SYNTHESIS SUMMARY 4

Bushfire

Bushfires are
extremely unpredictable
climate-related events.
They already pose a
significant threat to life
and property. Adapting to
an increased risk will mean
improving existing preparedness
and response activities.

NCCARF
National
Climate Change Adaptation
Research Facility

About this series

Between 2008 and 2013, the Australian Government funded a large nationwide Adaptation Research Grant Program (the ARG Program) in climate change adaptation. The Program was managed by the National Climate Change Adaptation Research Facility (NCCARF). It resulted in over 100 research reports that delivered new knowledge on every aspect of adaptation. The aim of the Program was to help build a nation more resilient to the effects of climate change and better placed to take advantage of the opportunities.

This series of Synthesis Summaries is based on research findings from the ARG Program, augmented by relevant new literature and evidence from practitioners. The series seeks to deliver some of the policy-relevant research evidence to support decision-making for climate change adaptation in Australia in a short summary. It takes an approach identified through consultation with relevant stakeholders about the needs of the intended audience of policymakers, decision-makers and managers in the public and private sectors.

About this summary

This summary deals with bushfires. The opening pages provide the context, including the nature and impacts of bushfire ('Why we need to adapt'), followed by a synthesis of research findings around the impacts of and adaptation responses to increasing bushfire weather ('The research base …'). It concludes with a summary of how this new research knowledge might help address key adaptation policy challenges. This final section is informed by a workshop held with practitioners ('Evidence-based policy implications'). Many of the papers used in this summary came from work carried out by NCCARF's Emergency Management Adaptation Research Network.

This brief was developed by NCCARF staff, with input on the policy challenges developed in workshops held in Mackay (Queensland), Adelaide (South Australia) and Cardinia Shire (Victoria) in December 2015. The workshop was attended by practitioners, policymakers and managers from within local, state and federal government organisations, community service organisations, not-for-profit organisations and universities.

The key research reports used to develop this summary are highlighted in Section 4. To see all reports from the ARG Program, please visit **www.nccarf.edu.au/adaptation-library**.

Key findings

Weather conditions that lead to bushfires are expected to worsen with climate change. Even under current conditions, complex and large bushfires can have catastrophic outcomes. Five principal adaptation challenges emerge from the research evidence:

1. **Define and understand shared risk:** Building resilience in communities means sharing risk. Agreement and understanding of responsibilities for both government and community means clearly defining those responsibilities and supporting communities to understand and accept their bushfire risk.

2. **Match practice and resourcing to policy:** Building community resilience requires investment. The expectation is that greater investment in building resilience to bushfires will gradually reduce the cost of recovery following a fire.

3. **Educate and communicate to change behaviour:** Information and dissemination about fire risk is essential to building community resilience. The process should be targeted in its delivery and message and aimed at building an understanding of risk.

4. **Plan and build with fire risk in mind:** For both new and existing developments, increased fire risk due to climate change may mean some areas are no longer suitable for development. For some existing developments, retrofitting or retreat and resettlement options may need to be considered.

5. **Identify emerging risks and challenges:** Increased fire risk, combined with expanded development in high fire-risk areas and changing demographics, is likely to increase the need for targeted communication, planning controls and new ways of engaging volunteers.

1. Why we need to adapt

1.1 The climate context

Fire is a common occurrence in Australia's south-east and is associated with high maximum temperatures, strong winds, low relative humidity and a preceding period of dry conditions. Fire seasons in Australia vary according to region (Figure 1). The potential for a fire to occur depends on four 'switches':

1. ignition (human or natural sources, such as lightning)
2. the amount of fuel available (fuel load)
3. how dry the fuel is, with lower moisture content increasing the risk of fire
4. suitable weather conditions for fire spread (i.e. hot, dry, windy).[4]

Meteorological conditions determine the 'settings' of the switches.[8] An increase in Forest Fire Danger Index days across a number of southern Australian sites has already been detected during the period 1973–2010.[12] This has been accompanied by a lengthening of the fire season into spring and autumn.[8] In northern Australia, cyclone debris can increase the fuel load and subsequent bushfire risk.

Future projections of the meteorological conditions that drive fire weather (i.e. monthly mean changes to maximum temperature, rainfall, relative humidity and wind speed) show that climate change is expected to increase the frequency and severity of extreme fire danger, with south-eastern Australia at the greatest risk. Modelling suggests that the number of extreme fire danger days in south-east Australia is likely to increase by 15–65% by 2020 relative to 1990 and by as much as 100–300% by 2050 if emissions continue to track at a high rate.[12]

Warmer temperatures combined with drying in southern and eastern Australia will lead to more fuels that are drier and ready to burn. In northern Australia and inland areas, the main factor driving bushfires is the availability of fuel, which in turn depends on year-to-year rainfall-driven vegetation growth. With little projected change in rainfall, it is expected there will be little change in fire frequency in tropical and monsoonal northern Australia.

1.2 Key risks

Bushfires are a threat to human life and wellbeing, property, infrastructure, crops, livestock and ecosystems. Australia is extremely fire-prone, and catastrophic and deadly fires in the past 40 years have prompted reviews of our bushfire response.[11] This has led to changes in emergency management of the fire threat over time, yet some of the most deadly fires in Australia occurred as recently as 2009 with the Black Saturday fires. Clearly, more needs to be done to adapt to the increasing threat posed by climate change.

An increase in fire weather risk is likely to see a reduced interval between fires, increased fire intensity, a decrease in fire extinguishment (i.e. suppression) and faster fire spread – increasing the complexity of the bushfire risk.[21] This, if combined with the expansion of development and settlement in peri-urban areas, is likely to not only put more lives at risk, but to increase property and economic losses. Existing management and response systems are likely to be challenged by these changes.[15] While the Victorian Bushfires Royal Commission handed down an extensive set of recommendations following the Black Saturday bushfires, which will help improve responses to future events, none of these directly addressed climate change.[21]

Increasing residential development and population growth in some of Australia's most fire-prone areas is pushing new development into high bushfire-risk areas. This is driven in part by amenity – a growing desire among a segment of the population to adopt a 'tree-change' lifestyle – and housing affordability on the outskirts of large urban centres.[20] These trends, coupled with an increase in the severity and frequency of bushfires, will mean that the number of people and properties at risk from bushfires will increase in the future.

Bushfires are tied to meteorological conditions that in themselves may be natural disasters, such as the deadly heatwave that preceded the Black Saturday fires and is known to have caused more deaths than the fires.[19] Multiple natural disasters in a relatively short period of time currently test the limits of Australia's disaster management system, and this is likely to worsen under future climate change.[11]

Widespread intense fires such as the Black Saturday fires can have a large impact on mental health and psychological stress. Increases in post-traumatic stress disorder, depression, family and gender violence and substance abuse have been linked to communities affected by bushfire tragedy.[9] Research shows that while many people recovered within four years[5], there remains a high economic cost associated with these impacts.[9]

Bushfire has both positive and negative impacts on biodiversity, with a number of Australian plants reliant on fire for their germination and flowering. Changes in fire regime can change the structure, species composition and function of ecosystems – which in turn may lead to increased risk of fire, and invasion of weeds and disease.[3] Protecting the built environment and human life while safeguarding conservation values will be a significant challenge under increased fire weather conditions.

Figure 1 Timing of fire seasons across Australia. Source: © Commonwealth of Australia 2016, Bureau of Meteorology.

2. The research base informing adaptation to bushfire

The scale of damage and lives lost in the Black Saturday fires raised questions about:

- the adequacy of warning systems the existing policy of 'prepare, stay and defend, or leave early'

- preparedness and the response of residents

- the roles of fire authorities and other emergency services

- and the appropriateness of land-use planning that allows development in high fire-danger areas.

The report of the Victorian Bushfires Royal Commission into the fires delivered valuable information for evidence-based adaptation to future bushfire risk.[16]

2.1 Designing for the future

Housing within bushland or close to its boundary (within 100 m) is clearly at high risk from bushfires. Management of fire by emergency services occurs at a landscape scale, primarily through fuel treatment such as controlled burning, and is complemented by individual strategies undertaken by householders. Management strategies to avoid individual property loss can be either preventative (e.g. reduction and removal of fuels from surrounds) or defensive (i.e. fire suppression).[18] Reducing fire risk in vulnerable areas (i.e. controlled burns) can impact on biodiversity values through species loss.

Suitable building design and construction materials can improve the fire resistance of housing. In addition, provision for sheltering was recommended by the Royal Commission in recognition that the 'stay and defend, or leave early' advice does not realistically reflect what people actually do and experience in a fire, with many waiting for too long before making a decision.[16] Shelters provide last-resort options. In recognition of this recommendation, the Australian Building Code has developed standards for the design and construction of bushfire bunkers for personal use.[1]

Building in vulnerable areas may ultimately become too risky, and mechanisms to support retreat and resettlement may become necessary. The Royal Commission recommended this strategy for current areas of unacceptable risk in Victoria, and 116 properties have since been purchased by the government. There is evidence that some high risk locations could be modified to remove them from the unacceptable risk category,[15] and this may be more cost effective.

2.2 Understanding and communicating risk to change behaviours

Traditional advice to residents at risk from bushfire has been 'prepare, stay and defend, or leave early'. Essential to this option is that residents are adequately prepared and that their property is defendable. Even in the severe Black Saturday fires, many residents did successfully stay and defend their properties. As few as 2 in 10 houses were destroyed where residents remained to defend, while half of undefended houses were destroyed.[21]

Preparedness and planning levels varied among those surveyed following the Black Saturday fires. A quarter of residents adopted a risky 'wait and see' approach – deciding to leave only once they felt unsafe or had seen the fire. Of those who opted to defend their property, a third ended up leaving due to perceived danger, equipment failure or because their house caught fire. Almost half of those who were forced to leave acknowledged that they had left late and that their departure was in itself very dangerous.[21]

Post-fire research indicates a gap between householder intentions and actions. The circumstances of decision-making need to be well understood. Revised advice in the *National framework for scaled advice and warnings to the community*[2] has included a new category of 'Catastrophic' or 'Code Red' fire danger (the terminology can vary between states). Advice on what each fire danger level means and what residents should do on receiving the warning is generally available from local fire agencies. An emphasis on leaving early as the safest option when under bushfire threat has been adopted by Australian fire agencies following Black Saturday.[13]

In Victoria, follow-up studies to consider if preparedness, planning and rates of early evacuation had improved in response to this new emphasis showed that only a small minority of residents were well-prepared to implement their plan.[13] A survey of residents living in high risk areas indicated that 60% said they would leave early if

a Code Red (catastrophic) fire danger was predicted. Yet when the residents were resurveyed following Code Red fire weather days in which no fire occurred, fewer than 2% of people actually did leave in response to the warning.[20]

There is inherent uncertainty associated with fire risk and prediction. So while a prediction of meteorological conditions likely to lead to a Code Red fire day is feasible, prediction of arson or fire ignition from arcing power cables is not. So effective warnings are based on the conditions for a fire rather than the actual fire and smoke that many at-risk residents respond to. This challenges both fire managers and householders to make decisions and allocate resources in emergency situations with very large uncertainties. Appropriate use of limited information and precautionary decision-making will be necessary.

O'Neill and Handmer[15] highlight that in the case of the Black Saturday fires, even though the state's Chief Fire Officer warned that the day would see extraordinary weather conditions, neither the standard agency advice to the public nor operating procedures for volunteer fire fighters were changed. Most of the residents surveyed did not receive an official warning of the fire threat (although they expected they would), but rather received information from family, friends or neighbours. There was poor understanding of the actions to be taken when receiving official fire warnings.

Although people often call for more information following fires, as was found in the case of the Black Saturday fires, the work of McNeill and colleagues[14] suggests that providing more information does not necessarily solve the problem of people evacuating late or leaving under late and risky conditions. Their research found that requests for more information are a symptom of 'delaying the decision' whether to stay and defend or to leave early rather than a true lack of information. So while these residents are aware of the risk bushfire poses to them and the need to plan, they are stuck between two competing responses – to save property or to keep themselves safe.

This delay in decision-making tends to mean fewer preparations for either or both options. It also means time must be taken during an emergency situation to make the choice when the circumstances do not support good decision-making – all of which can mean late evacuation. The conflict over the choice to defend or leave early is not an unreasonable one, and policy may need to look at building identifiable triggers or conditions leading individuals to a particular path. It is essential that these triggers and conditions are established before the fire season and reviewed annually. Increased awareness of the need to prepare for both evacuation and defend options may be needed if people are going to delay their decision to the point where one option is forced on them, and choice is removed.[14]

2.3 Understanding resilience and building adaptive capacity

In order to survive a bushfire, people must know that they are in an area of risk and must have identified strategies to manage their personal risk.[13] This includes understanding their vulnerability.

The potential defendability of buildings is an important factor in deciding whether to stay or leave. Following Black Saturday, forensic experts raised questions about the defendability of buildings occupied by almost a third of those who perished. There was concern from the Royal Commission that people were being given the option to 'defend' when essentially their houses were indefensible.[17] Residents generally do not understand the defendability of their property, and there is no formal mechanism to assess or test defendability in most states. So while there is good evidence that adequately prepared households and buildings can be successfully defended, quantifying and self-assessing what that means is an important but neglected aspect of the decision-making behind the 'prepare, stay and defend, or leave early' policy.

Some individuals and households may be inherently vulnerable. Almost half the fatalities in the Black Saturday bushfires reflected vulnerability due to age (over 70 years or under 12 years) and/or a chronic and/or acute disability, or some combination of these factors.[15]

Research has shown that men and women perceive, prepare for and respond to bushfire risk differently[22], making them *differently* vulnerable. A study of bushfire fatalities between 1900 and 2008 shows the majority of victims (67%) are men, most of whom die outside while trying to protect assets. Women are more likely to die while sheltering or evacuating.[10] Following Black Saturday, research found that women more often wanted to leave and would listen to advice of friends, family and authorities, while men were more likely to want to stay and defend.[22] Women were also more likely to reflect critically on their level of planning and preparedness than men, and there is scope for tailoring programs that engage specifically with women.[22] These different perceptions can create conflict within families that leads to delayed decisions and late evacuation.

Little is currently known about how bushfire is managed in Indigenous communities, some of which are in remote and isolated locations.[6] In some Indigenous communities, fire reduction strategies are part of seasonal work and there is a strong sense that the community can manage their own fire risks although, as in non-Indigenous communities, there is concern around the risks from out-of-control fires.

2.4 Governance and insurance

The current approach to emergency management in Australia is one of resilience, where the emphasis is on building capacity before disaster strikes.[7,11] The approach also looks to share responsibility between the private and public sectors. This philosophy is fundamental to the Australian 'prepare, stay and defend, or leave early' policy, leaving choice in the hands of the individual. O'Neill and Handmer[15] argue that, based on fatality data and the significant proportion of vulnerable people who perished, the risk was disproportionately loaded onto the private sector (individual householders) in the Black Saturday fires. This points to and highlights the challenges of a resilience approach.

For example, while agencies have considerable expert information, experience and corporate knowledge, when this is shared with the community, it is usually in a generalised form that takes no account of individual circumstance (i.e. the adaptive capacity of individual households: knowledge level, resources, location, health, mobility).

Howes and colleagues[11] identified four potential institutional reforms that included:

- a new funding mechanism that encourages collaboration between and across different levels of government, as well as promoting partnerships with business and the community

- improving community engagement through new resilience grants run by local councils

- embedding climate change researchers within disaster risk management agencies to promote institutional learning

- creating an inter-agency network that encourages collaboration between organisations.

O'Neill and Handmer[15] outline the following four response areas that could lead to a transformation in bushfire risk management:

- diminishing the hazard (e.g. regular maintenance of electrical infrastructure, targeting arsonists)

- reducing exposure of infrastructure and buildings (i.e. avoiding very high hazard areas)

- reducing vulnerability of people (e.g. formal fire training, mental preparedness training for individuals living in high risk areas)

- increasing the adaptive capacity of institutions (e.g. insurers requiring risk reduction as a condition of cover), and changing the focus of emergency response in very high risk fires (e.g. to saving lives and critical infrastructure only).

3. Evidence-based policy implications

Define and understand shared risk

Building resilience in communities means sharing risk. Agreement and understanding of responsibilities for both government and community means clearly defining those responsibilities and supporting communities to understand and accept their bushfire risk.

The *National Strategy for Disaster Resilience*[7] advocates a shared responsibility/resilience approach to build community resilience to catastrophic events, including bushfires.

For the shared responsibility/ resilience approach to be successful, both the public (government) and private (community) sectors need to be aware of their responsibilities and to have a sense that there is a partnership (or social contract). In the case of the community, ensuring they take responsibility for their risk is likely best achieved through grassroots and one-on-one engagement, supported by a clear understanding of the rationale behind government decision-making and on-site assessment of fire plans (including determining defendability of individual houses). Particularly for their ability to provide connectedness, community organisations have an important role to play both in supporting people to prepare for bushfires and during the event. Householders should be aware that warnings will not be delivered personally, and that decision-making and identifying the event that triggers a decision need to be built in as part of their fire plan. Any delay to community and individual decision-making (i.e. when the fire threatens) may not be rational in an emergency situation.

For government, shared responsibility might include:

- management of government assets, for example management of protected areas (e.g. national parks) with appropriately resourced fuel reduction treatment

- support and resourcing to community to build resilience and enable them to take responsibility for risk

- programs to identify and support the most vulnerable community members

- development of appropriate and effective governance arrangements

- appropriate planning regimes that reduce risk and promote disaster preparedness, including through the regulation of building standards.

Recovery from bushfire requires long-term investment beyond the 'sirens and lights'. As trusted information sources with strong community connections, local governments are positioned to provide not only an emergency response, but also a long-term recovery response and preparedness. This role could be formalised and acknowledged through resourcing and support and extended to include information and advice, for example, on dealing with other hazards such as asbestos and chemical risks.

The volunteer response (e.g. State Emergency Services and Country Fire Services) is part of the community's shared responsibility. Community are investing in reducing their risk and building social connectedness through volunteering, while government is investing in building resilience through resourcing these organisations.

ADAPTATION CHALLENGE 2:

Match practice and resourcing to policy

Building community resilience requires investment. The expectation is that greater investment in building resilience to bushfires will gradually reduce the cost of recovery following a fire.

While federal policy has shifted to a focus on action-based resilience planning and strengthening local capacity and capability, expenditure on disaster recovery continues to outweigh expenditure on building resilience and preparedness.

Successful building of a shared responsibility/resilience approach to the growing bushfire risk is likely to require an increasing level of investment.[11] For example, if increased controlled burning to reduce the fuel load is recommended to build resilience, then additional resources will be needed to enable this increase. Additional spending on preparedness and resilience will be needed at the same time as spending on recovery, with an expectation that the rise in spending is short-term until the balance shifts to a more resilient community that suffers less damage and loss in bushfires.

Funding often comes from disparate sources, making it difficult to structure and stage investment.[11] Increased funding for evidence-based project proposals that consider climate change, aim to increase future resilience and that are coordinated across federal and state agencies would ultimately deliver cost savings in the disaster-response area.[11] Funding could be invested in local government to implement adaptation planning, which builds community connectedness, risk reduction actions, education programs and community engagement. The approach could address broad adaptation and disaster preparedness goals.

ADAPTATION CHALLENGE 3:

Educate and communicate to change behaviour

Information and dissemination about fire risk is essential to building community resilience. The process should be targeted in its delivery and message and aimed at building an understanding of risk.

Communication and education are essential in preparing for bushfires. The message, tone and method of delivery are important to get right.[11]

Communication of risk should aim to give enough information (including technical information) to individuals so they understand their risk and responsibilities in preparing for bushfire. This includes an understanding that warnings are made on the basis of the best available information and that fire is extremely unpredictable – so sometimes a warning will not result in fire, but it should be treated as if it will.

Knowledge of what to expect and what it means is most effective if embedded in community understanding long before bushfire warnings are needed.

Stories of experiences in fires (including preparedness) can be effectively used in messaging. Channels for delivery of preparedness information might include schools, to help build social connectedness and future resilience, and social media. Messages might include information about the causes of fire (e.g. that a large percentage of fires that are caused by humans are through machinery use on fire ban days and private burn-offs) as well as effective preparedness measures. Communication approaches might look to other successful warning campaigns (e.g. cyclone season preparedness) for lessons around communicating and educating.

New residential developments in peri-urban areas pose particular challenges for bushfire education. It is likely that new residents will have little personal experience of bushfire. There is a need to identify and implement methods to communicate risk and build resilience rapidly, effectively and across the whole community.

ADAPTATION CHALLENGE 4:
Plan and build with fire risk in mind

For both new and existing developments, increased fire risk due to climate change may mean some areas are no longer suitable for development. For some existing developments, retrofitting or retreat and resettlement options may need to be considered.

People continue to live in areas prone to bushfire. As homes are rebuilt following fire and new developments expand into fire-prone areas, there is an opportunity to reduce fire risk through land-use and development planning and building design.

In areas of new development, there is opportunity to assess bushfire risk, determine whether the risk is acceptable and plan accordingly, avoiding high risk areas and providing both escape and shelter opportunities for residents. Building design and construction can improve the fire resistance of housing. Incorporating bushfire and climate risk considerations into property purchasing processes will also support home buyers to make informed decisions regarding their risk.

In existing settlements, the options are more complex. If the fire risk becomes unacceptable as climate change worsens, then mechanisms to reduce risk (e.g. retrofit of building materials or landscape changes) may need to be considered. Ultimately, mechanisms for retreat and resettlement may also need to be considered. Community engagement to ensure there is good understanding of the risk will be essential to support these actions.

ADAPTATION CHALLENGE 5:
Identify emerging risks and challenges

Increased fire risk, combined with expanded development in high fire-risk areas and changing demographics, is likely to increase the need for targeted communication, planning controls and new ways of engaging volunteers.

Climate change combined with urban expansion will mean more people are exposed to bushfire risk. In addition, changing demographics mean experience and skills to combat bushfire are being lost.

Most large urban centres are experiencing development expansion in peri-urban areas. New residents may have little or no experience of bushfires, and in some areas are recent immigrants. Finding channels for directing communication into these groups will grow in importance.

Changing demographics (e.g. aging populations, loss of forestry skills and workers, new residents, a reduced farm workforce, 'fly-in/fly-out' worker absences) are contributing to a reduced volunteer pool for essential fire preparation, fighting and recovery roles. Addressing this change may mean finding new ways of engaging volunteers (including managing the training and skill maintenance demands) and improving the community's understanding of volunteering as part of sharing responsibility. Following disaster there are often many 'spontaneous' volunteers. Community service organisations may look at better ways to use this resource.

4. Key information and references

NCCARF-supported research is marked with an asterisk*

1. Australian Building Codes Board (2014) Private Bushfire Shelters. Performance Standard (Australian Building Codes Board, Canberra).

2. Australian Emergency Management Committee (2009) National Framework for Scaled Advice and Warnings to the Community, http://www.abc.net.au/emergency/bushfire/warnings/documents/national_warnings_framework.pdf (accessed 22 August 2016).

3. Boulter S.L. (2012) An assessment of the vulnerability of Australian forests to the impacts of climate change: Synthesis. Contribution of Work Package 5 to the Forest Vulnerability Assessment (National Climate Change Adaptation Research Facility, Gold Coast).*

4. Bradstock R.A. (2010) A biogeographic model of fire regimes in Australia: current and future implications. Global Ecology and Biogeography 19, 145-158.

5. Bryant R.A. et al. (2014) Psychological outcomes following the Victorian Black Saturday bushfires. Australian and New Zealand Journal of Psychiatry 48, 634–43.

6. Christianson A. (2015) Social science research on Indigenous wildfire management in the 21st century and future research needs. International Journal of Wildland Fire 24, 190-200.

7. Council of Australian Governments (2011) National Strategy for Disaster Resilience: Building the resilience of our nation to disasters (Commonwealth of Australia, Canberra).

8. CSIRO (2015) Climate change in Australia: Information for Australia's natural resource management regions: Technical report (CSIRO and Bureau of Meteorology, Australia).

9. Deloitte Access Economics (2016) The economic cost of the social impact of natural disasters (Australian Business Roundtable for Disaster Resilience & Safer Communities, Australia).

10. Haynes K. et al. (2010) Australian bushfire fatalities 1900-2008: exploring trends in relation to the 'Prepare, stay and defend or leave early' policy. Environmental Science & Policy 13, 185-194.

11. Howes M. et al. (2013) Rethinking disaster risk management and climate change adaptation (National Climate Change Adaptation Research Facility, Gold Coast).*

12. Lucas C. (2007) Bushfire Weather in Southeast Australia: Recent Trends and Projected Climate Change Impacts. Prepared for The Climate Institute Australia (Bushfire CRC and Australian Bureau of Meteorology, Melbourne).

13. McLennan J. et al. (2015) At-risk householders' responses to potential and actual bushfire threat: An analysis of findings from seven Australian post-bushfire interview studies 2009-2014. International Journal of Disaster Risk Reduction 12, 319-327.

14. McNeill I.M. et al. (2015) Predicting delay in residents' decsions on defending vs. evacuating through antecedents of decision avoidance. International Journal of Wildland Fire 24, 153-161.

15. O'Neill S.J. and Handmer J. (2012) Responding to bushfire risk: the need for transformative adaptation. Environmental Research Letters 7, 014018.

16. Parliament of Victoria (2010) 2009 Victorian Bushfires Royal Commission Final Report: Summary (Parliament of Victoria, Melbourne).

17. Parliament of Victoria (2010) Transcript of the Proceedings 2009 Victorian Bushfires Royal Commission (Tuesday 27 April 2010). http://pandora.nla.gov.au/pan/96781/20100923-0223/www.royalcommission.vic.gov.au/getdoc/4e87724e-cf86-40d0-a6b8-7106823a9f31/Transcript_VBRC_Day_155_27-May-2010.pdf

18. Penman T.D. (2015) Reducing the risk of house loss due to wildfires. Environmental Modelling and Software 67, 12-25.

19. Queensland University of Technology (2010) Impacts and adaptation response of infrastructure and communities to heatwaves: the southern Australian experience of 2009 (National Climate Adaptation Research Facility, Gold Coast).*

20. Whittaker J. and Handmer J. (2010) Community bushfire safety: a review of post-Black Saturday research. Australian Journal of Emergency Management 25, 7-13.

21. Whittaker J. et al. (2013) After 'Black Saturday': Adapting to bushfires in a changing climate. In: Natural Disasters and Adaptation to Climate Change (Eds. Boulter S. et al.), pp 75-86 (Cambridge University Press, New York).*

22. Whittaker J. et al. (2015) Gendered responses to the 2009 Black Saturday bushfires in Victoria, Australia. Geographical Research 1-13.*

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