

Royal Commission into National Natural Disaster Arrangements
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27 April 2020

Dear Royal Commission,

The Bushfire and Natural Hazards Cooperative Research Centre (CRC) welcomes the opportunity to provide a submission to the Royal Commission into National Natural Disaster Arrangements.

The Bushfire and Natural Hazards CRC believes that any discussion on bushfire prevention and fire season preparedness must engage all parties, public and private, across all land tenures, to work towards mitigation of the fire hazard using a range of tools and activities.

These include, but are not limited to:

- **Reducing the level of bushfire risk through planned burning for given levels of investment and resourcing.**
- **Better understanding other means of fuel reduction across the landscape and at the interface between forests and communities, and how in combination with planned burning, these approaches can be combined to contribute to risk reduction for bushfire threats**
- **Educating communities to make better decisions about their behaviour before, during and after fires.**
- **Understanding the impact of climate change and weather variability on different ecosystems and fire's role in those landscapes.**
- **Planning for more appropriate land uses in high fire risk areas, including rebuilding in ways that mitigate future fire impacts.**
- **Recruiting and retaining volunteer and career firefighters in order cope with longer fire seasons.**
- **Ensuring there is a research capability and capacity to provide the best advice across prevention, mitigation, response and recovery.**

The Bushfire and Natural Hazards CRC¹ and its predecessor the Bushfire CRC² have accumulated almost two decades of research into the bushfire hazards faced by Australian communities.

The following attached documents include:

- Specific responses to Terms of Reference (b):

Australia's arrangements for improving resilience and adapting to changing climatic conditions, what actions should be taken to mitigate the impacts of natural disasters, and

¹ www.bnhcrc.com.au

² www.bushfirecrc.com

whether accountability for natural disaster risk management, preparedness, resilience and recovery should be enhanced....

- Terms of Reference – further terms addressed in CRC research *Impacts and Outcomes*
- *Bushfire Seasonal Outlook* – August 2019 and December 2019
- *Building a disaster resilient Australia on a solid foundation of expertise, evidence and networks*

Details on the full CRC research program can be found here: www.bnhcrc.com.au/research

The Bushfire and Natural Hazards CRC has a membership and stakeholder base that includes the following Commonwealth entities: the Department of Industry, Science, Energy and Resources; the Bureau of Meteorology; Geoscience Australia; and Emergency Management Australia/Department of Home Affairs. In addition, the CRC has partners from all states and territories: specifically, the fire and emergency services agencies; land management agencies; not-for-profits; as well as universities from around Australia.

The Commonwealth Government funded the centre under the Cooperative Research Centres Programme for an eight-year period, which ends on 30 June 2021. The CRC is actively working with its partners and the Government on opportunities for ongoing funding for further research on issues arising from the 2019-20 fires and other major hazard events.

If the Bushfire and Natural Hazards CRC can be of any further help to the Commission, please do not hesitate to contact me.

Yours sincerely,

Dr Richard Thornton
CEO
Bushfire and Natural Hazards CRC

Submission to the Royal Commission into National Natural Disaster Arrangements from the Bushfire and Natural Hazards CRC

Specific responses to Terms of Reference (b):

Australia's arrangements for improving resilience and adapting to changing climatic conditions, what actions should be taken to mitigate the impacts of natural disasters, and

whether accountability for natural disaster risk management, preparedness, resilience and recovery should be enhanced...

Bushfire hazard reduction

It has been long understood that fuel reduction will decrease fire intensity, flame height and the forward rate of spread. One of the most efficient methods of reducing fuel over large areas is through the use of controlled fire under prescribed conditions – that is, through prescribed burning or planned/preventative burning.

There are other methods of fuel reduction, including selected thinning and mechanical removal. Although these may be more labour intensive, and therefore more expensive, they may be more appropriately applied in areas where the use of fire is not practicable, such as close to housing or other infrastructure, where arguably it is more effective in reducing the risk.

Importantly, fire is applied to various ecosystems for other reasons than just as preventative burning for fuel reduction. This may include the preservation of ecosystem values such as biodiversity, water yield and quality, soil preservation and other objectives. These objectives are enshrined in various codes of practice or similar documents¹. Trade-offs and balances need to be made to achieve often conflicting objectives. This has become harder in recent years with evolving drought situations across the country, with changing climate making windows for prescribed burning fewer, and with an increasing lack of community acceptance of applying fire to the landscape due to smoke and other perceived or real environmental impacts and the fear of escaped burns.

With the focus on risk assessment and with the endorsement of the National Emergency Risk Assessment Guidelines (NERAG) by the Australian and NZ Emergency Management Committee, and the then Ministerial Council of Law, Crime and Community Safety, it is sensible to link the level of planned burning to the level of risk reduction to individual communities rather than just an arbitrary area-burnt target that is not linked to prioritised objectives. Without such objective-based measures there is no answer to the question on the right amount of land to treat.

This has long been an area of debate, with more intense discussions over the past decade. Arbitrary area-based targets can drive unintended behaviours in order to meet them. Therefore, it is important that whatever targets are put in place that these are based on the best available evidence

¹ For example: NSW Parks and Wildlife Fire Management Manual 2017-2018; Vic - Audit and Quality Assurance Framework for Bushfire Management and SA - Fire Management Environmental Assessment and Management Procedure

and scientific research. They should be measurable, achievable and articulated in such a way that the community understand their residual risk.

It is in this context that it becomes important that any targets are also relevant and referenced to the ecosystems involved, the local risks being considered and the expectations of the local communities. This makes an overarching national area burnt target an impossible one to implement. What makes sense in terms of hectares burnt in New South Wales, for example, is not reflective on what is needed in the Northern Territory. Indeed, even within a single jurisdiction uniform targets are meaningless, for example between northern Queensland and the south-eastern corner of that state. At small scales, what works in the mixed species eucalypt forests in the foothills of the Great Dividing Range in Victoria, would be very different to what is appropriate in the state's mountain ash forests. This was recognised by the science panel in the 2009 Victorian Bushfires Royal Commission. The panel agreed that in the mixed species foothill forest five per cent of the land could be treated, which would effectively reduce risk without overly impacting biodiversity values.²

Any target must recognise that no amount of hazard reduction will reduce the risk to zero, and that trade-offs are required. It is also important that the community understands that the effectiveness of hazard reduction is strongly dependent on the weather conditions that prevail on the day they are impacted by fire. On extreme days (like Black Saturday and at certain times during the 2019-20 season) the effectiveness of most prescribed burning on stopping runs of large fires will be reduced because medium and long-range spotting will see these large areas overrun.

However, research has shown that the fuel levels around properties and communities can make a significant difference to the intensity of the fire as it impacts private and public assets.

The 2009 Victorian Bushfires Royal Commission had a focus on the role that fuel levels on public land played on the events of Black Saturday. It was almost entirely silent on the role of fuels on private land, even though most deaths and damage to private assets resulted from the fires travelling over private land immediately before impact. This has also been the case in many subsequent fires, including fires over the 2019-20 season.

It is a falsehood to assume that by setting targets only for public land the risk to people and property can be solved. The idea that people should not consider the fuel levels on their own property and risk that it poses to themselves and others is inconsistent with the arguments and scientific evidence about the important role of fuels within 100 metres of properties. The idea that residents can ignore this because the government is treating the public land is dangerous and inconsistent with the arguments relating to shared responsibility outlined in the Victorian Bushfires Royal Commission report and enshrined in the National Strategy for Disaster Resilience.

Bushfires do not respect tenure boundaries and nor should a risk-based consideration of community protection. It is important that fuel reduction activities recognise the multiple players in land management, and that the government alone should not be solely responsible for the risk treatments.

This does then raise the issue of how private landowners undertake extensive fuel reduction measures. Barriers remain, including not being allowed to remove vegetation, because of local

² <https://www.bushfirecrc.com/news/news-item/experts-look-burning-reduce-fuel>;
http://royalcommission.vic.gov.au/getdoc/cd8d74a5-1159-4bee-815c-2287850a7e9c/Transcript_VBRC_Day_110_23-Feb-2010.PDF;
http://royalcommission.vic.gov.au/getdoc/ae6663c8-4565-4623-9657-87dc7559c969/Transcript_VBRC_Day_109_22-Feb-2010.pdf

council by-laws, and perceptions of community backlash against clearing. There are also challenges regarding risk management of prescribed burning on private blocks, and importantly the cost of undertaking such works, which arguably benefit the owner but also the community more broadly.

The Bushfire and Natural Hazards CRC had organised a National Fire Fuels Science Forum, planned for mid-March 2020, to address the issues and the opportunities in the science of prescribed burning, including the role of Indigenous burning in the south. The aim was to support the Royal Commission and other ongoing fire inquiries in their considerations of these issues. Unfortunately, this forum had to be cancelled due to the coronavirus. However, the CRC is now organising webinars based around the leading scientists and practitioners who had agreed to speak. These are organised for 6, 13 and 20 May. The webinars are free and open to the public. Initial documents submitted by the speakers and details of the webinars can be found here

<https://www.bnhcrc.com.au/2020/firefuels#tabs-0-contentmain-2>

Several other initiatives have or are about to come to completion and we feel would be useful to the Commission to consider.

Firstly, a special edition of the *International Journal of Wildland Fire* (Volume 29, numbers 4 & 5 2020), which was strongly supported through the CRC, and contains various pieces of CRC work was released recently: <https://www.publish.csiro.au/wf/issue/9893>. To quote the abstract from the introductory paper:

‘Despite evident advances in knowledge and understanding concerning the application of prescribed burning for delivering benefits in wildfire control and a variety of sociocultural, economic and environmental outcomes, the practical application of prescribed burning in Australia is increasingly administratively and logistically complex, often controversial and climatically challenging. This series of papers does not address the merits or otherwise of prescribed burning – we accept the lessons from antiquity and recent history that the use of prescribed fire in contemporary Australia is essential for reducing, although not always being able to deliver on, wildfire risks and meeting a variety of societal and environmental needs. This special issue focuses on several fundamental adaptive management and monitoring questions: are we setting appropriate management targets? Can these targets and associated indicators be readily measured? Can we realistically deliver on those targets? And if so, what are the costs and/or trade-offs involved? The 10 solicited papers included here provide a sample illustration of the diversity of approaches currently being undertaken in different Australian regions to address complex adaptive management and monitoring challenges.’³

Secondly, a major book is soon to be released through the Centre of Excellence for Prescribed Burning and AFAC that provides a collection of discussions of the science behind prescribed burning. As noted by the editors:

‘This book incorporates the best knowledge on the practice of prescribed burning and its effects currently available to inform policy. Part 1 examines the social context of prescribed

³ Russell-Smith, McCaw and Leavesley, *International Journal of Wildland Fire* **29(5)** 305-313, <https://doi.org/10.1071/WF20027>

burning, including indigenous burning. Part 2 reviews recent research and Part 3 is a compilation of opinions of recognised experts in bushfire research and practice.⁴



⁴ Leavesley, Wouters and Thornton (eds), 'Prescribed burning in Australasia – The science, practice and politics of burning the bush', AFAC, in press <https://knowledge.aidr.org.au/media/7723/afac-prescribed-burning-book-available-soon.pdf>

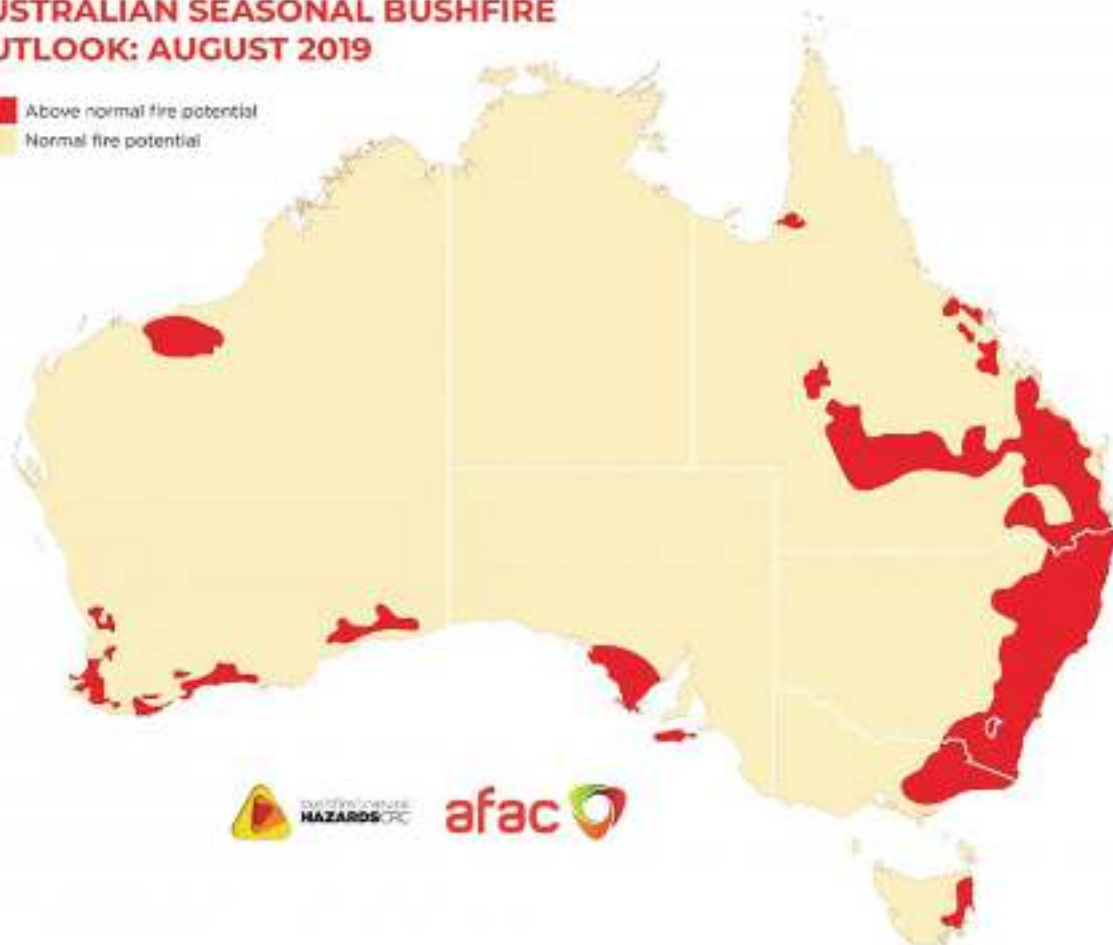
2019-20 Australian Seasonal Bushfire Outlook

Before the beginning of the 2019-20 southern fire season the Bushfire and Natural Hazards Cooperative Research Centre issued the *Australian Seasonal Bushfire Outlook* in August (<https://www.bnhcrc.com.au/hazardnotes/63>).

This *Outlook* is a product created after working with the scientists from the Bureau of Meteorology and with subject matter experts from land management and fire agencies around the country. This year's *Outlook* highlighted that most of the east coast forests were at an above normal risk of fires that would require resources from outside the region should a fire start. This *Outlook* was similar to those produced in the preceding years, owing to the increased impact of the drought and an increased average temperature as a result of climate change throughout eastern Australia. The fact the drought and climate change had been indicated in previous years, and that the drought had been intensifying, could have prompted more attention from governments and the public.

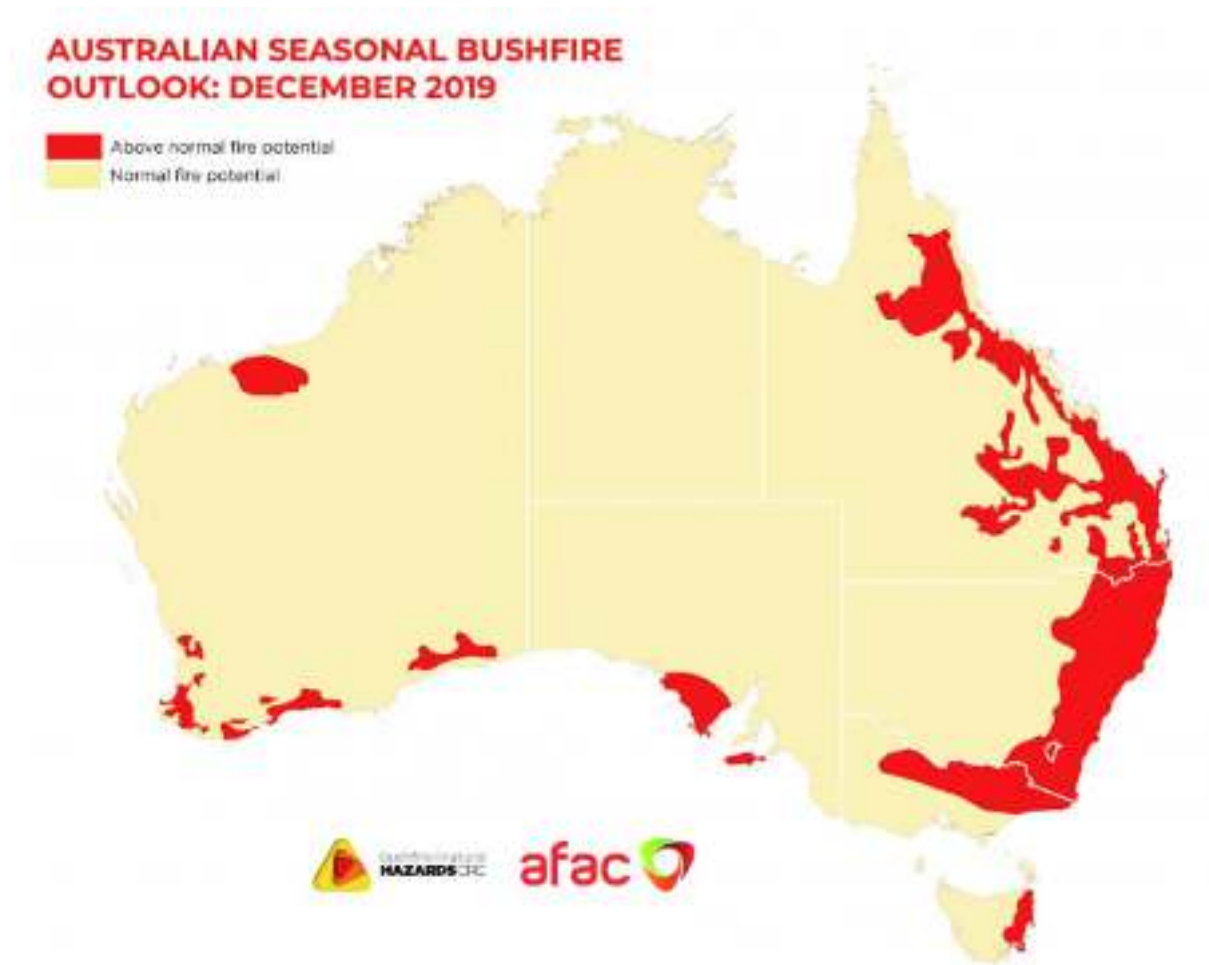
AUSTRALIAN SEASONAL BUSHFIRE OUTLOOK: AUGUST 2019

 Above normal fire potential
 Normal fire potential



The CRC launched its August outlook at the AFAC 2019 conference at a major media conference with all the commissioners and chief officers in each state and territory present. The media conference was attended by most of the major TV, radio and print media outlets. This was followed by extensive media interviews across the country, particularly through the ABC regional radio networks. The full media conference can be accessed at <https://youtu.be/WSIbe-NH1UM>, while a short highlights version can be accessed at <https://youtu.be/PYxUTi5ybSO>.

As the season got underway, the CRC continued to work with its partners. An update to the *Outlook* was issued in December showing that the fire potential had increased: (<https://www.bnhcrc.com.au/hazardnotes/68>).



The predominant reason leading to higher than normal fire potential was the long running drought across major parts of the country, with NSW and Queensland noting in particular that water availability for firefighting may become a problem during the season in some regions.

The CRC stated in its August *Outlook*, which is distributed widely through mailing lists, Facebook, Twitter and LinkedIn, as well as on the CRC website:

“The 2019/20 fire season has the potential to be an active season across Australia, following on from a very warm and dry start to the year.

Due to these conditions, the east coast of Queensland, New South Wales, Victoria and Tasmania, the ACT, as well as parts of southern Western Australia and South Australia, face above normal fire potential.

The *Australian Seasonal Bushfire Outlook: August 2019* shows fire potential across Australia over the coming months. Above normal bushfire potential refers to the ability of a large fire to take hold when you take into consideration the recent and predicted weather for a particular area, the dryness of the land and forests, recent fire history and local firefighting resources.

The *Australian Seasonal Bushfire Outlook: August 2019* is used by fire authorities to make strategic decisions on resource planning and prescribed fire management for the upcoming fire season. The *Outlook* is developed at an annual workshop convened by the Bushfire and Natural Hazards CRC and AFAC. The workshop discussed the weather, landscape conditions and cross-border implications leading into summer and determined areas that had the potential for a fire season that was above normal, normal or below normal.

The *Outlook* map shows the bushfire outlook for Australia through to the end of 2019. This map has been combined with the *Outlook* for the northern Australia bushfire season, which was released in July, to show the areas of fire potential for all of Australia.”

The CRC works closely with the communications and media units of all fire agencies across the country and the Bureau of Meteorology, as well as with that of Emergency Management Australia, in the Department of Home Affairs, who provide briefings to the Federal Minister for Emergency Management.

Fire season preparedness in Australia

Fire seasons are becoming longer and extreme fire weather is becoming more common⁵, but that is not the whole story in Australia. The management of natural hazards, including bushfire, is a highly complex issue involving all layers of government, the private sector, and the community⁶.

Hazards, such as bushfire, exist because they are a natural part of the environment and the phenomenon harms something we value: our lives, houses, livelihood, amenities or environmental or ecological values. There has been a long historical transfer of responsibility for the protection against such hazards to the government and its agencies on the premise that it is better to have properly trained and resourced organisations to respond and protect us. However, as pointed out by the 2009 Victorian Bushfires Royal Commission, that transfer of responsibility has probably gone too far. Individuals are no longer taking sufficient responsibility for their own risk management. It is analogous to the community not installing locks on houses because we have a police force to address the risk of burglary.

Governments over many years have allowed this risk transfer to continue through incentives that favour people not taking responsibility. In fact, the World Bank noted in [a World Development Report⁷](#) that it is not just a local problem. One of the main reasons why ‘DRR [*Disaster Risk Reduction*] savings are not always enacted is because political capital is rarely gained from cost-effective DRR measures’: voters reward politicians for delivering disaster relief funding but not for investing in disaster preparedness. That presents a fundamental challenge to the implementation of [the 2014 Productivity Commission’s inquiry⁸](#) into disaster funding arrangements, which in its report advocated a substantial shift of focus from funding relief and recovery to funding mitigation.

It is clear from Bushfire and Natural Hazards CRC research, conducted after major fire events, that while the community recognises it is living in a risky environment, many people do not perceive that as a risk to them personally. Information about household preparedness, and warnings about leaving early, are regularly unheeded. This presents a challenge for authorities responsible for fire season

⁵ State of the climate report, <http://www.bom.gov.au/state-of-the-climate/State-of-the-Climate-2018.pdf>

⁶ National Disaster Risk Reduction Framework, <https://www.homeaffairs.gov.au/emergency/files/national-disaster-risk-reduction-framework.pdf>

⁷ http://siteresources.worldbank.org/EXTNWDR2013/Resources/8258024-1352909193861/8936935-1356011448215/8986901-1380568255405/WDR14_bp_Disaster_Mitigation_is_Cost_Effective_Kelman.pdf

⁸ <http://www.pc.gov.au/inquiries/completed/disaster-funding>

preparations, with a large percentage of people waiting to see what will happen, which in many cases results in them leaving late and in the most dangerous circumstances. This is an area in need of further research to ensure that the messages are heard, understood and acted upon within communities.

National commitment to disaster risk reduction

The Federal Government, on its own and through COAG, has adopted the National Disaster Risk Reduction Framework, developed by the National Resilience Taskforce in 2019. This is an important step in recognising that disaster risk can be reduced if all parts of the community address the systemic issues. This Framework, including its underlying reports and evidence, is one of the most comprehensive approaches to DRR in the world.

Adoption of a framework is not enough to effect change on the growing risk. The Commonwealth and all states and territories, in collaboration with other non-government players, need to embrace an action and implementation plan. This plan must be evidence-based and include filling knowledge gaps, through investment in targeted and strategic research.

Through a comprehensive action and implementation plan, national level indicators can be developed that may help to understand those systemic drivers of future disaster risk. The key to this is the enabling of national datasets, across governments and the private sector. Currently, it is difficult to accurately determine future risks to communities, infrastructure and environments. A national capability to help to achieve this is necessary.

Scientific advice to government

There are many existing bodies capable of providing scientific and technical advice to the government and the parliament on topics relating to bushfires and indeed more broadly natural hazards in Australia. The Bushfire and Natural Hazards CRC is one of them. One of the challenges is that when there are no major fire events, the interest of government and parliamentarians in the topic rapidly wanes and it can be difficult to discuss key priorities during this time. However, during major fires and in the immediate aftermath there is intense interest. This can become a challenge in that maintaining a year-round national science capability requires a focused commitment during a time of potentially low interest. And indeed, it is what we do when there are no fires in the landscape that will most influence the extent of the impacts when there is uncontrolled fire in the landscape.

The CRC welcomes the interest in science and technology following the 2019-20 bushfires with the establishment of a Ministerial Advisory Roundtable of senior science leaders, by the Minister for Industry and Science, The Hon Karen Andrews, MP. This was also something that the former Science Minister Peter McGauran established in the early 2000s with the Bushfire Research Advisory Group.

The CRC believes that there is a national benefit in the maintenance of such a forum, but with a broader all-hazards remit, potentially based on the current roundtable convened by Minister Andrews.

Physical and mental health impacts

The fires of 2019-20 have raised many issues regarding the impact of widespread and prolonged smoke on major population centres, in particular Sydney, Canberra and Melbourne. Recent modelling by the University of Tasmania indicates that the death toll from the smoke would

probably exceed that from the fires themselves⁹. As the researchers noted, there is still a need to better assess the actual impact from an analysis of hospital and health records of the communities affected in order to get a more accurate indication.

It is also worth noting that in May 2019 there was also major concern about the smoke impacts on the population of Sydney following extensive prescribed burning activity in the surrounding forests.¹⁰

The CRC has conducted research on the physical impacts of smoke on communities¹¹ and better predictions of smoke plumes¹² under its contracts with the Victorian Department of Environment, Land, Water and Planning.

The mental health impacts arising from the fires have been shown to be significant and are particularly evident in recovery period. A landmark study, Beyond Bushfires, established at the University of Melbourne following the Black Saturday bushfires in 2009, has shown that the mental health impacts are still significant more than ten years later¹³. The CRC is now building on the work of the Beyond Bushfires team through its Recovery Capitals project¹⁴. These are, however, still areas in need of further understanding, particularly as the bushfire affected communities are now being impacted by the effects of the COVID-19 restrictions.

National research capability – past, current and planned

There have been many inquiries and royal commissions concerning fires. The recommendations have been collated and are searchable through the CRC's Disaster Inquiries Database (<https://www.bnhcrc.com.au/utilisation/ddr>), enabling any inquiry to examine the past inquiries more easily. The most recent reviews at the national level were:

- 'A Nation Charred: Report on the inquiry into bushfires' by the House of Representatives Select Committee into the recent Australian bushfires published in October 2003¹⁵;
- 'Report of the National Inquiry on Bushfire Mitigation and Management' Published by COAG in 2004¹⁶;
- The Productivity Commission inquiry into disaster funding arrangements published May 2015¹⁷.

At the state level there have been many inquiries, but the most significant was the Victorian Bushfires Royal Commission (VBRC) published in 2010¹⁸.

⁹ <https://onlinelibrary.wiley.com/doi/full/10.5694/mja2.50545>

¹⁰ See for example: <https://www.abc.net.au/news/2019-05-21/sydney-smoke-haze-from-fire-burn-could-last-for-days/11133792>

¹¹ <https://www.bnhcrc.com.au/research/smokeimpacts>

¹² <https://www.bnhcrc.com.au/research/smokemodelling>

¹³ <https://mspgh.unimelb.edu.au/centres-institutes/centre-for-health-equity/research-group/beyond-bushfires>

¹⁴ <https://www.bnhcrc.com.au/research/communityrecovery>

¹⁵

https://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=bushfires/inquiry/report/fullreport.pdf

¹⁶

https://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=bushfires/inquiry/govt_response.pdf

¹⁷ <https://www.pc.gov.au/inquiries/completed/disaster-funding/report>

¹⁸ <http://royalcommission.vic.gov.au/Commission-Reports/Final-Report.html>

From the Bushfire and Natural Hazards CRC's perspective there are two crucial recommendations that the Commonwealth and the States have not managed to complete:

COAG Recommendation 5.4: The Inquiry recommends that the Australian Government, in partnership with the states and territories and relevant research organisations, develop a strategy for sustaining bushfire research and capacity building, in the context of a risk management approach to bushfire mitigation and management.

VBRC Recommendation 65: The Commonwealth establish a national centre for bushfire research in collaboration with other Australian jurisdictions to support pure, applied and long-term research in the physical, biological and social sciences relevant to bushfires and to promote continuing research and scholarship in related disciplines.

Following the 2009 Victorian bushfires the Bushfire CRC was extended by three years and in 2013 there was the establishment of the Bushfire and Natural Hazards CRC for an eight-year period. However, neither of these met the intent of the reviews' recommendations, which were more focused on a sustainable and forward-looking capability for Australia.

The current approach of centres created for limited periods of time has led to a regular wind-up and wind-down of capability. This does not result in "sustaining bushfire research and capacity building". It also does not lead to the support of "pure, applied and long-term research".

The current funding of the Bushfire and Natural Hazards CRC from both the Commonwealth and its partners is due to end in June 2021. And indeed, the CRC has not been investing in significant new research since June 2019. The CRC is currently in discussions with the Commonwealth Department of Industry, Science, Energy and Resources and with our other partners about future funding.

The CRC notes that in other areas of research of national significance and substantial public benefit there have been national research institutes established. Examples include the Australian Institute for Marine Science, the Australian Nuclear Science and Technology Organisation, many rural research and development corporations, and in Antarctic research.

A two-page proposal is attached to this submission, outlining the need for ongoing research and importantly, the need to ensure that the capability and capacity are not lost to Australia, in an area of critical importance¹⁹.

¹⁹ <https://www.bnhcrc.com.au/resources/guide-fact-sheet/6855>

IMPACTS and OUTCOMES

15 years of the Bushfire CRC and the Bushfire and Natural Hazards CRC

Warnings that save lives

The CRC has conducted multi-disciplinary research to improve the timeliness and effectiveness of community warnings that have resulted in reductions in the loss of life and property in floods and bushfires.

Australian lives are being saved by CRC research that is shaping warnings and public information campaigns to prepare and protect communities threatened by flood, fire, heatwave and other natural hazards.

The insights from CRC researchers at the Queensland University of Technology are equipping emergency service agencies around Australia with better-targeted long-term public safety campaigns as well as evidence-based warning messages delivered to at-risk populations in the face of imminent natural hazard threats. The goal of the project was to save lives and empower communities to act to ensure their safety, by improving community warning messages.

The research underpinned the *National Emergency Management Handbook on Public Information and Warnings* and the companion guide *Warning Message Construction: Choosing Your Words*, both published by the Australian Institute for Disaster Resilience. The publications drew directly on the research to give guidance on the key considerations for writing effective warning messages, including structures and language styles for specific audiences, such as high-risk groups and non-English speaking communities.

Emergency service agencies have drawn from the project and have collaborated at the national level to determine a style and structure for official public messages now used in routine bushfire incidents. Queensland Premier Annastacia Palaszczuk credited the warnings research, combined with CRC fire mapping tools, with saving lives and the township of Gracemere in the November 2018 fires.

Better fire danger ratings

The CRC has conducted research into fire behavior that has improved the national fire danger ratings system, resulting in better warnings for the community.

A new National Fire Danger Ratings System is drawing from a range of CRC projects in fire behaviour, fire ecology, weather and climate, predictive services, and communications and warnings. Based on this research, the new system will improve community awareness of risk exposure, provide greater scientific accuracy behind decisions, advice and warnings and give communities greater confidence in the information being provided.

Fire prediction

The CRC-developed fire spread modeling system provides better real-time information on the likely path of bushfires, enabling better operational decisions to be made.

Phoenix RapidFire, developed through CRC research, is the main fire modelling and prediction software in Australia that predicts the movement of a bushfire across different types of topography

and vegetation, taking account of fire history, roads and other structures, and weather (temperature and wind) conditions.

Fire managers use this software to estimate the potential impact of bushfires and determine which communities need to be warned and where resources need to be deployed. Queensland Premier Annastacia Palaszczuk credited this research-based fire mapping tool, combined with CRC warnings research, with saving lives and the township of Gracemere in the November 2018 fires.

A seasonal view of bushfire

The unique research and partner networks of the CRC has enabled it to coordinate the production of a national seasonal bushfire outlook, which serves as a trigger for communities around the country to prepare for the coming season.

Strategic decisions on resources, prescribed fire management and community warnings have for the past 16 years been underpinned by the CRC's Seasonal Bushfire Outlook. Information from the Outlook is used by ABC Emergency to coordinate its national ABC Radio seasonal awareness and training program for its journalists.

Governments and fire authorities nationally are using the Outlook for planning purposes in the lead-up to their bushfire seasons, including refining their public messages that communicate bushfire risk and highlight areas with the highest potential for fire.

The CRC leads the preparation of the Outlook in close consultation with the Bureau of Meteorology, AFAC, and emergency service agencies in each state and territory. The Outlooks cover the Northern and Southern fire seasons and are published annually around June, September and November. In 2020, at the request of CRC partner agencies, the Outlook will shift to a quarterly release to better reflect the year-round nature of fire management and operations across Australia.

Mental health of first responders

The CRC worked with Beyond Blue to undertake a world-first study to better understand the mental health issues of emergency services workers.

A national research project into the mental health and wellbeing of police and emergency service personnel in a collaboration between the CRC and Beyond Blue with the University of Western Australia provided insights into the impacts of workplace culture. This research, the most comprehensive study of its type in Australia, is being used by the sector to review current mental health support strategies and to identify opportunities to modify existing or introduce new support programs.

Firefighter safety

The CRC's early work validated the many safety systems that are now standard in firefighting vehicles, saving firefighter lives should they get caught in a fire.

Early research in the Bushfire CRC has led to the wide adoption of vehicle sprinkler protection systems that protect fire crews in burnover situations. Other research has established standards for rest and hydration, and for heat and smoke protection, while acknowledging that the nature of firefighting involves strenuous shifts under hot and smoky conditions.

Volunteers

The CRC undertook research that has helped to ensure that the emergency services have sufficient capacity to fight bushfires and flood, though better understanding of the volunteer workforce.

Issues of recruitment, retention, diversity, and wellbeing among fire and emergency service volunteers have been identified in CRC studies since 2003 and backed with strategies to attract and support volunteer workforces. Research has resulted in agencies reviewing the way they manage volunteers with enhanced training and leadership skills, more support for volunteers and their families, and recruitment campaigns that target a younger and more diverse demographic.

Emergency planning for animals

The CRC's groundbreaking research into the behaviour of people with animals has led to better public guidelines on how to plan for disasters.

Australian's attachment to their pets heavily influences their decisions during an emergency, with findings from CRC research now adopted by fire and emergency services to support household planning for disasters.

The project identified best practice approaches to animal emergency management. This has given emergency management agencies the insights for better targeted public hazard preparation campaigns, and the data to make better decisions on planning and targeting of response and recovery resources.

Disaster risk education for kids

The CRC's work in understanding how children can be involved in their own natural hazards education, and how they can educate their families, has become a standard part of school curriculum in many schools.

Educating children and youth about disaster risk reduction and resilience is now front and centre around Australia, based on CRC research that identified the valuable role children play in the safety of their households and communities. This research began with a CRC PhD project that developed an interactive eBook to help parents discuss bushfire preparation and safety with their children. The research has since been expanded to support state fire agency children's education campaigns, as well as curriculum materials designed for primary and early secondary school.

House and vehicle safety

Early work of the CRC into how houses are lost in bushfire, has resulted in changes to the building standards for new properties.

Research drawing from both field and laboratory-based testing is providing fire agencies and communities with guidance on design and materials for house construction, pre-hazard season preparation of properties, and sheltering in vehicles during bushfires.

Decisions under fire

The multi-disciplinary research of the CRC undertaken in the aftermath of disasters with the communities has enabled better understanding of community decision making, ensuring that public safety messaging is more targeted and effective.

Public bushfire safety campaigns across Australia have been shaped by a decade of CRC research that identified the reasons why people under a direct threat of fire make their choice to either leave, stay and defend, or wait and see what develops.

Based on the evidence of the 2009 Victorian Bushfires Royal Commission and household interviews following those fires and other major fires across Australia, researchers were tasked to identify the principal drivers of resident's actions under threat of bushfire. The critical influences on their actions were found to be the priorities that shaped their intentions in the lead-up to the fire season. These included the safety of their families, protection of their homes and assets, and their own perceptions of their risk under particular fire scenarios.

Safer houses in high winds

Research work partially undertaken by the CRC has resulted in a Queensland Government grant program to retrofit properties against cyclones for vulnerable communities in northern Australia.

The award-winning Queensland Government Household Resilience Program, backed by research from the CRC, is increasing the resilience of homeowners in tropical cyclones. Owners of properties upgraded through this program are now seeing reductions in their insurance premiums.

The Cyclone Testing Station at James Cook University, worked with the Queensland Government to create the program, which provides Queensland homeowners with a grant for the upgrade of the roof structure, protection of windows and strengthening of doors – the key areas identified by the research as being at the highest risk of damage during strong cyclonic winds.

Collective strength

The CRC has built an extensive network of practitioners and academic researchers across Australia and internationally that collectively has improved community safety in the face of increasing disaster risk.

The strength of the CRC lays in its collective nature. As a cooperative research centre, the CRC is a collection of people and individual organisations, that bring a range of values to the whole. The CRC operates as a hub in the broad emergency and hazards sector, creating a pool of resources and insights at the local, national and international level. The CRC creates a bridge that link disparate and diverse groups together in a network focused on innovation.

With more than 250 researchers and 250 agency staff in Australia and internationally directly involved in the research projects - with many more indirectly involved - the collective strength is an efficient and effective way to advance the science of natural hazards. The CRC provides a research capacity that is not feasible at the individual state or territory or agency level, nor with any one university or research organisation.

A forum for independent knowledge

The CRC is seen as the go-to organisation by government, the agencies, the media and the community for authoritative and independent advice and commentary on all matters in natural hazards.

The CRC has created a space for discussion, learning and development of natural hazards science and disaster resilience through well-attended conferences and other research-based forums, plus regular academic and community focused publications.

The CRC is regularly called upon for independent advice on fires and other hazards by government and agency partners. The 2009 Victorian Bushfires Royal Commission relied upon the CRC for access to credible research findings and respected researchers and noted this contribution in its final report. Since then, the CRC and its researchers have regularly been called upon for independent advice and research on major issues including hazard reduction burning and fire season preparation, and for post-fire field research into fire behaviour and community safety.

2020+ - Upcoming Impacts and Outcomes

Resilience Index

The CRC has developed a national Disaster Resilience Index that will be used by governments to identify community strengths and weaknesses, to enable better targeted interventions to increase community resilience. (to be released in 2020)

The Australian National Disaster Resilience Index has been developed with governments and emergency service organisations across Australia and New Zealand. The Index, to be released widely in 2020, provides a tool for policymakers to understand at a national level how resilience varies in different regions of Australia, providing a means to track change over time and to allocate resources that are relevant and targeted.

Fire fuels

The CRC has developed a unique tool to enable practitioners to more accurately and more efficiently evaluate fuel levels in forests. (to be released in 2021)

Fuels3D is a program designed by researchers for fire and land managers in the field to quickly, accurately and consistently capture important information on fuel hazard and burn severity. This benefits the whole of organisations by reducing both staff hours in the field and individual biases in estimating bushfire risk.

Flammability

The CRC has developed remote sensing technology to map the flammability of Australia's forests and grasslands. This will be combined with the CRC project increasing the accuracy of soil moisture prediction to better inform agencies of the fire risk. (To be released 2020)

The Australian Flammability Monitoring System - trialled by the NSW Rural Fire Service in the 2019-2020 bushfires - is a support for fire risk management and response activities such as hazard

reduction burning and pre-positioning firefighting resources and, in the long-term, the new National Fire Danger Rating System. The web-based tool is useful for fire and land managers and other industries such as the insurance and agricultural sectors and electricity and water suppliers. Communities across land management and agriculture can assess how dry their properties are for a range of potential activities, including preparation for fire season.

“What if” investments

The CRC has developed a unique system to test planning decisions made today against future changes in climate demographics and disaster risk and ensure that we are not creating new risks for the future through poor decisions today (currently in trial in many jurisdictions)

State governments and agencies are able to evaluate potential investment decisions in disaster mitigation that consider a range of future scenarios. This CRC project is being advanced through a national training program in Victoria, South Australia, Tasmania and Western Australia involving bushfire, flooding, coastal inundation, earthquake and heatwave, with both the Western Australian and Tasmanian governments further investing into the development of a model to show natural hazard risk exposure for their states.

Understanding natural hazard impacts

The CRC and Geoscience Australia have developed the Australian Exposure Information for fire and emergency service agencies to understand what specific assets, businesses, services and people are at risk during an emergency.

The CRC has worked with Geoscience Australia to harness the national data in the National Exposure Information System (NEXIS) and make it available to emergency services, governments and other interested groups to assist in planning and situational awareness of the assets, services, infrastructure, businesses and population exposed to emergencies within any defined region.

Long-term community recovery

The CRC is developing a guide for communities and governments to better plan for recovery across a range of indicators.

This project, which began in July 2017, is addressing the factors that enable communities to build back better and smarter after disasters, including its social and economic systems.

One aspect of the project is investigating how a person’s history of moving to a new house or town influences the likelihood of their willingness to dissolve social ties.

The second area is examining the enablers and barriers to successful recovery by looking at natural, cultural, human, social, political, built and financial capital resources, their interconnectedness and interactions in disaster recovery. Examination of these assets through case studies and working with end-users is identifying areas for improvements, as well as what has worked well in recovering communities. This process is providing feedback and a guide for community and government planners and policy makers in the planning of recovery activities.

AUSTRALIAN SEASONAL BUSHFIRE OUTLOOK: AUGUST 2019

OVERVIEW

The 2019/20 fire season has the potential to be an active season across Australia, following on from a very warm and dry start to the year. Due to these conditions, the east coast of Queensland, New South Wales, Victoria and Tasmania, as well as parts of southern Western Australia and South Australia, face above normal fire potential.



This August 2019 *Australian Seasonal Bushfire Outlook* covers all states and territories. It provides information to assist fire authorities in making strategic decisions such as resource planning and prescribed fire management to reduce the negative impacts of bushfire.

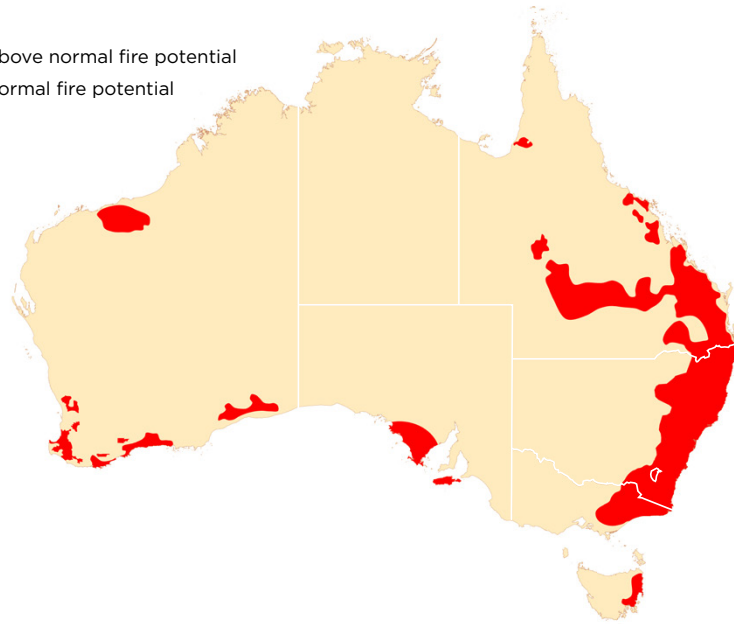
Bushfire potential depends on many factors. The volume, location and timing of rainfall are critically important when estimating vegetation (fuel) volumes and growth. The climate outlook for the next few months is also a crucial factor. Of particular interest are the future tendencies of Pacific sea surface temperature associated with the El Niño-Southern Oscillation, as well as the Indian Ocean Dipole, major climate drivers over Australia. Other less quantifiable factors, such as the distribution and readiness of firefighting resources, are also considered.

The *Australian Seasonal Bushfire Outlook: August 2019* is developed by the Bushfire and Natural Hazards CRC, AFAC, the Bureau of Meteorology, Queensland Fire and Emergency Services, the New South Wales Rural Fire Service, ACT Emergency Services Agency, ACT Parks and Conservation Service, Country Fire Authority, Department of Environment, Land, Water and Planning Victoria, Tasmania Fire Service, Country Fire Service, Department of Fire and Emergency Services and Department of Biodiversity, Conservation and Attractions Western Australia, and Bushfires NT.

RECENT CONDITIONS

Seasonal fire conditions are a function of fuel amount and state, and seasonal

 Above normal fire potential
 Normal fire potential



▲ Figure 1: AUSTRALIAN SEASONAL BUSHFIRE OUTLOOK AUGUST 2019. AREAS ARE BASED ON THE INTERIM BIOGEOGRAPHIC REGIONALISATION FOR AUSTRALIA AND OTHER GEOGRAPHICAL FEATURES.

weather conditions. The year to date has been unusually warm and dry for large parts Australia. For January to July, rainfall has been below to very much below average over much of Australia (Figure 2, page 2). It has been the fifth-driest start to the year on record, and the driest since 1970. This is especially the case over the southern half of the country, which has experienced the driest January to July on record (January to July 1902 is the second driest). Areas of above average rainfall are largely confined to central Queensland, extending to the coast.

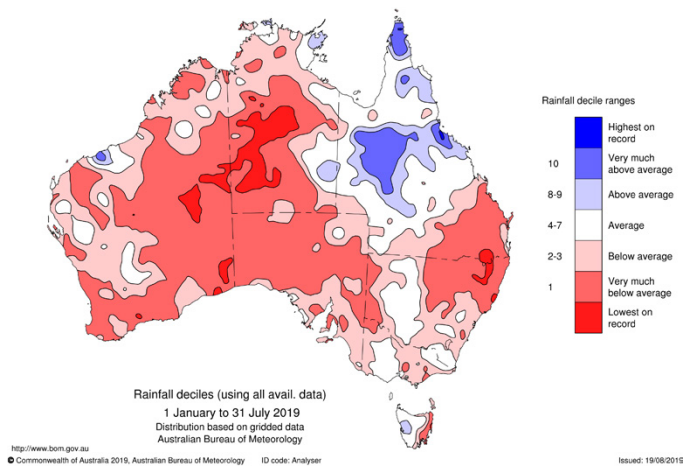
Some areas, such as New South Wales into south eastern Queensland, are into their third year of dry conditions. It will take a number of months of above average rainfall to remove the deficiencies which are in place, meaning that general landscape dryness is likely to persist for many areas.

The warming trend means that above average temperatures now tend to occur in most years, and 2019 has followed this pattern. Across Australia, temperatures for

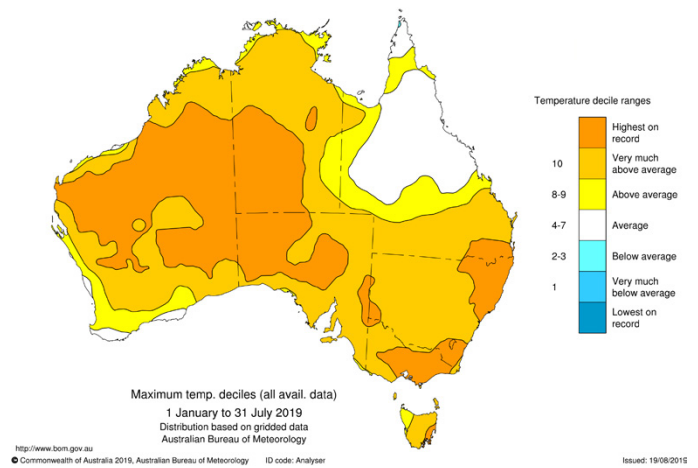
January to July have been very much warmer than average (2nd warmest for this period on record, 1.46°C above the 1961-1990 average), with daytime temperatures the warmest on record (1.85°C above the 1961-1990 average, see Figure 3, page 2). Summer 2018/19 was exceptionally warm (2.14°C above average, over 0.8°C greater than the previous warmest summer on record). These high temperatures add to the impact of reduced rainfall, and increase evaporation, further drying the landscape and vegetation.

As might be expected given the broad climatic factors, an early start to the fire season has been declared in many areas across eastern Australia. The dry landscape means that any warm and windy conditions are likely to see elevated fire risk. Countering the climate signal, poor growth of grass and annual plants means that vegetation loads are reduced in drought affected areas.

Fire season severity is increasing across southern Australia as measured by annual (July to June) indices of the Forest Fire



▲ Figure 2: RAINFALL DECILES FOR JANUARY TO JULY 2019 SHOWING DRY CONDITIONS OVER MUCH OF AUSTRALIA.



▲ Figure 3: MAXIMUM TEMPERATURE DECILES FOR JANUARY TO JULY 2019 SHOWING WARM CONDITIONS ACROSS AUSTRALIA.

DEFINITIONS

Bushfire potential: The chance of a fire or number of fires occurring of such size, complexity or other impact (such as biodiversity or global emissions) that requires resources (from both a pre-emptive management and suppression capability) beyond the area in which it or they originate. Fire potential depends on many factors including weather and climate, fuel abundance and availability, recent fire history and firefighting resources available in an area.

Decile: A decile is a statistical technique that ranks observations into 10 equal groups. A decile map will show whether the rainfall or temperature is above average, average or below average.

Danger Index (FFDI). The increases are tending to be greatest in inland eastern Australia and coastal Western Australia. For example, the Victorian annual FFDI has increased by about 50 per cent since 1950, with 2018/19 the fourth highest on record, behind the severe fire seasons of 2002/03, 1982/83 and 2006/07. The increases reflect rising temperatures and below average rainfall during the cool season (April to October).

CLIMATE OUTLOOK

The climate outlook for spring is mainly influenced by the Indian Ocean, together with other factors including long-term trends. Ocean temperatures in the tropical

Pacific remain close to average, with no El Niño or La Niña expected to develop in the coming months. A positive Indian Ocean Dipole during spring typically increases the chance of below average rainfall for southern and central Australia and has been linked to elevated summer fire danger. Other influences include Tasman Sea pressure patterns, which are favouring a reduction in onshore flow for parts of the east coast of Australia, and are likely contributing to the warmer and drier conditions forecast across NSW and southern Queensland.

The outlook for spring rainfall (Figure 4, page 3) shows a drier than average spring is likely for much of mainland Australia, especially for inland parts of southern Australia, and for large areas of northern Australia. Large areas of northern Australia are also likely to see a late northern rainfall onset, which may extend the fire season in the north. The likelihood of drier conditions is stronger in October compared with September. September is likely to be drier across northern Australia and small scattered areas of southern Australia, while October is likely to be drier across most of the mainland. Historical outlook accuracy for spring is moderate to high for most of the country, but low along the Northern Territory/Western Australia border, and the west coast of Western Australia.

The outlook for spring maximum temperatures favours above average daytime temperatures for nearly all of Australia. Probabilities are particularly high across much of northern Australia, where they widely exceed 80 per cent. Probabilities in the south are typically in the range of 50 to 80 per cent (Figure 5, page 3), implying that above average daytime temperatures

are favoured. The outlook for minimum temperatures (not shown) suggests above average temperatures are favoured across northern and western parts of Australia, with probabilities above 80 per cent in western parts of the Northern Territory and northern Western Australia. Historical accuracy for spring maximum temperatures is moderate to high for most of Australia, except parts of northern South Australia. Minimum temperature accuracy is patchy, but generally moderate across much of eastern Australia including Tasmania, and the tropical north. Moderate to low accuracy is seen across western Western Australia and South Australia, with low accuracy in central Western Australia, the central Northern Territory and parts of western Queensland.

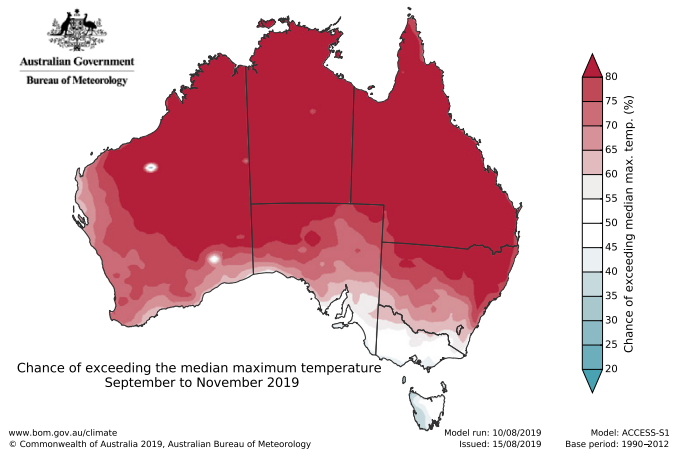
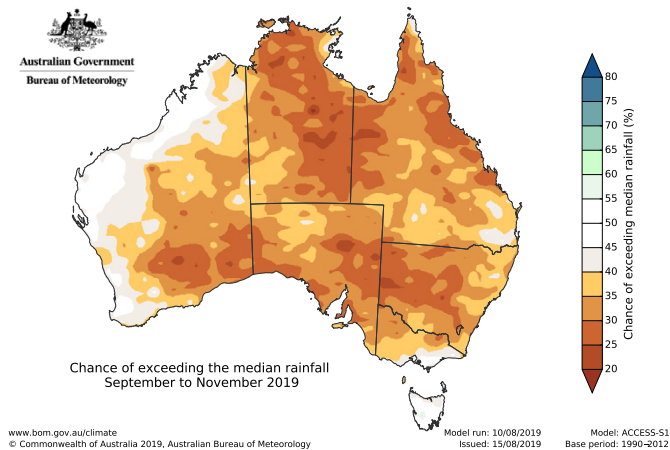
Updates to climate forecasts and the outlook for the Indian Ocean Dipole and the El Niño-Southern Oscillation will continue to be published at www.bom.gov.au/climate/ahead.

REGIONAL SUMMARIES

QUEENSLAND

2018/19 was a record fire season in Queensland, with November/December 2018 seeing unprecedented bushfires along the central to north coast. Following on from this, December 2018 saw record rainfall on the North Tropical Coast, as well as the Herbert and Lower Burdekin forecast districts. February and March 2019 also saw record and very much above average rainfall over northern parts of the state. Conversely for the 12 months to 31 July 2019, rainfall has been very much below average in south eastern parts of the state.

The lack of rain has resulted in the root zone soil moisture being below average - in



▲ Figure 4: CHANCE OF EXCEEDING THE MEDIAN RAINFALL FOR SEPTEMBER TO NOVEMBER 2019.

▲ Figure 5: CHANCE OF EXCEEDING THE MEDIAN MAXIMUM TEMPERATURE FOR SEPTEMBER TO NOVEMBER 2019.

the lowest one per cent on record for areas around Rockhampton and south to the New South Wales border. The rainfall and temperature outlooks make it very likely that this current soil moisture deficit will persist for the coming months, significantly increasing the available fuel in forested areas in south eastern Queensland.

Inland Queensland has been drought effected since 2013, and as a result there has been very little grass fuel available. However, the rainfall received this year will very likely see a return to average fuel loads in inland parts.

Since 1990, there has been a trend for Queensland fire seasons to start earlier and persist longer. This was the case last fire season, which saw record forest fire danger indices in August 2018 and February and March 2019. August 2019 has seen this trend continue, with Severe Fire Danger and successive days of Very High Fire Danger.

Above normal fire potential is expected in forested areas along the coast south of Rockhampton down to the NSW border, for woodland and grass fuels, inland areas in the south, and a small area west of Mackay. Although this was previously identified in the *Northern Australia Seasonal Bushfire Outlook 2019 (Hazard Note 62, June 2019)*, the hot and dry conditions experienced since June have dried the landscape even further. The Darling Downs and Granite Belt districts are facing severe water shortages as a result of the ongoing drought. This has the potential to impact the availability of water for fire suppression. QFES has been working closely with relevant local councils and their partners to manage this risk. Normal fire potential is expected for all other parts of Queensland.

NEW SOUTH WALES

Weather conditions have been exceptionally dry across NSW leading into the 2019/20 fire season. Much of central and northern NSW has experienced very much below average rainfall during the last three months, with a small percentage of areas experiencing driest on record conditions.

Long-term rainfall deficiencies, record-low for some areas in the north of the state, have severely impacted on water resources. With limited water availability, fire agencies in NSW are having to plan for firefighting tactics that minimise the use of water.

At the beginning of August, the NSW Department of Primary Industries mapped nearly all of NSW into one of three drought categories, with approximately 55 per cent of the state drought affected, 23 per cent experiencing drought, and 17 per cent experiencing intense drought.

Widespread significant soil moisture deficit has resulted in an early start to the fire danger period for many local government areas in NSW. Windy conditions in August have again resulted in many significant bushfires in forested areas north of the Hunter Valley.

With the short to medium-range climate outlooks favouring warmer and drier than average conditions across much of the state, there is significant concern for the potential of an above normal fire season in forested areas on and east of the Great Dividing Range.

Reports of grassland fuel conditions west of the Divide indicate that whilst grassy vegetation is cured, it is below average in quantity or load. With the chances of above median rainfall west of the Divide below 50 per cent to well below 50 per cent in the next three months, the balance of this situation

has resulted in an assessment of normal fire potential for these areas. It should be noted that while grass load is reduced and therefore the potential intensity of grass fires may be reduced, highly cured grass creates the potential for grass fire to spread rapidly.

ACT

The ACT has received less than average rainfall over the last two years, leading to a persistent and high level of drought. The lowland forests are dry, while highland forests are relatively moist. This indicates that fuel flammability in the lowland forests could remain high, creating risks early in the fire season. The dry conditions and grazing by farm stock and wildlife have led to lower levels of grass growth, resulting in reduced grass fire risk. The outlook indicates a potential for the highland forests to dry out, however this could be delayed by the occurrence of summer rain. Heatwaves and dust storms may make bushfire detection and suppression more challenging at times during the season.

The overall bushfire risk for the ACT is above normal. Community members should continue to prepare for the fire season by taking actions to reduce the bushfire risks around and within their property, and to review their bushfire survival plans.

VICTORIA

Potential for above normal bushfire activity continues across the coastal and foothill forests of East Gippsland, extending into West Gippsland and the Great Dividing Range. These areas are now experiencing their third consecutive year of significant rainfall deficit, with severe levels of underlying dryness persisting in soils

and heavy forest fuels, along with higher abundance of dead fuel components and higher flammability of live vegetation.

Across the rest of Victoria, mostly normal bushfire activity is expected, however there is likely to be increased growth rates in pasture and croplands in the west due to winter rain. There is uncertainty around the effect of the Indian Ocean Dipole and warm/dry outlook, with some risk that ash forests in the central highlands and Otways may dry out at faster rates and become more flammable than normal during summer.

TASMANIA

For the early part of Tasmania's fire season, most of the state has normal fire potential. The western half of the state is wet, but the east is drier than normal, especially between the Forestier Peninsula and Scamander. This eastern dry area has above normal fire potential. Without significant rain in the coming months, this area will expand. As in recent years, increased fire activity is likely in this dry strip before December and will require considerable response efforts. Eastern peat soils will be susceptible to fire and will burn to depth, with traditionally wet or damp gullies already dry.

The fire season in the remainder of the state will commence more normally, in late spring or early summer, and provide good conditions for planned burning.

SOUTH AUSTRALIA

Average to below average rainfall has occurred across South Australia, with some areas experiencing persistent dry conditions since the start of 2018. In areas of ongoing dry conditions, grass fuel growth is either average, to well below average, which creates the likelihood of normal fire potential in these areas. This level of fire potential also continues in central and southern parts of South Australia, where average rainfall has occurred.

The Bureau of Meteorology's El Niño watch is currently neutral and the Indian Ocean Dipole is forecast to be positive.

Similar forecasts have resulted in drier and warmer than average conditions in the lead up to, and throughout, South Australia's fire season. The dry spring forecast may result in an earlier start to the fire season in parts of South Australia.

The Mount Lofty Ranges have recorded almost average rainfall, which has reset the Soil Dryness Index to zero. However, late winter rainfall may promote increased vegetation growth before summer, and could increase the available bushfire fuels during the fire season. Forecast conditions maintain the potential for bushfire across the populated areas of the Mount Lofty Ranges.

Parts of the Lower Eyre Peninsula have received good rainfall, resulting in a bumper cropping season and higher than normal grass fuel growth. Due to the increased fuel load, these areas have above normal fire potential. Kangaroo Island also has above normal fire potential, with a combination of drier than average, and wetter than average conditions (depending on the vegetation type) across the island. These conditions may result in above average fuel loads in parts, and drier than average vegetation in others, especially in areas of forested and scrub vegetation.

The prolonged dry conditions across much of South Australia is also likely to create increased occurrences of raised dust during the windy conditions that often accompany high fire risk days. The dust may affect the operational capabilities of aerial firefighting assets and limit their effectiveness. Fire managers will carefully monitor this issue during the fire season, noting that without rainfall, dust suppression is impossible on the scale required.

There are currently no forecasts indicating any potential for above average rainfall during spring and summer, which may prolong the fire season across parts of South Australia. Significant bushfires have occurred in similar conditions, and even areas of normal fire potential can expect to experience dangerous bushfires as per a normal South Australian fire season.

WESTERN AUSTRALIA

Rainfall deficiencies have persisted across most of the south west of Western Australia, with this area experiencing its driest start to the year, followed by the seventh-driest autumn on record. In addition, drier and warmer than average conditions are forecast through to October, which will increase soil moisture deficits and stress in woody vegetation. These conditions have resulted in above normal fire potential for parts of the Swan Coastal Plain, Avon Wheatbelt, Jarrah Forest, Warren, Esperance Plains and Mallee regions. In parts of the Nullarbor, higher than normal fuel loads will contribute to above normal potential.

Above normal fire potential is also expected for coastal areas of the Pilbara which experienced heavy rainfall in association with Severe Tropical Cyclone *Veronica* in March 2019. This rainfall promoted good growth of soft grass and spinifex, as well as delaying curing compared to the rest of the region. As conditions dry out, greater continuity and loading of grassy fuels will increase the fire potential in parts of the Pilbara affected by *Veronica*.

NORTHERN TERRITORY

The late and weak monsoon activity for the 2018/19 wet season has led to dry conditions, with the Top End experiencing the driest wet season since 1992. Similarly, large areas of central Australia have received below average rainfall over the last 12 months.

This has led to reduced growth of vegetation, but despite this, the Northern Territory is expecting normal bushfire potential to continue for the remainder of the fire season, due to a shift in the timing of fire management activities. In the Top End, both mitigation activities and bushfires occurred two months earlier than normal, with large, long duration, early season fires that would normally be pulled up by temporary watercourses taking place. With a late onset to the 2019/20 wet season expected, dry conditions are likely to be extended.

The Bushfire and Natural Hazards CRC is a national research centre funded by the Australian Government Cooperative Research Centre Program. It was formed in 2013 for an eight-year program to undertake end-user focused research for Australia and New Zealand.

Hazard Notes are prepared from available research at the time of publication to encourage discussion and debate. The contents of *Hazard Notes* do not necessarily represent the views, policies, practises or positions of any of the individual agencies or organisations who are stakeholders of the Bushfire and Natural Hazards CRC.

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AUSTRALIAN SEASONAL BUSHFIRE OUTLOOK: DECEMBER 2019



OVERVIEW

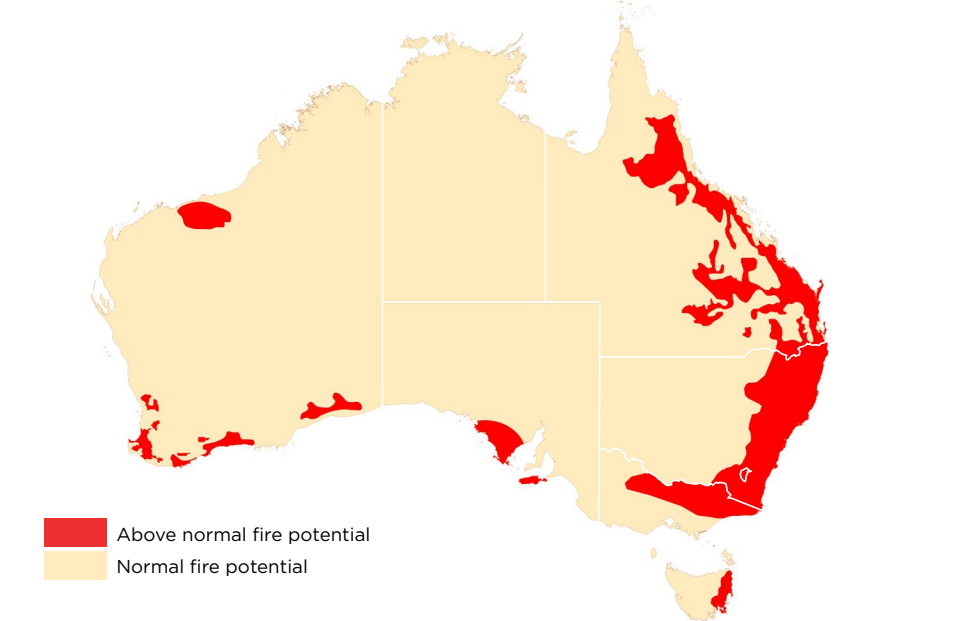
The 2019/20 fire season is well underway with multiple large bushfires occurring since the release of the previous Outlook in August. Queensland and New South Wales in particular have experienced severe fires, but all states have had challenging fire conditions. Catastrophic fire danger ratings have been issued in NSW, Western Australia, South Australia and Victoria, and there has been loss of human lives and animals, and damage to property and the environment.

2019 has seen the second warmest January to November period on record for Australia, 0.01°C behind 2013, coupled with the second-driest on record for the same period. Looking forward into the Outlook period, it is these conditions that lead to the continued above normal fire potential across most states and territories into 2020. A long and challenging fire season is expected, and all states and the ACT are warning of increased fire danger as the fire season progresses.

This December 2019 *Australian Seasonal Bushfire Outlook* covers all states and territories through summer 2019/20. It provides information to assist fire authorities in making strategic decisions such as resource planning and prescribed fire management to reduce the negative impacts of bushfire.

Bushfire potential depends on many factors. The volume, location and timing of rainfall are critically important when estimating vegetation (fuel) volumes and growth. The climate outlook for the next few months is also a crucial factor.

The *Australian Seasonal Bushfire Outlook: December 2019* is developed by the Bushfire and Natural Hazards CRC, AFAC, the Bureau of Meteorology, Queensland Fire and Emergency Services, the New South Wales Rural Fire Service, ACT Emergency Services Agency, ACT Parks and Conservation Service, Country Fire Authority, Department of Environment, Land, Water and Planning Victoria, Tasmania Fire Service, Country Fire Service, Department of Fire and Emergency



▲ Figure 1: AUSTRALIAN SEASONAL BUSHFIRE OUTLOOK DECEMBER 2019. AREAS ARE BASED ON THE INTERIM BIOGEOGRAPHIC REGIONALISATION FOR AUSTRALIA AND OTHER GEOGRAPHICAL FEATURES.

Services and Department of Biodiversity, Conservation and Attractions Western Australia, and Bushfires NT.

RECENT CONDITIONS

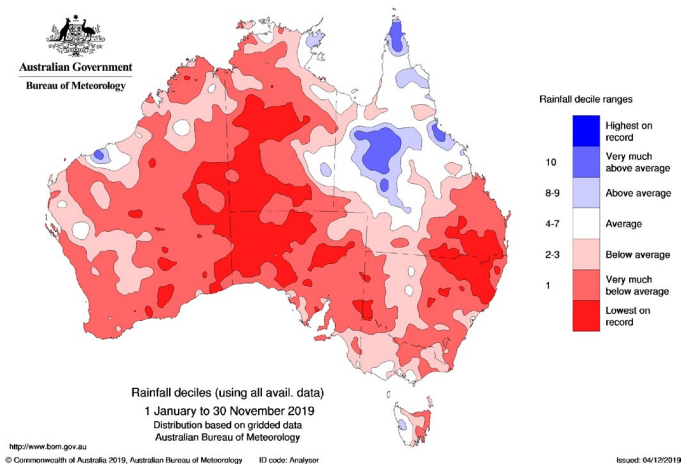
Seasonal fire conditions are a function of fuel amount and state, and seasonal weather conditions. The year to date has been unusually warm and dry for large parts of Australia (Figures 2 and 3, page 2), with many records set.

For January to November, rainfall has been below to very much below average over much of Australia. It has been the second-driest January to November on record for Australia (rainfall records begin in 1900), and the driest since the peak of the Federation Drought in 1902. It has been especially dry over the southern half of Australia (south of the Northern Territory/South Australia border), which had the driest January to November period on record. At a state level, rainfall deficiencies affect large areas, especially south eastern Queensland through eastern New South Wales, the ACT, South Australia,

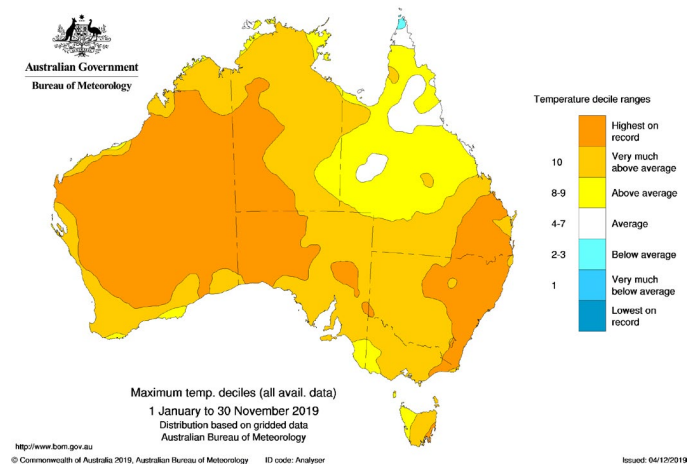
eastern Tasmania, south western WA, north western Australia and parts of eastern Victoria on a range of timescales. Areas of above average rainfall are largely confined to central Queensland, extending to the coast where heavy rainfall occurred early in the year.

Some areas, such as NSW extending into south eastern Queensland, are into their third year of dry conditions. It will take a prolonged period of above average rainfall to remove the deficiencies which are in place, meaning that general landscape dryness is likely to persist for many areas for some months. The combination of severe dry conditions over the long and short-term, coupled with high temperatures and record low humidity have contributed to the dangerous start to the southern fire season.

The warming trend means that above average temperatures now tend to occur in most years, and 2019 has followed this pattern. Temperatures in Australia for January to November have been the second warmest on record (1.37 °C above the 1961-1990 average, behind 1.38 °C for the same period



▲ Figure 2: RAINFALL DECILES FOR JANUARY TO NOVEMBER 2019 SHOWING DRY CONDITIONS OVER MUCH OF AUSTRALIA.



▲ Figure 3: MAXIMUM TEMPERATURE DECILES FOR JANUARY TO NOVEMBER 2019 SHOWING WARM CONDITIONS ACROSS AUSTRALIA.

DEFINITIONS

Bushfire potential: The chance of a fire or number of fires occurring of such size, complexity or other impact (such as biodiversity or global emissions) that requires resources (from both a pre-emptive management and suppression capability) beyond the area in which it or they originate. Fire potential depends on many factors including weather and climate, fuel abundance and availability, recent fire history and firefighting resources available in an area.

in 2013), with daytime temperatures clearly the warmest on record (1.9 °C above 1961-1990 average, temperature records begin 1910). These high temperatures add to the impact of reduced rainfall by increasing evaporation, further drying the landscape and vegetation. However, it should be noted that poor growth of grass and annual plants means that vegetation loads are reduced in many drought-affected areas. Dust storms may be a common occurrence.

With the combined hot and dry conditions in place it is not surprising that the southern fire season started early and has been severe to date. Large areas have seen record fire danger overall, as well as a very early start to the high fire danger period. In area average terms, the fire weather as measured by the Forest Fire Danger Index (FFDI) for spring was record high for Australia, as well as all states and territories apart from South Australia (second) and Victoria.

The tendency for fire seasons to become more intense and fire danger to occur earlier in the season is a clear trend in Australia's climate, reflecting reduced and/or less reliable

cool season rainfall and rising temperatures (see State of the Climate 2018). Fire season severity is increasing across much of Australia as measured by annual (July to June) indices of the FFDI, with the increases tending to be greatest in inland eastern Australia and coastal Western Australia.

CLIMATE OUTLOOK

The climate outlook for summer is mainly influenced by the Indian Ocean, together with other factors including long-term trends. Ocean temperatures in the tropical Pacific remain close to average, with El Niño or La Niña unlikely to develop in the coming months.

The positive Indian Ocean Dipole pattern which has brought dry conditions to Australia in recent months is forecast to decay by mid-summer. Temperatures in Australia for January to November have been the second warmest on record (1.37 °C above the 1961-1990 average, behind 1.38°C for the same period in 2013), with daytime temperatures clearly the warmest on record (1.90 °C above 1961-1990 average, temperature records begin 1910). Usually Indian Ocean Dipole events break down at the end of spring or early summer with the arrival of the monsoon into the southern hemisphere. However, this year the monsoon has been slow to move south—in fact it was the latest retreat on record from India—and international climate models suggest the positive Indian Ocean Dipole is likely to last longer than usual.

The other unusually persistent climate driver is a negative Southern Annular Mode. A negative Southern Annular Mode means Australia's weather systems are further north than usual. At this time of the year, this means stronger westerly winds for Tasmania and the southern mainland. In areas where those winds are coming off the ocean, it's been cooler and wetter, but in parts where westerlies blow

across long fetches of land, this air becomes dry and hot with reduced rainfall.

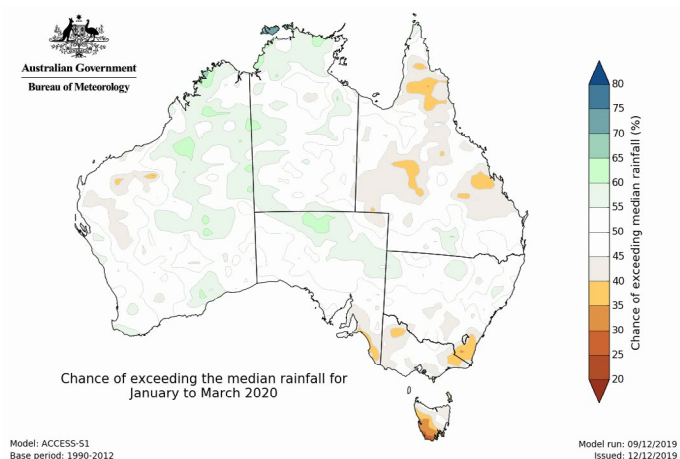
While both climate drivers are likely to decay by mid-summer, their legacy will take some time to fade. The positive Indian Ocean Dipole and the dry conditions experienced in winter and spring are known to be associated with a more severe fire season for south east Australia in the subsequent summer.

The rainfall outlook for January to March (Figure 4, page 3) suggests that rainfall is likely to be above average in western areas, while eastern Australia generally sees odds which are close to 50:50. The decay of the Indian Ocean Dipole means that probability swings are less strong than earlier in the season for eastern areas, suggesting that some relief in dry conditions is possible in the coming months.

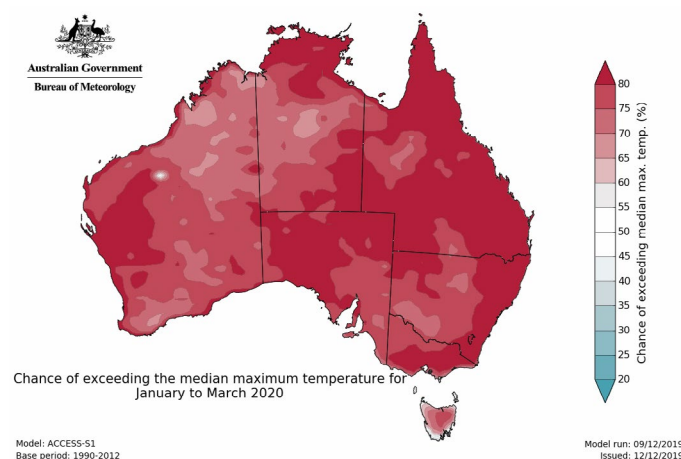
Historical outlook accuracy for January to March is moderate across western and southern mainland Australia, as well as the northern NT and northern Queensland. Elsewhere, accuracy is low to very low.

The outlook for January to March maximum temperature outlook (Figure 5, page 3) favours above average daytime temperatures for nearly all of Australia, exceeding 80 per cent across much of the eastern half of the country. The outlook for minimum temperatures (not shown) also strongly favours above average temperatures across much of Australia, excluding the south east. Historical accuracy for January to March maximum temperatures is moderate to high across most of Australia, but low surrounding the Great Australian Bight, and to the south of the Gulf of Carpentaria. Minimum temperature accuracy is moderate to high for most of Australia, except the central NT and central to western parts of Queensland, where accuracy is low to very low.

Updates to climate forecasts, including forecasts of monthly, fortnightly and weekly



▲ Figure 4: CHANCE OF EXCEEDING THE MEDIAN RAINFALL FOR JANUARY TO MARCH 2020.



▲ Figure 5: CHANCE OF EXCEEDING THE MEDIAN MAXIMUM TEMPERATURE FOR JANUARY TO MARCH 2020.

outlooks and the outlook for the Indian Ocean Dipole and the El Niño-Southern Oscillation will continue to be published at www.bom.gov.au/climate/ahead

REGIONAL SUMMARIES

QUEENSLAND

Following a record fire season in Queensland in 2018/2019, the 2019/2020 fire season started in late August. Since then Queensland has seen several intense pulses of fire weather affecting an already chronically dry and hotter landscape, mainly in the south east - from Rockhampton to the NSW border and extending inland to around St George.

As this season has progressed, the drought has intensified in many areas, particularly in the south east, with the Main/Border Ranges area, and the area bounded by Warwick, Toowoomba and the Lockyer Valley standing out. These areas are showing the lowest one per cent on record for the monthly relative root zone soil moisture deficit for November. The long-term, and recently more intense, drought has seen significant additional surface fuels (vegetation) added in forest areas due to stressed trees dropping significant amounts of branches and leaves over winter and spring. As a result, these areas are seeing fires continuing to carry more widely and with more intensity than usual, even when humidity increases overnight.

Normally wet and fire-resistant rainforest and wet forests are becoming available and burning for the second season in a row, with this phenomenon now extending into southern Queensland to areas such as the Lamington and Main Range National Parks. The rainfall deficit has also increased inland of Bowen, Townsville and Cairns over the past two months, and as a result the northern forests and heavier woodlands are showing

above normal bushfire potential and will continue to do so until these areas experience significant rainfall.

Large areas of inland Queensland have been drought effected since 2013, and as a result there has been very little grass fuel available, with the exception of sporadic and short-lived growth due to irregular inland rain. The Darling Downs and Granite Belt districts are continuing to face severe water shortages as a result of the drought. This has impacted the availability of water for fire suppression. QFES continues to work closely with their partners to manage this risk. The longer the delay in the arrival of the monsoon, the likelihood of campaign fires in northern forest areas will continue to build.

NEW SOUTH WALES

The start to this fire season has been unprecedented for New South Wales, with large fires occurring across the state. Since July, more than 8,000 bush and grass fires have occurred, burning over 2.8 million hectares. Six human lives have been lost, more than 700 homes destroyed and more than 1,600 other buildings. Resources have been drawn from around NSW, other states and from overseas.

Much of the state has experienced very much below average rainfall during the last three months, with a small percentage of areas in northern NSW experiencing driest on record conditions. Long-term rainfall deficiencies, record-low for some areas in the north of the state, have severely impacted on water resources.

At the end of September, the NSW Department of Primary Industries mapped nearly all of NSW into one of three drought categories - intense drought, experiencing drought or drought affected.

With the short to medium-range climate

outlooks forecasting warmer and drier than average conditions across the state, above normal fire potential will continue in forested areas on and east of the Great Dividing Range. Under these conditions, existing large fires will continue to remain a threat.

West of the Divide there is minimal grass fuels available due to the drought, and as a result reduced fire potential.

ACT

The ACT has received less than average rainfall for nearly three years, leading to a persistent and high level of drought. The lowland forests have been very dry for some time, while highland forests are now dry as well. This indicates that fuel flammability in the forests is high and could remain so. The forest fire risk is elevated. The dry conditions and grazing by farm stock and wildlife have led to lower levels of grass growth, resulting in reduced overall grass fire risk. On bad days grass fires may still reach and impact on unprotected property. This situation should persist until rains return. Heatwaves and dust storms may make bushfire detection and suppression more challenging at times during the season.

The overall bushfire risk for the ACT is above normal. Community members should continue to prepare for fire by taking actions to reduce the bushfire risks around and within their property and to review their bushfire survival plans.

VICTORIA

The potential for above normal bushfire activity continues across the coastal and foothill forests of East Gippsland, extending into parts of West Gippsland, Great Dividing Range, and into the central Goldfields. This is due to the above average temperatures and continuation of drying trends observed in these regions over the last three months,

coupled with three years of significant rainfall deficit across much of East Gippsland and across the Divide. During spring, cold fronts generated rainfall in southern Victoria, however much of inland Victoria received insufficient rainfall. In these inland areas soil moisture is lower compared to the long-term average. This is likely to cause moisture stress on live vegetation thereby increasing the quantity of dead fuel components and result in higher flammability in live vegetation. Wet forests (such as the Central Highlands and Otway Ranges) are generally close to average conditions for this time of year.

Across the rest of Victoria, mostly normal conditions are expected. In the west of the state, grassland fuel conditions indicate that curing is average for this time of year, and that there is average to above average quantities of grass and crop loads. When grasses and crops are close to or fully cured, there is potential in the coming months for fire behaviour that can rapidly escalate under elevated fire weather conditions.

TASMANIA

Tasmania experienced an early start to the fire season with serious fires in the north and south of the state in October. While there was easing in the fire weather during November, by the end of the month a very strong continuous westerly airstream coincided with a number of ignitions in the north and east, resulting in a continuing campaign fire west of Swansea in the Eastern Tiers. The weather conditions were very unusual and effective fire suppression was impossible during the conditions experienced.

The area of above normal fire potential in eastern Tasmania continues to expand, while the west of Tasmania is receiving good rains which are replenishing water tables and the moisture in organic soils. The area of above normal fire potential includes the far north east, the Fingal and Royal George valleys and the Midlands, the east coast from St Helens to Tasman Island and the lower Derwent Valley. The remainder of the state has normal fire potential, noting the dominance of fuels in the

west for which soil moisture is less important than in forests.

SOUTH AUSTRALIA

Minimal rainfall, and predominately warmer than average temperatures have persisted across South Australia through spring. As a result, the fire danger season was brought forward, with most areas commencing two weeks early.

The early start to the fire danger season has coincided with a number of total fire bans, and several significant fires have occurred. The Eyre Peninsula experienced Catastrophic fire danger conditions twice in November alone.

On 20 November Catastrophic fire danger was predicted for seven of the 15 weather districts across the state. A total fire ban was declared statewide, with Catastrophic fire danger recorded simultaneously across half the state. Temperature records were broken and 45 new bush and grass fires occurred. Eleven homes were lost on the Yorke Peninsula.

The current three month outlook for January to March 2020 indicates that South Australia is highly likely to experience above average day and night time temperatures, and there is little chance of above average rainfall during this period. This would indicate that the current dry conditions, which have supported major fires, are likely to continue throughout summer.

Based on the current climate outlook, and observed fire behaviour, parts of the Lower Eyre Peninsula and Kangaroo Island continue to have above normal fire potential. Forecast and observed conditions have also demonstrated the rest of South Australia maintains the potential for significant bushfires, including in the populated areas of the Mount Lofty Ranges.

The prolonged dry conditions are also likely to create increased occurrences of raised dust during the windy conditions that often accompany high fire risk days. The dust may affect the operational capabilities of aerial firefighting assets and limit their effectiveness. Fire managers will carefully monitor this issue, noting that without rainfall, dust suppression

is impossible on the scale required.

The fire danger season may be prolonged across parts of South Australia. Significant bushfires have occurred in similar conditions, and even areas of normal fire potential can expect to experience dangerous bushfires as per a normal South Australian fire season.

WESTERN AUSTRALIA

With the positive Indian Ocean Dipole delaying the onset of the monsoon, high temperatures and dry lightning in the northern part of Western Australia have resulted in heightened bushfire risk for the Kimberley until rain arrives. Above normal fire potential continues for parts of the south west, south coast, Nullarbor and Pilbara.

NORTHERN TERRITORY

The Top End's bushfire season started two months earlier in 2019 due to the preceding poor wet season. Large, long duration fires occurring from early in the season that typically would have pulled up in temporary watercourses.

The bushfire risk remains across the Top End in areas of the Gregory and Carpentaria Regions, with localised and patchy rainfall occurring in coastal areas. This risk will continue until the effects of the monsoon occur inland.

In central Australia, below average rainfall over the last 12 months has led to reduced growth of vegetation. Due to these dry conditions, mitigation programs conducted by pastoral enterprises has reduced as the need for retention of standing vegetation increases for cattle production. Despite this, the Northern Territory is expecting normal bushfire potential to continue for the remainder of the central Australian fire season. However, significant bushfires have occurred in similar conditions, and even areas of normal fire potential can expect to experience dangerous bushfires. This will be particularly relevant in areas that surround unmanaged land with remanent vegetation growth, particularly remote communities and outstations.

The Bushfire and Natural Hazards CRC is a national research centre funded by the Australian Government Cooperative Research Centre Program. It was formed in 2013 for an eight-year program to undertake end-user focused research for Australia and New Zealand.

Hazard Notes are prepared from available research at the time of publication to encourage discussion and debate. The contents of *Hazard Notes* do not necessarily represent the views, policies, practises or positions of any of the individual agencies or organisations who are stakeholders of the Bushfire and Natural Hazards CRC.

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Building a disaster resilient Australia on a solid foundation of expertise, evidence and networks.

Our nation's future well-being depends on the resilience of our communities, cities and ecosystems. Building resilience is about the smart and informed actions we can take now so that the impact of inevitable future shocks and stresses are minimised.

A CRITICAL NEED

Over the coming decades, Australians will experience disasters with increasing frequency and severity, and on a scale beyond our current experiences. The economic, social and environmental impacts of these events will be unprecedented and unsustainable. How we understand and contend with this, and how we work to reduce the impact is the challenge we face. With a concerted, collaborative, national effort, we can harness expertise and leadership from research, government, fire and emergency services and industry to find new ways to adapt and respond to disaster risk.

The increasing frequency, scale and impact of natural hazards and disasters is a threat to the sustainability of the Australian way of life

Australians are accustomed to living with many different hazards; from storm, flood and cyclone to drought, bushfire and extreme heat. The steadily increasing occurrence, scale and impact of these hazards demands new ideas and solutions.

Decision-makers need evidence, information and tools to make the necessary critical decisions

Decisions made without evidence introduce new risks. We have some of the data and scientific modelling, but we need to better equip leaders with the right information, insight and confidence to make decisions about Australia's future.

Complex challenges need dedicated, sustainable, national research

Solving the complex and interdependent problems inherent in building Australia's disaster resilience requires diverse disciplines to work together in collaborative partnerships. Failing to connect research on climate adaptation and disaster risk reduction, denies logical synergies and hinders progress. Individual research outcomes can fall short of industry requirements due to the lack of shared objectives or a multi-disciplinary approach to answering critical questions

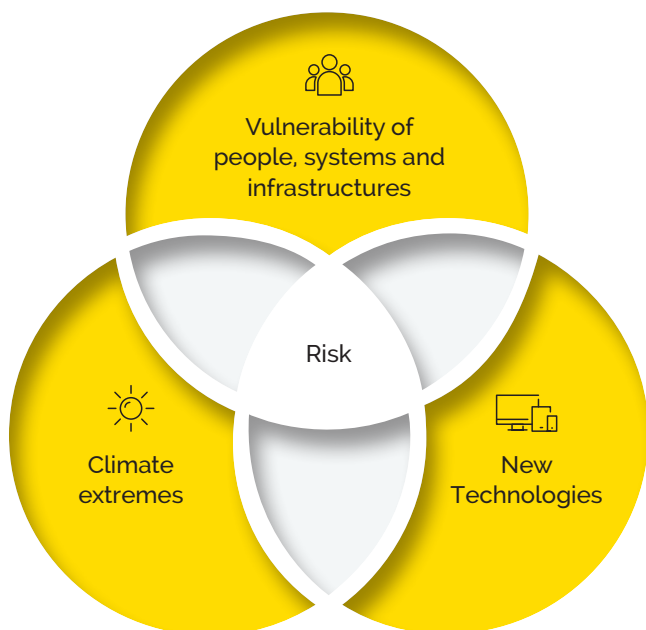
NATIONAL AND GLOBAL CONTEXT

Australia's **National Disaster Risk Reduction Framework** sets out a long-term vision, clear goals and four national priorities to reduce the physical, social and economic harm caused by disasters.

Internationally, Australia is a signatory to both the United Nations **Sendai Framework for Disaster Risk Reduction 2015-2030** and the 2015 United Nations **'Paris Agreement'** to combat climate change and adapt to its effects.

By 2030, the Sendai Framework aims to achieve: "The substantial reduction of disaster risk and losses in lives, livelihoods and health, and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries."

Recognising the impact of the increasing number of disasters in our region, Australia's leadership in the south Pacific area is also of critical importance. The Pacific Islands Forum's 2018 **Boe Declaration** on Regional Security, of which Australia is a signatory, calls for recognising climate change as the single greatest threat to the livelihoods, security and wellbeing of peoples of the Pacific.



THE SCOPE

As outlined in recent National Resilience Taskforce's **profiling Australia's Vulnerability** the interconnectedness of Australia's population, systems and infrastructure are at the core of the disaster risk discussion. Vulnerability converts exposure to shocks and strains into damages and impacts. How can vulnerabilities be reduced?

Demographic change is inherent in a country like Australia. The population is growing, ageing and becoming more diverse. Cities and towns are expanding into rural and coastal zones. How is demographic change affecting vulnerabilities?

Climate extremes impacts are expected to increase in line with global temperature increases. Extreme and rare weather events of the past are becoming the norm and the unimaginable is becoming possible. How can we better predict and prepare for extreme events?

New Technologies are rapid and widespread – in telecommunications, building and construction materials, and in the home and workplace. It presents both opportunities and risks. What impact does technological change have on the vulnerable, the exposed and the unprepared as well as the agencies? AI-assisted decision making, and big data will impact our planning and response. New hardware such as robotics and drones will impact our resourcing.

PRIORITIES FOR RESEARCH

End-users of research have articulated the problems that need to be supported by research. Over the last two years, the Bushfire and Natural Hazards CRC has consulted extensively with research investors and partners to define four key research priorities for the decade ahead:

1. Shared responsibility and community engagement
2. Communicating risk and understanding the benefits of mitigation
3. Impacts of climate change
4. Predictive services and warnings

THE BENEFITS OF NATIONAL RESEARCH

A dedicated national disaster risk and resilience research institute, accessible to all, will significantly contribute to reducing the impact of hazards and disasters in Australia.

- Disaster risk reduction policies and strategies will be based on evidence.
- Emergency management practices and policies will be nationally consistent, leading to better and faster adoption.
- Shared investment in research delivers value for money outcomes, and makes a substantial, multi-dimensional research agenda possible.
- Australia will continue to be globally acknowledged for research capability and leadership in advancing disaster resilience through a network of researchers, government and industry.

COLLABORATIVE SCIENCE FOR IMPACT

A long-term, trusted national entity for these collaborations is needed, with a dedicated focus on disaster risk reduction research. The essential elements are available: research expertise and acumen, with a track record of delivery and impact in the community, industry knowledge and leadership, government commitment and clear policy objectives.

What is now needed is the sustained financial capacity to invest in its success, and a shared agreement to contribute and collaborate across traditional boundaries and borders.

The capability and capacity exists. All that is needed is ongoing investment.

