews, as it may not have been possible to extract them if conditions changed rapidly.

There were several examples in NSW of backburning operations escaping under conditions of elevated bushfire danger, sometimes destroying properties. Veteran firefighters described the associated decision-making processes as “damned if you do, damned if you don’t”, as the alternative was often to place firefighters in front of an intense approaching fire front, or to allow a fire to run unimpeded until weather conditions moderated

sufficiently to enable some form of direct attack. This highlights the need for new firefighting approaches to be developed.

8.3 Proven control strategies

When fires become mega-fires, control becomes increasingly difficult as there can be hundreds or even thousands of kilometres of fire perimeter to contend with. When there are multiple mega-fires burning simultaneously, obvious resourcing problems arise. Fire agencies need to make difficult decisions about risk versus reward and utilisation of increasingly scarce resources. In practice, this means that as more fires break out, there are fewer and fewer resources available to respond to them, and then greater likelihood that the new fires will themselves rapidly increase in size.

Ultimately it can be impractical and futile to try to control very large fires – fire services are often relegated to limited containment objectives, and solely to life and asset protection on the worst fire weather days. As fire chiefs said on several occasions during the 2019-20 fire season, it was going to take substantial rain to control the fires. Ultimately this proved to be correct when torrential rain extinguished fires in NSW and Victoria in February 2020.

There are no known new demonstrated firefighting techniques or strategies able to assist in dealing with mega-fires. Even the use of more large air tankers (LAT) and very large air tankers (VLAT) than ever before deployed in Australia made little difference in containing the major fires of 2019-20.

However, there are three areas in which concerted effort can make a difference, not by controlling mega-fires, but by stopping them from developing in the first place:

1. Rapid, accurate fire detection and location capabilities.
2. Rapid aerial first attack to contain the fire until arrival of ground crews.
3. Rapid deployment of highly trained remote area fire teams.

Improved fire detection technologies approaches might include, in conjunction with lightning detection systems:

- remote controlled cameras capable of identifying smoke,
- infra-red and thermal imaging technologies capable of identifying new fires,
- use of large drones and advanced imaging, perhaps deployed by the ADF,
- increased aerial patrols, and
- use of existing fire lookout towers.

Once new fires are detected, a rapid initial response and suitable weight of attack (number of aircraft, tankers, personnel etc.) are necessary to limit fire spread. It has been established that rapid deployment of suitable firefighting aircraft to remote fires correlates with increased likelihood of early control, and a smaller area burned (Waters & Fuller 2020; Plucinski 2012).

Lightning-caused fires in very remote locations may not be able to be reached quickly enough by helicopters, LAT and VLAT. LAT and VLAT can be too large to be effective due to their high air speed, relative lack of maneuverability, straight line drop pattern, and limited airport options often distant from the fire (longer turnaround times). As will be explained in the following section, a different type of firefighting aircraft is routinely used in a fast attack role in countries such as Canada, the USA, France and Spain, often in conjunction with smaller 802 Air Tractor single engine air tankers (SEAT), which are already used extensively in Australia. Twin engine amphibious water-scooping aircraft with twice the capacity of a SEAT can be used to great effect in first attack roles where there is access to suitable bodies of water for scooping, or small airfields.

The third component crucial to rapid suppression in conjunction with rapid detection and fast initial air attack is availability of sufficient numbers of strategically located remote area fire teams, together with suitable ground and air transport.

8.4 Early detection and initial attack

With the increasing number, intensity and frequency of bushfires, there is an urgent need to adopt new and innovative ways to detect and rapidly respond to bushfires as quickly as possible following ignition, especially during Severe, Extreme and Catastrophic fire danger rating days, with the aim of deploying ground and aerial firefighting resources to rapidly attack, contain and successfully extinguish new fires before they take hold and overwhelm firefighting capabilities.

Some key elements of an early detection and initial attack system are:

- rapid detection, location and reporting of bushfire ignitions, together with local weather conditions.
- tracking of the movement, intensity and contributing factors affecting a fire (terrain, fuel conditions, weather, firefighting efforts).
- provision of early, timely and continuous information to communities, rapid response of initial fire attack equipment including ground crews and water-bombing aircraft.

Early detection sensing networks are already available with modern technologies that provide 24-hour bushfire ignition detection and real time fire movement tracking coupled

with live, localised weather information and air quality data (LVIN, 2020). The provision of a comprehensive, timely detection and reporting system capable of triggering an appropriate initial response, provide critical situational data, real-time information to assist tactical and operational decisions, and early and ongoing updates to nearby communities will increasingly be demanded by people living in bushfire-prone areas.

Recommendation 12: The Senate Inquiry should find that more attention and resourcing need to be applied to rapid detection of and response to new fire outbreaks during periods of serious fire weather. A range of new rapid fire-detection technologies should be trialed. Together with rapid detection, new fast attack strategies for new outbreaks, particularly remote fires caused by lightning, need to be introduced with clear objectives, e.g. putting fires out within 24 hours and before they exceed ten hectares. Fast attack should involve rapid dispatch of a suitable number of water bombing aircraft to achieve rapid turnaround and constant direct attack on fire fronts, complemented, as soon as possible by aerial insertion (where practicable) or ground insertion of remote area fire teams to complete extinguishment.

9. Firefighting aircraft

9.1 Firefighting aircraft a tool, not a solution

During the 2019-20 bushfires, firefighting aircraft were used extensively under local and national arrangements. There was significant public dialogue about the use of aircraft, and ELCA concedes that our calls for the Federal Government to provide increased support to states and territories in funding large aircraft may have helped fuel an incorrect perception that aircraft alone can control fires, and led to added expenditure on a large number of LAT and VLAT which was probably less effective than other approaches that could have been taken had there been the necessary assured Federal funding and lead-time. This section is lengthy given the need to correct some perceptions of ELCA's reasoning.

Aircraft cannot control fires on their own. They are expensive assets, there are varying types with differing, complementary roles, and they are ineffective unless used in close coordination with firefighting crews on the ground.

Given the huge expense, it is crucial that more research be conducted into the operational efficacy and cost effectiveness of various aerial firefighting platforms, and that a wider, and more cost effective range of capabilities be introduced into Australia rather than continually increasing the use of VLAT and LAT, which have been proven to be very useful in certain roles, but nevertheless have inherent operational restrictions together with significant costs.

ELCA is concerned about the direction in which aircraft utilisation for firefighting in Australia is heading, given the demonstrated failure in many cases of aircraft to make any appreciable difference to extreme fires on the worst fire weather days. Contracting more LAT and VLAT each year is unlikely to make an appreciable difference into the future.

The aftermath of the 2019-20 fires should be taken as an opportunity to conduct a fundamental review of the operational and cost effectiveness of the use of various aerial platforms, and how the different types can be integrated, using their particular strengths, to augment and support ground operations.

Research into aerial firefighting is relatively sparse, however the most relevant study with comparative assessments of various aerial platforms is that conducted by the Rand Corporation, sponsored by the United States Forest Service in 2012, looking at the optimal mix of aerial firefighting assets. It recommended that the US Forest Service adopt a mix comprising just a small number of LAT and VLAT for specific roles, with a large fleet of smaller 6,000 litre water-scooping aircraft, together with helicopters and small fixed wing aircraft, in order to benefit from the most flexible operational mix while remaining cost effective (Keating et al. 2012). This and other studies highlight the benefits of aircraft being tasked and utilised in a fast attack role in order to keep fires as small as possible until ground attack crews can extinguish them (Keating et al. 2012; Plucinski 2012; Waters & Fuller 2020). LAT and VLAT are not suited to a fast-attack role.

9.2 National arrangements for firefighting aircraft

ELCA is of the view that Australia has insufficient aerial firefighting resources, there has been insufficient research into the effectiveness and efficiency of various aerial platforms, that there is a concerning growth in reliance on large and very large aircraft, and that there is an identified gap in the current mix of aerial firefighting resources.

Australian fire and land management agencies involved in firefighting have significant experience and expertise in using aircraft for firefighting roles. The roles include, but are not limited to:

- Aerial reconnaissance / fire mapping
- Fire detection
- Insertion of remote area firefighting teams
- Transport of people and equipment
- Command and control
- Dropping of aerial incendiaries
- Dropping of water, foam, gel and retardant onto, or in front of, flame fronts.

(NAFC 2020)

For decades, up until and including the 2009 Black Saturday fires, only small fixed wing aircraft (predominantly 802 Air Tractors carrying 3,200 litres), small, medium and large helicopters were used. The large helicopters, predominantly Erikson Aircranes carrying 9,000 litres, were all sourced from North America on lease.

After the 2009 fires, both the NSW and Victorian governments trialed the use of LATs (carrying 12-15,000 litres), and a VLAT (DC10 jet aircraft carrying 45,000 litres, later reduced to 35,000 litres). The trials were deemed to be successful and the National Aerial Firefighting Centre (NAFC), an entity created by the national council for fire and emergency services, AFAC, managed funds from the Australian Government and State and Territory governments to arrange and manage lease arrangements as well as managing movement of a variety of other fixed and rotary wing aircraft comprising a shared national fleet of firefighting aircraft. In addition to the shared assets, several states and territories own or lease additional aircraft according to their own assessed needs.

The influence of climate change, as previously detailed, has resulted in significant overlap between the northern and southern hemisphere bushfire seasons, reinforcing the need to consider establishing a fleet of medium, large and very large firefighting aircraft in Australia. The NSW Government has purchased a converted Boeing 737 LAT.

9.3 Funding

Funding for a national fleet of specialised firefighting aircraft was agreed between all governments and fire agencies after the 2003 Canberra fires. Prime Minister Howard agreed on a dollar for dollar joint funding arrangement in acknowledgement that air assets could be moved around Australia according to priorities and needs and therefore constituted a strategic national resource. The national council for fire agencies, AFAC, formed the NAFC in July 2003 to procure and manage a national fleet of aircraft. The national fleet augmented aircraft owned and leased by states and territories (NAFC 2020).

In subsequent years the states and territories escalated their contribution to the joint funding arrangement and expanded the aerial fleet, but successive Federal Governments

did not. In recognition of the growing need for a large strategic aerial firefighting capability given worsening bushfire conditions and extreme weather events nationally, AFAC developed a detailed business case for additional annual Australian Government funding in 2018; a modest ask for about \$11M pa. The business case detailed how inflation and escalating costs were being borne solely by the states and territories, and how large aircraft are a strategic national resource because of their ability to rapidly travel long distances (NAFC 2018a).

Prior to this AFAC and NAFC made a detailed submission to a Senate Inquiry into the 2016 Tasmanian Bushfires on behalf of all Australian fire services, requesting Commonwealth backing for development of a national fleet of large firefighting aircraft, stating: “Large fixed-wing airtankers are likely to be an important component of enhanced bushfire suppression capability in Australia. A shared, national large fixed-wing airtanker capability is logical and is an attractive strategy.” (NAFC 2016). The NAFC submission was cognizant of deteriorating climatic conditions leading to more widespread and intense bushfires and increasing overlap with fire seasons in the northern hemisphere, limiting access to leased aircraft. The Federal Government rejected the recommendation, stating that it was a “State and Territory responsibility”, ignoring the established agreement that recognised that individual jurisdictions cannot afford large aerial platforms alone, and the strategic benefits outlined in the NAFC submission.

Emergency Leaders for Climate Action sought to meet with the Prime Minister from April 2019 to raise this and other issues but were unsuccessful. Funding for additional firefighting aircraft was strongly recommended in letters to the PM and via the media but was continually rejected.

Ultimately after significant media, political and community pressure, the Prime Minister agreed to provide an additional \$11M on a one-off basis mid-way through December 2019. NAFC had difficulty sourcing appropriate aircraft at short notice, resulting in premium prices and varying delivery times. The additional aircraft sourced using the additional funds were not yet available when NSW experienced significant property loss and deaths in the last 2 weeks of December 2019.

On 4 January 2020 the Prime Minister (PM) held a press conference at which he stated that the \$11M would now be provided on an ongoing basis in accordance with the 2018 AFAC Business Case, and that the Government would immediately provide an additional \$20M to NAFC. Interestingly this appears to have been “re-announced” as a new initiative in May 2020. Fire agencies were not consulted about this prior to 4 January, or other announcements concerning callout of the ADF made by the PM, as made clear by NSW RFS

Commissioner Shane Fitzsimmons in various media interviews on that day (The Guardian 2020b).

Again, NAFC had to make rapid contact with overseas suppliers, and to pay premium rates due to the short notice. Four large jet aircraft were sourced, but ultimately arrived after fires had started to be controlled – so the \$20M was effectively wasted. A number of countries offered to provide firefighting aircraft to assist, but most were rejected.

9.4 Strategic and tactical use of aircraft

Small, medium and large helicopters as well as small fixed wing water bombers generally drop their loads directly onto flames in order to immediately reduce fire intensity and reduce rate of spread, usually in conjunction with firefighters on the ground. A reduction in fire intensity, particularly when close to buildings and other assets, can allow firefighters who otherwise would have had no prospect of controlling a fire, the opportunity to mount a direct attack and gain a measure of control.

LATs and VLATs are generally used differently. Their larger payloads usually comprise of a mixture of water and “PhosChek”, a fire retardant with a trademark red colour that adheres to vegetation. Retardant is usually applied ahead of, not directly onto, fire fronts. The theory is that retardant lines create a fire break, slowing down or halting the progress of the fire front.

In practice there are significant issues with this. Australian eucalypt vegetation is renowned internationally because it generates spot fires ahead of fire fronts; during the 2019-20 season up to 12 kilometres ahead. This limits the effectiveness of LATs and VLATS on the worst fire danger days as fires easily cross retardant lines.

LATs and VLATs require a large airport runway with room for infrastructure (portable tanks and pumps) to conduct rapid refilling. In practice this often limits them to commercial airports capable of taking large passenger jets, and large air force bases. This can result, depending on fire location in relation to airport location, in long aircraft cycle times between drops, reducing effectiveness further.

Another limitation on all firefighting aircraft is wind velocity. On days of Severe, Extreme and Catastrophic fire danger, many firefighting aircraft have to be grounded due to high wind velocities. Whilst LATs and VLATs are less restricted in this respect, they are unable to deploy without a “lead” aircraft that flies ahead and indicates where to drop the retardant load. On days of high winds, the lead aircraft are unable to fly.

9.5 Research into the use of firefighting aircraft

Very little research has been conducted in Australia into the effectiveness of various types of firefighting aircraft, limiting current understanding and development of aerial firefighting capabilities, strategies and tactics.

Existing research strongly suggests that as fires intensify (arguably under the influence of climate change), use of aircraft in a first attack / rapid attack role, will be crucial (Keating et al. 2012; Plucinski 2012; Waters & Fuller 2020). This forms the basis of aerial firefighting strategies in Europe, Canada, and the USA, but is not practiced routinely in Australia other than in the Adelaide Hills and parts of Gippsland where it has been very effective, albeit relatively expensive.

Opinions about the use of LAT and VLAT aircraft vary, however there appears to be a consensus that they are a particularly valuable strategic tool, for example in assisting to establish containment lines and reducing fire intensity around assets. Research conducted for the United States Forest Service clearly outlines roles in which large fixed wing aircraft are most useful, but found that smaller, more agile aircraft had greater operational flexibility (Keating et al. 2012)

The 2016 bushfire season and then the 2018 season in Tasmania resulted in significant skepticism in that state about the use of LATs. Four LATs were deployed to fires in World Heritage Areas in 2016 (NAFC 2016). However, there was nowhere suitable in Tasmania for the aircraft to land – they were instead required to fly from Victoria, make their drop, fly back to Avalon across the Bass Strait, land, reload, then fly back. This resulted in long delays between drops, and a lack of effectiveness as fires simply burned around the retardant lines. There was a similar experience in 2018. The Tasmanian Government received a hefty bill for retardant and jet fuel on both occasions.

A different type of aircraft, amphibious water-scooping water bombers, would arguably have been far more effective and far less costly in the Tasmanian situation given the availability of large bodies of water, and numerous airports capable of supporting the smaller aircraft. Despite having a smaller payload (6,000 as opposed to 12-15,000 litres), the operational and cost effectiveness of a scooping aircraft would have been greater due to shorter turnaround times resulting in a much larger volume of water being dropped (Keating et al. 2012). These types of aircraft were unfortunately not available in Australia because they have been excluded from consideration due to NAFC tender requirements.

9.6 Water-scooping aircraft as an additional resource

The types of aircraft used by Australian fire services have been broadly outlined previously and are detailed on the NAFC website (NAFC 2020).

Together with an urgent need for research into the use and efficiency of firefighting aircraft in Australia, there should also be a rapid re-think on the growing reliance on very expensive LATs and VLATs to the exclusion of other large firefighting aircraft which can complement their specific capabilities. A purpose-built water scooping aircraft used in other bushfire-prone countries around the world, the CL415, is unable to be used in Australia at present due to a contractual requirement that any aircraft put forward for tender must carry a minimum of 6,800 litres, automatically excluding the CL415 from consideration as its capacity is just over 6,000 litres (NAFC 2018b).

It is possible that there is lingering prejudice against this type of aircraft within some fire and land management agencies due to what was perceived at the time as an aggressive and unwelcome marketing campaign by the then manufacturer, Bombardier, in the late 1990s. An evaluation of the aircraft at that time that rejected their use can no longer be considered valid given the subsequent acceptance of LAT and VLAT aircraft in Australia. The few arguments that continue to be put forward against this type of aircraft appear to be ill-informed and based on hearsay and non-current information. The CL415, which is capable of direct attack at low altitudes and faster cycle times than LAT and VLAT, can play a role that is currently not being fulfilled in Australian aerial firefighting.

Australia uses small aircraft, then jumps to large and very large. Failure to include a medium sized, more cost effective and flexible option limits strategic and tactical options, impacts on costs, and ultimately the effectiveness of response strategies (for example the 2016 Tasmanian experience). There is clearly a need for all types and sizes of aircraft in Australia's aerial firefighting fleet in order to maximise flexibility, and limit costs.

The Viking (formerly built by Bombardier) CL415 "Super Scooper" carrying 6,000 litres is used throughout Europe, in Canada, Malaysia, and California and is the only purpose-built firefighting aircraft in the world, as opposed to all LAT and VLAT which have seen previous lengthy commercial or military service. They have an enviable safety record with no recorded crashes. A converted jet powered water scooping aircraft carrying 12,000 litres, the Be200, is used in Russia. The Be200 does not yet have clearance to fly in Australia and little is known about these converted aircraft. The advantages of a CL415 are:

- Purpose-built firefighting aircraft, in contrast to LAT and VLAT which are all converted from previous military or civilian service.

- Amphibious and multi-purpose: eg Malaysia uses their aircraft for maritime border patrol.
- Similar operating concept to 802 Fire Boss aircraft, but faster, greater range, and nearly twice the payload.
- No need to land to refill – can scoop water from rivers, dams, lakes and the ocean, and refill in about 18 seconds.
- No need for special airport facilities (which limit LAT and VLAT significantly). Not restricted to large airports, so able to be based regionally - can land on water or on small regional airstrips.
- Can be refilled on the ground if no large body of water available: significant advantage is that this can be done locally, reducing turnaround time.
- Ideal aircraft for rapid response and rapid attack: the Gospers Mountain fire near Sydney could have been attacked by CL415 aircraft, had they been available, scooping from the Hawkesbury River. Depending on the number of aircraft assigned, the fire may have been able to be controlled in the early stages. LAT were ultimately ineffective on this fire.
- Lower air and stall speeds than LAT and VLAT, therefore able to operate at lower altitude with greater maneuvering capability to drop directly on flames.
- More cost effective than LAT and VLAT aircraft because of the ability to drop greater amounts in a shorter time (shorter return cycles), and less onerous maintenance requirements.

The Spanish Airforce operates that country's fleet of CL415 aircraft, working in close coordination with firefighting authorities.



Figure 4: Canadair CL415 “Super Scooper”. Note ability to carry out low altitude drops, increasing effectiveness.

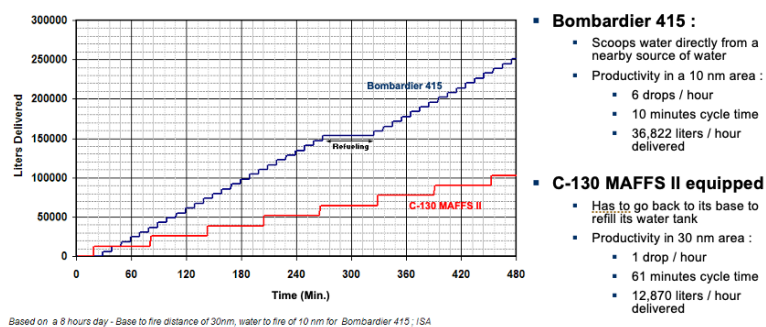
The costs are similar to a LAT, however cost effectiveness can be demonstrated to be much better in most scenarios because of greatly reduced cycle times between drops, higher volumes delivered as a result, and therefore greater firefighting effectiveness. To properly

determine comparative cost-effectiveness, it is necessary to compare volumes of water able to be delivered in a given timeframe in realistic scenarios (Keating et al. 2012).

In terms of safety, the airframes have known histories and have never had to withstand the rigours or number of hours of commercial or military service that most LAT and VLAT aircraft, all at least second hand, have undergone prior to modification for firefighting service.

The 2012 Rand Corporation study concluded that “This type of aircraft (CL415) combines some of the advantages of fixed-wing aircraft, such as speed, with the shorter cycle times associated with rotary-wing aircraft” (Keating et al. 2012 p.34). Further, that in consideration of the identified operational and productivity advantages, the optimum mix for the US Forest Service would be a large fleet of CL415 aircraft with a smaller number of LAT reserved for specific strategic tasks. It rejected criticism of CL415 aircraft on the basis of alleged non-availability of bodies of water for scooping, finding instead that most settled areas where direct attack would be crucial had natural or man-made bodies of water nearby, and in any case, unlike LATs, a CL415 could land and be filled locally by tankers at small airports (Keating et al. 2012). The research clearly explained the superior cost effectiveness of a CL415 compared to a LAT, based on gallons able to be delivered. The findings have direct application to the Australian environment.

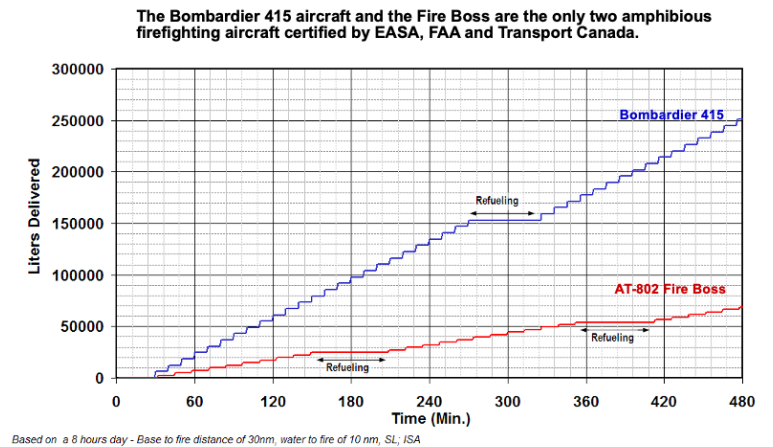
The Bombardier 415 aircraft productivity versus C-130-MAFFS II



BOMBARDIER

Figure 5: Comparison between drop efficiency between a 415 water scooping aircraft and a converted C130 Hercules aircraft. (Source: Bombadier)

The Bombardier 415 aircraft productivity versus AT-802 Fire Boss



BOMBARDIER

Figure 6: Comparison between drop efficiency between a 415 water scooping aircraft and a 802 Fire Boss scooping aircraft. (Source: Bombardier)

9.7 Military Strategic Lift (cargo) aircraft as firefighting backup

In the United States, some units of the Air National Guard provide assistance to fire authorities during significant bushfire emergencies by temporarily converting military Lockheed C130 Hercules aircraft (J and H models) into airtankers carrying about 13,000 litres. The system, known as Modular Airborne Fire Fighting System (MAFFS) enables rapid conversion of the cargo space using a roll-on, roll-off device to accommodate a pressurised tank, compressor and pump system (Keating et al. 2012). Early systems required C130s to fly with the rear cargo door down, which could adversely affect stability, speed and deployment. A newer system, MAFFSII produced by Aero Union Corporation in the USA, incorporates a nozzle system that fits into the rear passenger door, enabling the aircraft to remain pressurised in flight. MAFFS is used by air forces in the USA, Brazil, Columbia, Morocco, and Thailand (Avgeekery 2016).

ELCA is not suggesting that, in the unlikely event that the RAAF had capacity to participate routinely in firefighting missions, this would be a good option for establishing and enhancing Australian aerial firefighting capabilities. To the contrary, there are a number of problems with this approach that make it a “second best” option. Chief amongst these is that RAAF pilots will have little or no experience in firefighting missions, limiting their effectiveness. The other is that the rear nozzle comes out of the side of the aircraft rather than beneath, and this can adversely affect the dynamics of dropping retardant loads because of interaction with the jet stream behind the aircraft.

However, in a very serious season such as 2019-20, any additional aerial suppression assets would be helpful, even if only to release more suitable / purpose-built assets with the most experienced pilots from smaller, less risky fires, to concentrate on those that are

likely to cause the most damage. For this reason it may be worthwhile to suggest that the ADF conduct a trial of a MAFFSII system during a fire season to evaluate its effectiveness.

Recommendation 13: The Senate Inquiry should recommend that, as a condition of receiving a portion of Australian Government annual funding support, the National Aerial Firefighting Centre be required to conduct a trial, in consultation with the Royal Australian Air Force and Australasian Council of Fire and Emergency Service Authorities Council, of CL415 amphibious water-scooping aircraft in a first attack / direct attack firefighting role. Australian fire services at present use small and large fixed wing water bombers, but not medium sized, a clear gap in capabilities. Given the success of 3,200 litre water scooping single engine air tankers (SEAT), a twin engined purpose-built aircraft with significantly greater air speed, range, flexibility and twice the payload would be a logical and useful addition to current arrangements. The only purpose-built firefighting aircraft in the world, they are used extensively and successfully in most other fire-prone countries.

Recommendation 14: The Senate Inquiry should recommend that the Federal Government require, as a condition of receiving a portion of annual funding advances, that the National Aerial Firefighting Centre vary tender requirements for large firefighting aircraft to remove payload requirements that expressly exclude consideration of CL415 water-scooping aircraft in Australia, given the strong evidence that due to shorter refill and cycle times they can outperform large aerial tankers in terms of total volumes able to be dropped on fires.

Recommendation 15: The Senate Inquiry should recommend that the Federal Government and RAAF conduct a trial of the feasibility of fitting one or more RAAF C130 Hercules aircraft with Modular Airborne Fire Fighting Systems (MAFFSII) to evaluate introduction of a capability within the ADF to augment aerial firefighting capabilities during major disasters.

10. Building standards in bushfire-prone areas

10.1 Construction standard a key resilience measure

Australian Standard 3959 (construction of buildings in bushfire prone areas) is a national standard that was reviewed and updated after the Black Saturday bushfires in 2009. The standard details construction standards and elements aimed at making homes more likely to withstand a bushfire. It classifies different bushfire intensity levels that a home might experience during a bushfire. These are known as Bushfire Attack Levels (BAL) and there are 6 levels ranging from BAL Low to BAL-FZ (Flame Zone) (See Figure 7; Standards Australia 2018).

Each level is determined by a variety of factors including the location of premises, the type of vegetation around the premises and its proximity as well as the degree of slope of the property. The BAL designates requirements for construction including building materials and other factors aimed at mitigating bushfire risk- for example building in BAL Flame Zone has much stricter construction requirements and all materials and components must be fire tested (Bell 2019). The purpose of these standards and building requirements are to reduce the risk of ignition from a bushfire, flames, burning embers, radiant heat and intensity of bushfire attack (Loveridge 2020).

BAL	Description
BAL-LOW	There is insufficient risk to warrant any specific construction requirements.
BAL- 12.5	There is a risk of ember attack.
BAL- 19	Ember attack plus burning debris ignited by windborne embers, plus radiant heat.
BAL- 29	Increasing levels of ember attack and burning debris ignited by windborne embers, plus increased radiant heat (19 – 29 kW/m ²).
BAL- 40	Much increased risk from ember attack and burning debris ignited by windborne embers, plus higher level of radiant heat and some likelihood of direct exposure to flames (29 - 40 kW/m ²).

BAL- FZ (Flame Zone)	Highest risk of ember attack plus direct exposure to heat (> 40 kW/m ²) plus flames from the fire front. The standard notes that Authorities may require additional measures, other than construction requirements.
----------------------	---

Figure 7: Bushfire Attack Levels (Standards Australia 2018)

The updated 2009 AS 3939 is a national standard which applies to all bushfire-affected construction from the 1st of May 2019, with some variations on a state by state basis. For example, in Victoria the Integrated Planning and Building Framework for Bushfire in Victoria prioritised human life over other policy provisions through the Planning Scheme Amendments VC83 (Bell 2019).

An additional issue related to home construction in bushfire prone areas was brought into stark relief in the 2003 ACT fires, the 2009 Black Saturday fires, and the 2019-20 fires – fire storms, fire tornadoes and gale force winds on days of Extreme and what would now be termed Catastrophic fire danger damaged or tore off roofs: leaving the interior exposed to ember intrusion and rendering the home useless as a refuge. More research needs to be conducted into this facet with possible introduction of roofing construction standards based on cyclone categories.

Australia's building standards must also be reflective of climate change and be appropriately stringent; in some cases there may be larger areas across Australia that are no longer safe to build in due to the escalating bushfire threat. With varying legislation and building codes across states and territories a more integrated approach to planning for fire risk, which better connects planners with emergency management, will be critical (Norman et al. 2014).

Innovative approaches based on research, which is yet to be conducted, are urgently needed. For example, in some areas, similar to approaches taken in tornado-prone areas in the USA, thought might be given to relaxing building standards with the knowledge that they will not withstand a serious bushfire, BUT ONLY if a suitable bushfire bunker is available adjacent to the home.

Some small communities, under certain weather conditions, are neither defensible nor safe. They are often remote and leaving by vehicle can prove to be fatal. In these areas local dual-use facilities, such as a sporting / community hall, should be constructed that is able to also act as an emergency community refuge able to withstand a major fire, a flood or significant storm.

Recommendation 16: The Senate Inquiry should recommend that in the wake of the devastating 2019-20 fires, and recognising that climate change continues to drive an increase in Australia's bushfire threat, it is critical that building and planning regulations and standards be reviewed, particularly Australian Standard 3959.

Recommendation 17: The Senate Inquiry should recommend that roof design and strength is included as a critical factor in future bushfire design of homes and other buildings. Requirements need to be increased to reflect increasing wind velocities fueled by climate change, and fire storms and fire tornadoes caused by pyroconvective events that damage and remove roofs. If a roof is damaged or destroyed survivability of the structure and its ability to act as a refuge are diminished or eliminated.

Recommendation 18: The Senate Inquiry should note the variation in legislation and bushfire planning and building standards across states and territories. A more integrated approach to planning for fire risk, which better connects planners with emergency management, will be critical as bushfire threats continue to escalate in a warming, drying climate. As fire danger indices and fire paths from 2019-20 are analysed, locations might be identified where rebuilding should not occur due to excessive levels of fire and life risk.

Recommendation 19: The Senate Inquiry should recommend that states and territories provide, in remote communities or communities deemed to be at extreme risk and with limited safe egress, dual-purpose community buildings capable of providing all community members with refuge in an extreme bushfire, flood or storm emergency.

11. National Support Coordination

11.1 Military support crucial, but not to take over

The Senate Inquiry needs to assist in debunking a myth being postulated in some political and government circles that can be best summarised as “*Let’s Call in the Military Professionals*” whenever there is a crisis, including to handle all things related to emergency response and recovery. The military is a vital asset, when not tasked to their core defence roles and when they have appropriate elements of capability available. But they are not a panacea or silver bullet capable of dealing with any type of emergency. The Australian Defence Forces (ADF) have vital support capabilities that need to be utilised in a more coordinated manner without usurping the role of state and territory emergency management agencies, which are tailored to local needs and have a depth of experience together with a range of specific, tailored capabilities (see Section 12).

To say that the military is “professional” is entirely correct but that is in, as it should be, the “profession of arms”. Their expertise and resources in logistics, civil engineering, airlift, and other roles designed to support troops and assets in the field have application to assist in any emergency setting, as seen again and again. However they are not, and should not, be trained to fight fires independently, and suggesting that they can be used as frontline firefighters shows a lack of understanding of ADF roles and capabilities, not to mention the fire and emergency services.

Unfortunately, and possibly due to political misunderstanding, current national leadership seems to be saying that Defence is always best placed to decide how to respond in an emergency, apparently placing ADF professionalism ahead of the truly outstanding professionalism and capability of Australia’s 300,000 volunteer and career personnel across the emergency management spectrum. Our emergency services are admired internationally and routinely deploy to assist with bushfire control in the USA and Canada, and following earthquakes through the internationally accredited Urban Search and Rescue Task Forces maintained by Fire & Rescue NSW and the Queensland Fire & Emergency Services.

The senior leadership cadre of fire and emergency services are arguably as well trained and experienced in leadership and strategic command and control as any General officer in the military. The CEO of AFAC, Lieutenant Colonel Stuart Ellis AM (ret) recently wrote that he would compare Commissioner Shane Fitzsimmons and his leadership during the bushfires favourably with any senior military leader, and that it was “deeply offensive” to emergency services to suggest that they were in some way deficient or inferior (Ellis 2020).

11.2 No need to duplicate state and territory capabilities

The slow and inadequate response from politicians in Canberra during the 2019-20 fires was disappointing, typified by constant changes and contradictions seemingly driven more

by media opportunities than by a well thought-out strategy, measured consultation, and a genuine readiness to assist the states and territories based on situational analysis and requests. To the contrary, ideas or ‘thought bubbles’ seemed to routinely come to the fore, usually at press conferences. It was telling that when the Prime Minister announced call-out of ADF Reserve forces on January 4 2020, the Commissioner of the NSW Rural Fire Service and the NSW Premier stated that they had not been consulted and did not know what roles the Reserves would fulfil.

Similarly, calling for a so-called disaster-ready Reserve may prove to be a worthwhile contribution, but would require very careful consideration in terms of both training and indemnity of the individuals involved; especially since the skill set of emergency responders is significantly different to military skills. The announcement was construed by many in the emergency management sector as a diminishment and lack of respect of the role that they play 365 days of the year, rather than what it probably was; a rapidly constructed media grab and thought-bubble aimed at extricating Canberra from valid criticisms at the time.

Our emergency management personnel are highly trained and committed, whether they are involved in front line areas of emergency service, logistics support, health care, community support, welfare, or other areas. Volunteer professionals must meet similar employment standards and competencies as their career and paid counterparts, and they are equally responsible for their actions and decisions in response to and recovery from a disaster. There is no need to duplicate these capabilities, but there need to be arrangements in place to bolster and support them when necessary.

Implicit in the following sections is the absolute necessity for Emergency Management Australia (EMA) to work in close collaboration with the fire and emergency services, and in particular their peak body, AFAC.

11.3 The role of Emergency Management Australia

The role of the agency tasked with coordinating Commonwealth assistance to states and territories, Emergency Management Australia EMA has been diminished and become vague at the very time that is becoming more crucial due to increasing climate risks.

Australia’s States and Territories are primarily responsible under the Australian Constitution for the protection of life and property, and longstanding arrangements are in place for jurisdictions to seek assistance from the Commonwealth in an emergency context. National assistance arrangements were put in place just ahead of the Cyclone Tracy disaster in 1974 with the establishment of the Natural Disasters Organisation, now EMA.

This Commonwealth mechanism has proven to be robust and works effectively with the jurisdictions to exercise, respond and coordinate.

All Australian Defence Force (ADF) support in times of need is activated as part of a Commonwealth response to a request for support. The request is determined taking account of the operational tempo of the ADF at the time and mechanisms are in place through EMA to coordinate the most efficient take-up of ADF and other Commonwealth resources on a “craft of opportunity” basis. Future emergencies may be any event that involves major disruption including natural disasters as well as potential human-caused ones meaning the same volunteer and career responders would be drawn on, as would available ADF resources should these be appropriate and sought. The national response to COVID-19 is a case in point.

Since 2001, and following several machinery of government changes, EMA has gone from being a part of the Defence Organisation, to the Attorney General’s Organisation – a decision taken by Prime Minister Howard after the September 11 terrorist attacks in 2001 – and later to the Home Affairs portfolio. What seems to have gone missing over those moves is a clear understanding by many in the Commonwealth of how the jurisdictions seek assistance and what to do when they do. For this reason, officials and political leadership need reminding that EMA has the status, resources, and authority to get on with the job, with the ADF making its professional contribution in an emergency setting along with all the other professionals engaged, whether these are Commonwealth, State, Local or community volunteers.

There needs to be a single point of Commonwealth tasking which can provide the Prime Minister and COAG (or National Cabinet arrangement) with the combined picture of emergent needs and progress on response actions—in much the same way as our Chief Health Officer (CHO) has led this arrangement through the Australian Health Protection Principals Committee (AHPPC) during COVID 19.

In the absence of agreed national emergency management legislation that would outline the accountability trail and establish key appointments with specific responsibility, it remains unclear exactly who now leads any Commonwealth response. It is therefore difficult to meet community needs as a part of any response and recovery situation, particularly where Commonwealth responses have recently seemed to be driven more by sound bites and perceived media opportunities than by real operational needs and verified intelligence.

As the Commonwealth body formerly responsible for this, EMA, now a Division arguably buried and subsumed within the huge Department of Home Affairs, has no mandate,

legislation or Cabinet endorsement with which to coordinate. The delivery of EMA functions, for the most part, is the result of goodwill on behalf of other agencies, states and territories, which is clearly unsatisfactory. EMA should be a statutory authority with legislated capability to provide nationwide assurance to Cabinet that Commonwealth mitigation efforts along with policy, planning, response and recovery resources have been applied as efficiently, expeditiously and effectively as possible.

Throughout the 2019-20 fire crisis, there were regular sound bites from the Prime Minister and Minister for Emergency Management, but arguably no clear authoritative statement as to what EMA and the Commonwealth were doing to assist devastated communities. Apart from a few military personnel, there were limited statements from authorised Commonwealth officials who could clearly explain in a non-politicised manner exactly how, why, when and where actions were being taken to support state and territory responses.

It is crucial during an emergency that there is strong political leadership, but also open, clear, no-nonsense operational leadership and communication from people who are not hobbled by political considerations and whom the public implicitly trust because they clearly “tell it like it is”. For a solid example, one only need look at NSW RFS Commissioner, Shane Fitzsimmons’ outstanding performance throughout the 2019-20 fire crises. The recent use of AHPPC and the CHO throughout COVID-19 also clearly demonstrates this in action.

EMA needs more than the current case-by-case acceptance of its role by other Commonwealth and state agencies. EMA needs a mandate from Cabinet to lead the Commonwealth’s response to significant crises. It requires the power and authority to ensure that all Commonwealth agencies are properly coordinating planning for disaster mitigation and the monitoring, testing and exercising of their emergency response plans as part of the government’s broader crisis-management responsibilities, coordinated with state and territory emergency management agencies. This will also minimise duplication of effort.

11.4 Catastrophic disaster planning and coordination

A current gap in organisational and planning arrangements is recognition of what would happen if there were a truly catastrophic disaster that removed the ability to govern and respond – for example a widespread earthquake and tsunami. Cyclone Tracey in 1974 is an example of a situation where local response and leadership capabilities were removed.

Whilst the 2019-20 fires were unprecedented and shocking, states and territories maintained capabilities to respond and to make decisions. There was no need for a Commonwealth assumption of command authority or overall leadership.

EMA could also be given a mandate to coordinate state and territory resources when the requirement for disaster response overwhelms any jurisdiction's capacity, and significant urgent support from other jurisdictions is required. There is no need to establish a new position: the job description for a new role of Coordinator-General and Statutory appointment fits that of the Director-General, EMA, who in such situations could answer directly to the Prime Minister through the Secretary of the Department of Prime Minister and Cabinet.

Former Deputy Chief of the Royal Australian Airforce (RAAF), Air Vice Marshal John Blackburn AO (ret) has lobbied for years for the Commonwealth to pay greater attention to Australia's vulnerabilities to various disaster scenarios. A number of senior officials have warned that COVID19 is a "dress rehearsal" for an even greater national crisis which could in weeks see basic services such as water, transport and food seriously eroded (ABC 2020b). Bigger thinking is urgently needed and EMA is well-placed to coordinate discussion and planning, provided it is resurrected from its subordination within the enormous Home Affairs bureaucracy, and given new legislative authority.

11.5 Lessons learned from counter terrorism planning

Australia's approach to the unprecedented fires, in terms of assessing and monitoring the risks, developing capabilities to minimise the risks and potential harm, absorbing whatever harm occurs and then returning to normality as soon as possible, is similar in some respects to responding to terrorism.

Over the last 19 years there has been considerable planning and investment by the Federal Government (including consultation/ agreement by states and territories) focused on our capacity to plan for, prevent, respond to and recover from a major terrorist attack on our soil. While a mass casualty terrorist attack in Australia remains a distinct possibility, assessed against the risk of probability, Australia is far more likely to have to deal with increased frequency and severity of natural disasters. The consequences of natural disasters are increasing, as evidenced by these latest fires, under climate change intensifying.

In the case of a national terrorist situation, the Australian government determines policy and strategies. But this role isn't replicated for large scale natural disasters that cause catastrophic damage and considerable impact on community health and wellbeing. The

need to think big in relation to disasters of any kind, (including realistic testing of response and recovery and acting on identified shortcomings), has been raised with successive governments. If anything, the evolving nature of the current COVID-19 crisis has reinforced this need, and the community would expect this.

Arguably this message has fallen on deaf ears in Canberra because of concerns about scaring the community. In 2009, Black Saturday was a wakeup call with 173 deaths, 414 injuries and 2029 homes lost. But this event didn't have the added complication (in Mallacoota) of managing 4000 displaced persons across two states. It is unclear what would have occurred if a thousand or even 300 of these people required urgent retrieval and medical assistance.

The most important item is the need to establish clear leadership. The States have constitutional responsibilities for emergency management and control most of the functions essential for effective disaster prevention, response and recovery. But there's uncertainty on who would be in charge in the situation of a major national disaster in Australia and how the response would be coordinated across borders.

With the agreement of states and territories, the government should appoint a Coordinator-General with national executive authority. This individual would have executive powers to direct and oversight the utilisation of Commonwealth resources for a specific period in order that assistance is rendered quickly and efficiently. This should also include the supporting the ongoing recovery process for all those affected by an event. Recovery is a long-haul task post-disaster, which many forget about after a couple of months. A national Coordinator-General should work in concert with each affected state recovery coordinator.

Recommendation 20: The Senate Inquiry should detail why the military is not in a position to, nor should it, take over from state and territory emergency services during natural disasters, but instead work in close collaboration. In its Findings, the Senate Inquiry should recognise the strong leadership and achievements of state and territory emergency service leaders, and particularly of the many emergency workers, career and volunteer, who worked on the front lines or in support for months, mostly without pay, and in some cases, ultimately without homes to return to.

Recommendation 21: The Senate Inquiry should find that significant additional expenditure on the ADF to build a new disaster response capability is not necessary and would be an expensive duplication of existing state and territory capabilities. The focus should be on complementarity and support, not taking over or creating expensive new structures.

Recommendation 22: The Senate Inquiry should note the deficiencies that occurred at the national political level during the fires for the official record, so that it will hopefully not be replicated in future. Despite expert warnings, it appears that the Federal Government was seriously unprepared for the fires, but it was promising to see stronger leadership during the subsequent COVID-19 pandemic. An apparent failing during the fires was the lack of engagement of expert officials to underpin well-informed and firm evidence-based decision making by politicians.

Recommendation 23: The Senate Inquiry should recommend that the role of Emergency Management Australia be revitalised and strengthened. EMA is currently subsumed in the large Home Affairs bureaucracy, but should have direct access to the Prime Minister and Secretary of the Department of Prime Minister and Cabinet. It should continue to work closely and collaboratively with the peak council for fire and emergency services, the Australasian Fire and Emergency Service Authorities Council.

Recommendation 24: The Senate Inquiry should recommend that Emergency Management Australia be given legislative power to coordinate Commonwealth assets in support of states and territories when required, rather than the current arrangements that are reliant on goodwill. Goodwill is insufficient in disaster situations where clear lines of authority, command, control and firm decision-making based on evidence, are required.

Recommendation 25: The Senate Inquiry should recommend that EMA lead a collaborative project to develop detailed plans and arrangements to deal with catastrophic

disasters that remove the ability of states and territories to respond and to govern. By necessity this will involve a range of stakeholders including but not limited to: state and territory governments, emergency services and their peak council, and the Australian Defence Forces. Australia must not wait for a catastrophic disaster to occur before working out how to deal with it.

12. Use of Australian Defence Force capabilities

12.1 Climate change impacting ADF

Climate change is placing increasing pressure on the Australian Defence Force (ADF) in three key areas.

Firstly, climate change increases the need for the ADF to respond in Humanitarian Aid and Disaster Relief (HADR) and Defence Aid to Civil Community (DACC) capacities. This is occurring internationally, regionally (Indo-Pacific), and domestically. For example, from 2005-06 to 2012-13 Defence assisted in 275 domestic emergencies, with this number likely to be higher (ANAO 2014). The ADF support to the 2019-20 bushfires (Operation Bushfire Assist) saw the largest peacetime deployment of the ADF involving more than 6,400 personnel, including 2,500 reservists, 350 international service personnel, and more than 13 fixed wing aircraft, 20 rotary wing platforms and 2 naval vessels (AusDoD 2020).

Secondly, and closely coupled with the increase of HADR / DACC missions, climate change will require changes to ADF force structure, training, doctrine, planning, interoperability, and other inputs to capability. Operation Bushfire Assist provided numerous lessons learnt. For example, the need to include improved pre-crisis scenario planning with state government authorities (especially around how to best integrate and connect ADF units with local authorities); improvements in inter-agency communications for 'on-ground units' between the ADF and emergency services and clarity around call-out procedures between Federal and State governments. Climate change will also drive careful consideration by the ADF regarding the types of capability that are needed for future operations in a world increasingly shaped by climate change impacts. Better consultative processes with states and territories and emergency services could help shape future strategic capability enhancements and procurements, with an emphasis on interoperability and complementarity.

Thirdly, as recognised by the Chief of the Defence Force General Angus Campbell, climate change will increasingly drive a fundamental re-think of Australia's key national security drivers and how—as a country—we need to confront the 21st century security dynamic (ABC 2019). ELCA suggests that this will require a much broader approach to future White Papers to embrace wider and deeper concepts of security, including a consideration of climate change and its impacts, such as more frequent natural disasters that are increasingly stretching or overwhelming state and territory capabilities to respond and recover. In the interim, acknowledgement of the increased pressure that climate change will place on the ADF, as well as a plan for how the ADF will support relevant emergency services and recovery agencies in the future, must be acknowledged in key Defence policy and planning documents. This includes any assessment of the strategic underpinnings of the 2016 Defence White Paper, or reviews on how the ADF can be more responsive to changing circumstances or updates to the DoD's force structure plan (The Australian 2019; Hellyer 2019).

12.2 Utilise existing ADF capabilities for support roles

Fire and emergency services are not advocating for development of a separate emergency response capability within the ADF. The array of logistical and engineering capabilities that already exist can be readily adapted to a range of emergency and recovery management contexts provided there are adequate consultative processes to ensure that appropriate elements of capability are deployed. During the 2019-20 fires sections of the media and some politicians called for the ADF to be deployed to fight fires. This would have been neither practical nor safe, as the minimum training required for a volunteer or career firefighter to safely deploy under qualified supervision is around 3 months. The best approach is to utilise the ADGF strengths in logistics and engineering.

12.3 DACC arrangements need to be reviewed and simplified

ELCA tried to suggest to the Prime Minister several times in 2019 that the cumbersome arrangements for seeking and deploying Defence Aid to the Civil Community level 2 (DACC2) should be examined and simplified. The lack of an overall plan for the ADF to support civilian operations and civilian emergency services in response and recovery ultimately proved to be an impediment to their eventual deployment. The focus should initially be on simplifying processes for requesting, approving and sustaining support, and simplifying DACC2, which essentially always emerges as an ad hoc (unplanned) arrangement. It is time to modernise the processes and increase interaction with state and territory emergency services as a routine role for the ADF.

Recommendation 26: The Senate Inquiry should recommend that Australia's National Security Strategy needs to embrace wider and deeper concepts of security, including a consideration of climate change, natural disasters driven by extreme weather, and their impacts, as well as the possibility of compound events (where two or more extreme weather events combine to produce impacts that are worse than the effects of each event independently). The Australian Defence Force has comprehensive logistics, engineering and heavy lift capabilities that can be applied to assist emergency services and communities in the response and recovery phases.

Recommendation 27: The Senate Inquiry should recommend that key Defence policy papers, such as the next Defence White Paper, should incorporate a clear forward plan for how the ADF will support emergency services and recovery agencies in the future, as climate change drives an increased number of extreme fire danger days and other natural disasters in Australia and regionally.

Recommendation 28: The Senate Inquiry should recommend that the Australian Government conduct a fundamental review of longstanding Defence Assistance to the Civil Community (DACC) arrangements. The arrangements can be cumbersome and slow, and levels of understanding between the ADF and emergency services about respective capabilities, needs, and arrangements can be improved.

Recommendation 29: The Senate Inquiry should recommend that the ADF further develop its capability to assist states and territories during disasters, with a focus on utilisation of existing capabilities for civil defence roles under the control of emergency services and state and territory governments, rather than developing new capabilities that might serve to duplicate state and territory capabilities and ultimately cause confusion and inefficiencies.

13. Other matters pertaining to emergency management

13.1 Alignment of emergency warnings nationally

Emergency Warnings, introduced following the 2009 Black Saturday fires, are different in every state and territory, even to the point that not all states colour-code Emergency Warnings (red), Watch and Act (Yellow) and Advice (Blue) messages on the various applications used to promulgate warnings to the public. The level of information provided varies from almost nothing, to comprehensive updates (NSW and Victoria).

This is confusing for people holidaying or crossing borders and detracts from the overall spirit and intent of agreements reached following the 2009 bushfires. A national approach and agreement is urgently required to align the disparate state and territory approaches to public warnings.

13.2 Radio communication and interoperability

The ability to interface radio communications systems between fire and emergency services remains difficult within some states and territories, and almost non-existent across borders. Direct radio communication, particularly at fast moving fires, is critical to maintaining situational awareness and safety.

Even in NSW, fire and land management agencies do not routinely communicate directly with each other at the same fires – they may or may not speak on a common channel or “strategic” channel, or back at a fire control centre. As a work-around solution, shared emergency service channels or strategic command channels, in practice do not work well at the tactical level, as tactical units continue to operate on their normal radio talk groups or channels in isolation from other agencies. This is dangerous and should no longer be tolerated in the 21st century where there are numerous technological solutions available, including within current radio platforms. The technology exists to integrate communications at incidents, but the organisational leadership and will to do so, (including when members of ELCA were in charge) or perhaps budget, appears in some cases to have been lacking.

In California each fire is assigned a common radio channel accessible to be used by all assisting Fire Departments for management of each fire. It is time that Australia adopted the same principle universally rather than on an ad hoc basis. This will improve interoperability, situational awareness, safety and operational effectiveness.

There are no longer any technical or process issues to excuse this from happening – all agencies utilise the Australasian Inter-service Incident Management System to manage operations, so it will be a relatively simple matter to align radio communication procedures and protocols. AFAC as the peak council for fire and emergency services should be engaged to help make this happen.

13.3 Common operating picture and national situational awareness

A national approach to developing an over-arching Common Operating Picture (a screen-based system showing current emergency situations across jurisdictions including resource commitments, available resources, resource requests, predictions and warnings as a minimum) has been discussed in the past, but judged to be too difficult to create, host and maintain. If military technologies could be utilised and a system hosted nationally, perhaps by EMA, this would be a major leap forward for all jurisdictions and overcome some state and territory issues with regard to funding and alignment of technologies.

Each fire and emergency service agency would share agreed emergency information, mapping and resource deployment information so that all jurisdictions could maintain a national picture, thus informing their own state of readiness or ability to assist.

13.4 Community resilience – electricity and mobile telephony

What occurred on the NSW South Coast on New Years Eve 2019 demonstrates an issue that routinely afflicts the resilience and safety of Australian communities during and after fires, storms, floods and cyclones – the loss of electrical power and mobile phone towers. As major bushfires burned hundreds of buildings and lives were being lost, wooden power poles at multiple locations caught fire and fell, taking down power lines, and up 1000 mobile phone towers and nodes were disabled (SMH 2020). This resulted in widespread power failures, then cascading issues affecting mobile telephone towers, water pumping stations, radio networks, ability to receive emergency warnings, sewage systems, and food refrigeration.

Falling and arcing power lines are also an identified source of new fires, particularly given that days of Very High fire danger and above involve higher wind velocities, and therefore a higher probability that trees or branches will be blown onto power lines, causing sparks and ignition of bush and grass fires, and fast moving fires will impact on remote communications infrastructure. There are numerous examples of storms and cyclones where one of the most urgent recovery tasks has been the restoration of power, and specifically, the repair of fallen and damaged power line infrastructure.

One of the most profound resilience measures that could be taken in Australia is the huge and expensive undertaking of firstly, abandoning the early 20th century engineering solution of installing overhead power lines and power poles, and secondly, embarking on a targeted program commencing in the most high risk areas. To place existing electrical transmission infrastructure underground.

Recommendation 30: The Senate Inquiry should strongly recommend that state and territory governments agree on and then align how they promulgate emergency warning information in order to avoid confusion as people cross borders. As a minimum, there needs to be alignment of colours used in threat maps, and the level of information provided by agencies to the public in emergency warnings.

Recommendation 31: The Senate Inquiry should recommend that states and territories, coordinated by the Australasian Fire & Emergency Service Authorities Council, develop protocols and arrangements, backed by appropriate technologies, to enable direct tactical radio communications between all emergency services operating at the same major incident. Work around solutions such as additional inter-agency talk groups should be eliminated as they can reduce overall situational awareness.

Recommendation 32: The Senate Inquiry should recommend that a technological solution to implement a shared situational awareness tool, or National Common Operating Picture (COP), be developed by Emergency Management Australia and shared with all state and territory emergency services. The COP would enable all agencies in real time to monitor current incidents, deployments and emerging needs, as well as the ability to flag emerging local requirements. AFAC should partner with EMA to deliver the project.

Recommendation 33: The Senate Inquiry should find that loss of electricity through inevitable damage to overhead powerline infrastructure during fires, storms and cyclones has immediate, cascading and profound effects that impact on response, recovery and community resilience. Community lifelines including all forms of electronic communication, drinking and firefighting water, sewerage and hygiene, refrigeration and food, can all be impacted. The Senate Inquiry should recommend that new electrical supply installations in future be required to be underground, and that the Council of Australian Governments should develop a long term nationwide program prioritised to high risk areas, to eventually place the majority of electrical distribution lines underground.

References

Abatzoglou, J. T., & Williams, A. P. (2016) Impact of anthropogenic climate change on wildfire across western US forests. *Proceedings of the National Academy of Sciences*, 113(42), 11,770–11,775. <https://doi.org/10.1073/pnas.1607171113>.

ABC (Australian Broadcasting Commission) (2019). Climate change could stretch our defence capabilities, Defence Force chief speech warns. Accessed at: <https://www.abc.net.au/news/2019-09-25/australian-defence-force-angus-campbell-climate-change-speech/11543464>

ABC (2020a). Victorian fire chief says calls for more fuel reduction burns are an ‘emotional load of rubbish’. Accessed at: <https://www.abc.net.au/news/2020-01-07/fuel-reduction-burn-debate-rubbish-says-vic-fire-chief/11849522>

ABC (2020b). Think of corona virus as a test run: military leaders warn we must prepare for worse. Accessed at: https://www.abc.net.au/news/2020-04-29/military-leaders-warn-australia-prepare-for-worse-coronavirus/12193228?utm_source=abc_news&utm_medium=content_shared&utm_content=mail&utm_campaign=abc_news

ACT Government (2020) State of Emergency Declared for ACT (media release, 31/01/2020). Accessed at: https://www.cmtedd.act.gov.au/open_government/inform/act_government_media_releases/barr/2020/state-ofemergency-declared-for-act.

AIDR (Australian Institute of Disaster Resilience) (2020a). Knowledge Hub. Tasmania February 1967. Black Tuesday bushfires, 1967. Accessed at: <https://knowledge.aidr.org.au/resources/bushfire-black-tuesday/>

AIDR (Australian Institute of Disaster Resilience) (2020b). Knowledge Hub. Victoria and South Australia Ash Wednesday bushfire 1983. Accessed at: <https://knowledge.aidr.org.au/resources/bushfire-ash-wednesday-1983/>

ANAO (Australian National Audit Office) (2014) The Auditor-General, Audit Report No. 24 2013-14 Performance Audit: Emergency Defence Assistance to the Civil Community, ed. Department of Defence. Canberra: Commonwealth of Australia.

Andrews D, Premier (2020) 'Immediate Support For Victoria's Wildlife And Biodiversity', media release, 23 January. Accessed at <https://www.premier.vic.gov.au/immediate-support-for-victorias-wildlife-and-biodiversity/>.

Arriagada NB, Palmer AJ, Bowman D, Morgan GG, Jalaludin BB, and Johnston FH (2020). Unprecedented smoke-related health burden associated with the 2019-20 bushfires in Eastern Australia. Accessed at:

[https://www.mja.com.au/journal/2020/213/6/unprecedented-smoke-related-healthburden-associated-2019-20 - bushfireseastern?utm_source=tiles&utm_medium=web&utm_campaign=homepage](https://www.mja.com.au/journal/2020/213/6/unprecedented-smoke-related-healthburden-associated-2019-20-bushfireseastern?utm_source=tiles&utm_medium=web&utm_campaign=homepage)

AusDoD (Australian Department of Defence) (2020) Operation Bushfire Assist 2019-20 20. Accessed at [https://news.defence.gov.au/national/operation-bushfire-assist-2019-20 20](https://news.defence.gov.au/national/operation-bushfire-assist-2019-20-20)

AvGeekery (2016) How do you convert a C-130 into a firefighting aircraft? Accessed at <https://www.avgeekery.com/convert-c-130-firefighting-aircraft/>

Bell N (2019) Development in Australian bushfire prone areas. *Environment*. Australian Institute of Architects. Issue 05: Oct 19. Accessed at <https://www.architecture.com.au/wp-content/uploads/Development-in-Australian-bushfire-prone-areas-Australian-Institute-of-Architects.pdf>

Blanchi R, Leonard J, Haynes K, Opie K, James M and de Oliveira FD (2014) Environmental circumstances surrounding bushfire fatalities in Australia 1901-2011. *Environmental Science and Policy*, 37: 192–203.

Boer MM, Resco de Dios V and Bradstock RA (2020) Unprecedented burn area of Australian mega forest fires. *Nature Climate Change*, 10, pages171–172. Accessed at: <https://www.nature.com/articles/s41558-020-0716-1>

BoM (Bureau of Meteorology) (2018a) Special Climate Statement 65- persistent summer-like heat sets many April records. Accessed at: <http://www.bom.gov.au/climate/current/statements/scs65.pdf>

BoM (2018b) Special Climate Statement 66- an abnormally dry period in eastern Australia. Accessed at: <http://www.bom.gov.au/climate/current/statements/scs66.pdf>

BoM (2018c) Variations and Changes in Fire Weather across NSW. Australian Bureau of Meteorology. Canberra. 2020

BoM (2019a) Special Climate Statement 71—severe fire weather southeast Queensland and northeast New South Wales in September 2019. Accessed at <http://www.bom.gov.au/climate/current/statements/scs71.pdf>.

BoM (2019b) Victoria in 2019: warmer and drier than average. Accessed at <http://www.bom.gov.au/climate/current/annual/vic/archive/2019.summary.shtml>.

BoM (2020a) Climate change — trends and extremes. Accessed at:
http://www.bom.gov.au/climate/change/index.shtml#tabs=Tracker&tracker=timeseries&tQ=graph%3Dtmax%26area%3Daus%26season%3D0112%26average_yr%3D0.

BoM (2020b) Australia in December 2019. Accessed at:
<http://www.bom.gov.au/climate/current/month/aus/archive/201912.summary.shtml>.

BoM (2020c) Australia in Spring 2019. Accessed at: <http://www.bom.gov.au/climate/current/>

BoM (2020d) Special climate statement 72 – dangerous bushfire weather in spring 2019. Accessed at <http://www.bom.gov.au/climate/current/statements/scs72.pdf>

BoM (2020e) Annual climate statement 2019. Accessed at:
<http://www.bom.gov.au/climate/current/annual/aus/>.

Broome RA, Johnston FH, Horsley J and Morgan GG (2016) A rapid assessment of the impact of hazard reduction burning around Sydney, May 2016, *Medical Journal of Australia*, 205 (9): 407-408.

Buxton M, Haynes R, Mercer D and Butt A (2011) Vulnerability to bushfire risk at Melbourne's urban fringe: The failure of regulatory land use planning. *Geographical Research*, 49: 1–12.

CalFire (2020a) California Department of Forestry and Fire Protection. Accessed at:
https://www.fire.ca.gov/media/5511/top20_destruction.pdf

CalFire (2020b) California Department of Forestry and Fire Protection. Accessed at:
<https://www.fire.ca.gov/incidents/2019/10/23/>

Canberra Times (2019) Barilaro pours more fuel on bushfire spat. Trask, S. 13 November 2019. Accessed at: <https://www.canberratimes.com.au/story/6491091/barilaro-pours-more-fuel-on-bushfire-spat/?cs=14231>

Canberra Times (2020) Australia's 2019-20 bushfire season. O'Mallon F and Tierman E, 10 January 2020. Accessed at
<https://www.canberratimes.com.au/story/6574563/australias-2019-20-bushfireseason/?cs=14231>

CFS (South Australia Country Fire Service) (2020). Bushfire History. Accessed at:
https://cfs.sa.gov.au/site/about_cfs/history_of_the_cfs/bushfire_history.jsp

Clarke H, Lucas C and Smith P (2013) Changes in Australian fire weather between 1973 and 2010 . International Journal of Climatology. Accessed at <https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/joc.3480>.

Climate Council (2014) Climate Change & the Australian Bushfire Threat. Accessed at: <https://www.climatecouncil.org.au/resources/be-prepared/>.

Climate Council (2015). Longer bushfire seasons leave Australia exposed. Accessed at: <https://www.climatecouncil.org.au/longer-bushfire-seasons-leave-australia-exposed/>

Climate Council (2019a) Australia not prepared for new overlapping bushfire seasons. Accessed at: <https://www.climatecouncil.org.au/resources/australia-not-prepared-fornew-overlapping-bushfire-seasons/>

Climate Council (2019b) Dangerous Summer: escalating bushfire, heat and drought risk. Accessed at: https://www.climatecouncil.org.au/wp-content/uploads/2019/12/report-dangerous-summer_V5.pdf

Climate Council (2019c) This is not normal: climate change and escalating bushfire risk. Accessed at: [climatecouncil.org.au/wp-content/uploads/2019/11/cc-nov-Bushfire-briefing-paper.pdf](https://www.climatecouncil.org.au/wp-content/uploads/2019/11/cc-nov-Bushfire-briefing-paper.pdf)

Climate Council (2020a) Summer of Crisis. Accessed at: <https://www.climatecouncil.org.au/resources/summer-of-crisis/>

Climate Council (2020b) Setting the Record Straight on Hazard Reduction: fact sheet. Accessed at: https://www.climatecouncil.org.au/wp-content/uploads/2020/01/CC_MVSA0211-Fact-Sheet-Hazard-reduction-Fuel-Loads-Bushfires_Bella-Edit-A4.pdf

CSIRO and BoM (2016) State of the Climate 2016. CSIRO and Bureau of Meteorology, Melbourne, 22pp. Accessed at: <http://www.climatechangeinaustralia.gov.au/en/publications-library/technical-report/>.

CSIRO and BoM (2018) State of the Climate 2018. Accessed at: <http://www.bom.gov.au/state-of-the-climate/State-ofthe-Climate-2018.pd>

Dowdy, A. J. (2015) Large-scale modelling of environments favourable for dry lightning occurrence. 21st International Congress on Modelling and Simulation, Gold Coast, Australia, 29 Nov to 4 Dec 2015 www.mssanz.org.au/modsim2015.

Dowdy AJ (2017) Climatological Variability of Fire Weather in Australia. *J. Appl. Meteor. Climatol.*, 57, 221–234. Accessed at <https://doi.org/10.1175/JAMC-D-17-0167.1>.

Dowdy AJ and Pepler A. (2018). Pyroconvection risk in Australia: climatological changes in atmospheric stability and surface fire conditions. *Geophysical Research Letters*, doi:10.1002/2017GL076654

Dowdy A *et al.* (2019). Future changes in extreme weather and pyroconvection risk factors for Australian wildfires. *Scientific Reports*. 9: 10073. Accessed at <https://www.nature.com/articles/s41598-019-46362-x>

DELWP (Department of Environment, Land, Water and Planning) (2020) Victoria's bushfire emergency: Biodiversity response and recovery Preliminary report - Version 1. Accessed at https://www.wildlife.vic.gov.au/_data/assets/pdf_file/0034/449746/Victorias-bushfire-emergency-Biodiversity-response-and-recovery-Version-1-23-January-2020.pdf.

Doogan, M (2006) The Canberra Firestorm. Inquest and Inquiry into 4 deaths and 4 fires between 8 January and 18 January 2003. Volume 1. ACT Coroners Court. Accessed at: https://courts.act.gov.au/_data/assets/pdf_file/0007/961468/canberra_firestorm_vol_i.pdf

DSE (Department of Sustainability and Environment Victoria) (2005). Report of the investigation into the future of cattle grazing in the Alpine National Park. Alpine Grazing Taskforce. Accessed at: <http://environment.gov.au/epbc/notices/assessments/victoria-alpine-national-park/pubs/b6-alpine-grazing-taskforce-2005.pdf>

Earl N., Love P., Harris R., Remenyi T (2019) Dry lightning has set Tasmania ablaze and climate change makes it more likely to happen again. The Conversation 7 February 2019 <https://theconversation.com/dry-lightning-has-set-tasmania-ablaze-and-climate-change-makes-itmore-likely-to-happen-again-111264>

Earth Systems and Climate Change Hub (2019). Bushfires and climate change in Australia. Accessed at http://nspclimate.com.au/wp-content/uploads/2019/11/A4_4pp_brochure_NESP_ESCC_Bushfires_FINAL_Nov11_2019_WEB.pdf

Ellis, S (2020). Don't insult or duplicate firefighters' efforts. Accessed at: <https://www.afac.com.au/auxiliary/publications/newsletter/article/don't-insult-or-duplicate-firefighter's-efforts>

FFMV (Forest Fire Management Victoria) (2019) History and incidents. Past bushfires. A chronology of major bushfires in Victoria from 2013 back to 1851. Accessed at: <https://www.ffm.vic.gov.au/history-and-incidents/past-bushfires>

Gergis J and Carey G (2020) Some say we've seen bushfires worse than this before. But they're ignoring a few key facts, The Conversation. Accessed at: <https://theconversation.com/some-say-weve-seen-bushfires-worse-than-thisbefore-buttheyre-ignoring-a-few-key-facts-129391>.

Greens (Australian Greens Party) (2020). Bushfires, Hazard Reduction and Backburning. Accessed at: <https://greens.org.au/bushfires>

Hannam, P (2019a) An ill wind fans the flames. Sydney Morning Herald. Accessed at: <https://www.smh.com.au/environment/climate-change/an-ill-wind-fans-the-flames-20190912-p52qir.html>

Hannan, P (2019b). NSW fire losses mount as Queensland sets record, adjusted data show. Sydney Morning Herald <https://www.smh.com.au/national/nsw-fire-losses-mount-as-queensland-sets-record-adjusted-data-show-20191116-p53b6d.html>

Hellyer M (2019) Defence's strategic reassessment: squaring the circle with tied hands. Accessed at <https://www.aspistrategist.org.au/defences-strategic-reassessment-squaring-the-circle-with-tied-hands/>

ICA (Insurance Council of Australia) (2020) CAT195 Australian Bushfire Season (2019/20) NSW, QLD, SA, VIC. Accessed at: <https://disasters.org.au/current-catastrophes/2019/11/13/november-bushfires>.

Keating *et al.* (2012). Air Attack Against Wildfires. Understanding US Forest Service Requirements for Large Aircraft. Rand Homeland Security and Defense Centre. Sponsored by the United States Forest Service. Rand Corporation. Santa Monica. California. USA.

Loveridge RW (2020) Australian building codes don't expect houses to be fire-proof- and that's by design. The Conversation. Accessed at <https://theconversation.com/australian-building-codes-dont-expect-houses-to-be-fire-proof-and-thats-by-design-129540>

Luke H, McArthur A (1978) Bushfires in Australia. Australian Government Publishing Service. Canberra

LVIN (2020) Latrobe Valley Information Network. Accessed at: <https://lvin.org/about-lvin.html>

Mariani M, Holz A, Veblen T, Williamson G, Fletcher M-S, Bowman D (2018) Climate Change Amplifications of Climate-Fire Teleconnections in the Southern Hemisphere, *Geophysical Research Letters*, DOI: 10.1029/2018GL078294.

Matthews S, Sullivan AL, Watson P and Williams RJ (2012) Climate Change, fuel and fire behaviour in a eucalypt forest. *Global Change Biology*, 18: 3212–3223

McRae RHD, Sharples JJ & Fromm M (2015) Linking local wildfire dynamics to pyroCb development, *Natural Hazards and Earth System Sciences*, 15: 417–428.

NAFC (National Aerial Firefighter Centre) (2016). Submission of the National Aerial Firefighting Centre to the Senate Environment and Communication References Committee Inquiry into the response to, and lessons learnt from, recent bushfires in remote Tasmanian wilderness. Accessed at: https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Tasmanian_Bushfires/Submissions

NAFC (National Aerial Firefighter Centre) (2018a) Brief on NAFC Business Case for additional funding to support national capability

NAFC (National Aerial Firefighter Centre) (2018b) Request for proposal large airtanker services 2018 +. Accessed at: <http://nafc.org.au/wp-content/uploads/2017/12/RFP-LAS-2018.pdf>

NAFC (National Aerial Firefighter Centre) (2020) National Aerial Firefighting Centre. Information. Accessed at: <http://www.nafc.org.au/>

NCC (Nature Conservation Council) (2020). Bushfire Program. Accessed at: <https://www.nature.org.au/healthy-ecosystems/bushfire-program/>

News.com.au (2019) The myths around Australia's horror fire season debunked. Accessed at: <https://www.news.com.au/technology/environment/climate-change/the-myths-around-australias-horror-bushfire-season-debunked/news-story/199c41bf9eb5af07a75575fea278c1f8>

Norman B, Weir KJ, Sullivan K and Lavis J (2014) Planning and bushfire risk in a changing climate. Bushfire CRC, Australia. Accessed at https://www.bushfirecrc.com/sites/default/files/urban_and_regional_planning.pdf

NSW RFS (New South Wales Rural Fire Service) (2019) Bush Fire Danger Period starts in a further 53 areas this weekend. Accessed at: https://www.rfs.nsw.gov.au/_data/assets/pdf_file/0013/111208/190830-Bush-firedanger-1-SeptemberFINAL.pdf

NSW RFS (2020a) Fire History. Accessed at: <https://www.rfs.nsw.gov.au/about-us/history>

NSW RFS (2020b). 2019/20 Bush Fire Season Overview. Bush Fire Coordinating Committee. 19 March 2020.

NSW Parliament (2014) Issues Backgrounder. Bushfires in NSW: Timelines and key sources. Number 6/June 2014. NSW Parliamentary Research Service. Accessed at: <https://www.parliament.nsw.gov.au/researchpapers/Documents/bushfires-in-nsw-timelines-and-key-sources/Bushfires%20in%20NSW%20-%20timelines%20and%20key%20sources.pdf>

OEH (NSW Office of Environment and Heritage) (2012) Living with Fire in NSW National Parks – A strategy for managing bushfires in national parks and reserves 2012– 2021. NSW Office of Environment and Heritage. Sydney

Plucinski, M (2012) Factor affecting containment area and time Australian forest fires featuring aerial suppression. Accessed at: <http://dx.doi.org/10.5849/forsci.10-096>

Queensland Government (2020) Queensland Bushfires Review. Report 2: 2019/20. Brisbane. Inspector General Emergency Management.

Romps, D., Seeley, J., Vollaro, D., and Molinari, J. (2014) Projected increase in lightning strikes in the United States due to global warming, Science, 346(6211): 851-854.

SA DHS (South Australian Government Department of Human Services) (2020). 2020 Feb 17 Official Bushfire Damage Statistics. South Australian Government. Adelaide.

SBS (2020) Labor's Kim Carr says funding for bushfire research centre must be secured past next year's deadline. Accessed at: <https://www.sbs.com.au/news/labor-s-kim-carr-says-funding-for-bushfire-research-centre-must-be-secured-past-next-year-s-deadline>

Sharples A, Hilton J and Sullivan A (2019) Pyroconvective interactions and spot fire dynamics. Bushfires and Natural Hazards CRC. Accessed at <https://www.bnhcrc.com.au/hazardnotes/61>

SMH (Sydney Morning Herald) (2019) The economic cost of bushfires on Sydney revealed: up to \$50 million a day and rising. Accessed at: <https://www.smh.com.au/national/nsw/the-economic-cost-of-bushfires-on-sydney-revealed-up-to-50-million-a-day-and-rising-20191212-p53jbq.html>.

SMH (2020a) Rain brings some relief as crews fight to gain upper hand on bushfires. Accessed at: <https://www.smh.com.au/national/nsw/rain-brings-some-relief-as-crews-fight-to-gain-upper-hand-on-bushfires-20200112-p53qsa.html>

SMH (2020b) More than 1000 mobile towers and nodes went down during bushfires.

Accessed at: <https://www.smh.com.au/politics/federal/more-than-1000-mobile-towers-and-nodes-went-down-during-the-bushfires-20200430-p54opo.html>

Standards Australia (2018) Australian Standard AS 3959:2018 Construction of buildings in bushfire-prone areas, 14 November 2018.

Steffenson, V (2020) Fire Country. Hardie Grant Travel, a division of Hardie Grant Publishing. Melbourne and Sydney

Stretton, L (1939). Report of the Royal Commission to Inquire into The Causes and Measures Taken to Prevent the Bush Fires of January 1939 and to Protect Life and Property, AND the Measures to be Taken to Prevent Bush Fires in Victoria and to Protect Life and Property in the Event of Future Bush Fires. Accessed at:

[http://www.voltscommissar.net/docs/Leonard Stretton-1939 Bush Fires Royal Commission Report.pdf](http://www.voltscommissar.net/docs/Leonard_Stretton-1939_Bush_Fires_Royal_Commission_Report.pdf)

Styger, J., Marsden-Smedley, J., & Kirkpatrick, J. (2018) Changes in Lightning Fire Incidence in the Tasmanian Wilderness World Heritage Area, 1980–2016. Fire, 1(3), 38.

<https://doi.org/10.3390/fire1030038>

Teague, B (2010) 2009 Bushfires Senate Inquiry . Final Report Summary. Accessed at: .

[http://royalcommission.vic.gov.au/finaldocuments/summary/PF/VBRC Summary PF.pdf](http://royalcommission.vic.gov.au/finaldocuments/summary/PF/VBRC_Summary_PF.pdf)

The Australian (2019) Out-of-date-strategies in defence white paper. Accessed at

<https://www.theaustralian.com.au/nation/defence/outofdate-strategies-in-defence-white-paper/news-story/3e871d6322765aa33b72123b28b21d70>

The Australia Institute (2019) High Carbon from a Land Down Under: Quantifying CO₂ from Australia's fossil fuel mining and exports. Accessed at:

<https://www.tai.org.au/content/high-carbon-land-down-under-quantifying-co2-australia-s-fossil-fuel-mining-and-exports>.

The Guardian (2019) Scientists fear surge in supersized bushfires that create their own violent thunderstorms. Accessed at: <https://www.theguardian.com/>

[environment/2019/dec/20/scientists-fear-surgeinsupersized-bushfires-that-create-their-ownviolentthunderstorms](https://www.theguardian.com/environment/2019/dec/20/scientists-fear-surgeinsupersized-bushfires-that-create-their-ownviolentthunderstorms)

The Guardian (2020a) Hazard reduction burns are not a “panacea” for bushfire risk, RFS boss says. Accessed at: [https://www.theguardian.com/australia-](https://www.theguardian.com/australia-news/2020/jan/08/hazard-reduction-is-not-a-panacea-for-bushfire-risk-rfs-boss-says)

[news/2020/jan/08/hazard-reduction-is-not-a-panacea-for-bushfire-risk-rfs-boss-says](https://www.theguardian.com/australia-news/2020/jan/08/hazard-reduction-is-not-a-panacea-for-bushfire-risk-rfs-boss-says)

The Guardian (2020b) Australian fires: RFS commissioner not told of Scott Morrison's call-up of ADF reserve. Accessed at: <https://www.theguardian.com/australia-news/2020/jan/05/australia-fires-rfs-commissioner-not-told-of-scott-morrison-call-up-of-adf-reserve>

University of Adelaide (2020) Adelaide Geohazard: Bushfires. Accessed at: <https://adelaideunibushfires.wordpress.com/about/>

University of Sydney (2020) More than one billion animals killed in Australian bushfires. Accessed at: <https://www.sydney.edu.au/news-opinion/news/2020/01/08/australian-bushfires-more-than-one-billion-animals-impacted.html>.

Victorian Government (2020) Research Papers. Bushfires 2019-20. Parliament of Victoria. Accessed at https://www.parliament.vic.gov.au/publications/research-papers/download/36-research-papers/13904-bushfires-2019-20#_ftn16

Wallace-Wells, D (2019) Los Angeles Fire Season is beginning again. And it will never end. A bulletin from our climate future. Intelligencer. Accessed at: <https://nymag.com/intelligencer/2019/05/los-angeles-fire-season-will-never-end.html>

Waters, K and Fuller, S (2020) The impact of utilizing Aerial Tankers in fighting forest fires. Prepared for Global Super Tanker Services. Virginia, USA

Williams, E. (2005) Lightning and climate: A review. Atmospheric Research, 76(1-4), 272–287. <https://doi.org/10.1016/j.atmosres.2004.11.01>.