

PREDICTIONS IN PUBLIC: USING QUALITATIVE DATA TO UNDERSTAND THE DESIGN, COMMUNICATION AND DISSEMINATION OF PREDICTIVE MAPS TO THE PUBLIC

Work Package 4: Community perceptions and understanding of incident and predictive maps

Erica Kuligowski¹, Philippa Perry¹, Gita Pupedis¹, Amy Griffin¹, Natasha Mondel-McCann¹, Chloe Begg², Paula Dootson³, Angela Gardner⁴, Timothy Neale⁵, and Graham Dwyer⁶

1. Royal Melbourne Institute of Technology University, VIC, 2. Country Fire Authority, VIC, 3. Queensland University of Technology, QLD, 4. Victorian Department of Education, VIC, 5. Deakin University, VIC, 6. Swinburne University of Technology, VIC





Version	Release history	Date
1.0	Restricted release of document	27/09/2023
1.1	Public release of document	28/01/2025



Australian Government

Natural Hazards Research Australia receives grant funding from the Australian Government.

© Natural Hazards Research Australia, 2025

We acknowledge the Traditional Custodians across all the lands on which we live and work, and we pay our respects to Elders both past, present and emerging. We recognise that these lands and waters have always been places of teaching, research and learning.

All material in this document, except as identified below, is licensed under the Creative Commons Attribution-Non-Commercial 4.0 International Licence.

Material not licensed under the Creative Commons licence:

- Natural Hazards Research Australia logo
- Australian Government logo
- Any other logo
- All photographs
- All figures and graphics

All rights are reserved in content not licenced under the Creative Commons licence. Permission must be sought from the copyright owner to use this material.



Disclaimer:
Country Fire Authority, Victorian Department of Education, Royal Melbourne Institute of Technology University, Queensland University of Technology, Deakin University, Swinburne University of Technology Natural Hazards Research Australia advise that the information contained in this publication/material comprises general statements based on scientific research. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in all circumstances. No reliance or actions must therefore be made on the information contained in this publication/material without seeking prior expert professional, scientific and/or technical advice. To the extent permitted by law, Country Fire Authority, Victorian Department of Education, Royal Melbourne Institute of Technology University, Queensland University of Technology, Deakin University, Swinburne University of Technology and Natural Hazards Research Australia (including its employees and consultants) exclude all liability and responsibility for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this publication/material (in part or in whole) and any information, material, omission, error or inaccuracy contained in it. Country Fire Authority, Victorian Department of Education, Royal Melbourne Institute of Technology University, Queensland University of Technology, Deakin University, Swinburne University of Technology and Natural Hazards Research Australia (including its employees and consultants) make no representation or warranty as to the accuracy, completeness, or reliability of information contained in the publication/material. The information contained in the publication/material is only current at the date of publication. Country Fire Authority, Victorian Department of Education, Royal Melbourne Institute of Technology University, Queensland University of Technology, Deakin University, Swinburne University of Technology and Natural Hazards Research Australia (including its employees and consultants) accept no responsibility to update any person regarding any inaccuracy, omission or change in information in the publication/material or other information made available to a person in connection with the publication/material. By accessing the publication/material you are confirming you have understood and accept the disclaimer as outlined above.

Publisher:
Natural Hazards Research Australia

ISBN: 978-1-923057-19-7

Report number: 38.2025

January 2025

Cover: 01_Credit Matt Palme_Unsplash



Table of contents

Acknowledgements	4
Executive summary	5
End-user statement	9
Introduction	9
Brief background	11
Research approach	12
Recruitment method	12
Interview approach and guide	13
Respondents	14
Data analysis	16
Ethics clearance	16
Results	17
Part 1 – Recent experiences with bushfire	17
First awareness	17
Sources and channels of information – Maps and other information	17
Map usage	19
Challenges with map usage and participant feedback	20
Participant responses to the bushfire	22
Part 2 – Example bushfire maps used in Victoria, NSW/ACT, and Tasmania	24
Map awareness	24
Map features that capture attention	28
Map comprehension	28
Map perceptions of risk	35
Behavioural intentions	38
Map usage	41
Participant feedback and suggestions for improvement	43
Discussion	47
Previous experiences with maps (Part 1)	47
Engagement with example maps (Part 2)	47
Implications for fire spread prediction maps	49
Next steps	52
References	53
Appendix A – Pre-interview Questionnaire	55
Appendix B – Maps and accompanying warning text	58
New South Wales/ Australian Capital Territory Map 1	58



New South Wales/ Australian Capital Territory Map 2	60
Victoria Map 1	61
Victoria Map 2	64
Victoria Map 3	67
Tasmania Map 1	69
Tasmania Map 2	71
Appendix C – Interview Guide	73



Acknowledgements

The project team would like to acknowledge members of the project's Steering Committee of end-users for this Natural Hazards Research Australia-funded project. The researchers thank the member agencies for collaborating on the selected maps and interview guide for this work package and for facilitating collaboration between project team members and local council and fire agencies in each of our three study locations.

The researchers would also like to thank local councils and local fire agency units for their help in finding places to hold interviews and sending out information about the study to participants. Finally, the project team would like to thank the residents from Cardinia Shire, the Huon Valley, southern Australian Capital Territory (ACT) and the Snowy Monaro who shared their experiences of previous fires and perspectives on current incident and fire spread prediction maps with the research team. The authors are forever grateful for their time and their insights on bushfire communication, and in particular, ways to improve incident and prediction maps in future bushfires.



Executive summary

Research in Australia has been conducted on the public's response to risk and warning communication (Dootson et al. 2019; 2021). However, less research effort has focused exclusively on maps and even less has focused on fire spread prediction maps in an Australian context. The purpose of this research is to assess the extent to which community members use, comprehend, perceive, and act upon maps, including incident and fire spread prediction maps in bushfires.

In collaboration with the project's Steering Committee, we identified three locations across Australia that recently experienced a bushfire event and were willing to work with us on this project. These locations were: Cardinia Shire, Victoria (the 2019 Bunyip Complex fires); Southern ACT and Snowy Monaro Regional Council, New South Wales (NSW) (2019-2020 Black Summer fires); and the Huon Valley Council, Tasmania (2019 Riveaux Road fire). Across the three locations, we interviewed 94 participants using a semi-structured interview technique. The interviews explored community residents' use, comprehension, perceptions, and actions in response to bushfire maps, including fire spread prediction maps, in two scenarios: 1) during their previous experiences in actual fire events; and 2) when shown two types of maps and associated warning messages relevant to their state/location during the interview. All recorded interviews were transcribed, and we used qualitative data analysis methods to organise and analyse the interview data (i.e., the transcripts).

Part 1: Previous Experience with Maps

In the first part of the interview, residents were asked about a recent experience with a bushfire, including the types of information they received and what they did in response to that information and how bushfire maps played a role in their decision-making (if at all). See Appendix A for the pre-interview questionnaire and Appendix C for the interview guide. The findings of Part 1 are summarised, below.

Across all three locations, people were first made aware of the fire event via a number of means, including both physical and social cues. However, first awareness was complicated by the many fires to which they were exposed over the course of that fire season.

Throughout the event, residents used different types of maps on a fairly frequent basis, including maps from:

- Local fire agencies (accessed via the agency's app or website),
- The Bureau of Meteorology,
- Google, and
- Third-party weather or hazard mapping platforms, like the Windy app, DEA hotspots map, and bushfire.io.

People checked maps more often during certain periods, including when the fire hadn't spread to them yet (for early information) or during the event, e.g., when the fire was moving faster. Many participants used maps on a frequent basis, even mentioning using them between 20 to 50 times per day. However, at some point, constant checking like this could restrict people from doing other necessary actions and therefore, may be reduced by clearly communicating when map updates are likely to occur.

Maps were only one tool in their information 'toolbox', since they often used maps in combination with other information sources provided via different sources and channels. One such example were community meetings, where residents had an opportunity to view the maps and listen to fire agency experts explain the maps in more detail.

Participants used maps for different purposes. These included:

- To self-localise, or identify where they were in relation to the fire event;
- Gather information about the fire event (i.e., fire and weather conditions) and what to do next;
- Monitor the extent or rate of spread using the burnt area;
- Cross-reference map information with other sources;
- Confirm or explain the physical cues that they were seeing around them (however, residents also consulted trusted sources to confirm what they saw on the map);
- Make judgements about fire spread predictions and risk levels;
- Inform or warn others who may be at risk; and



- Monitor the impact of the fire on their or others' properties (e.g., after they evacuated).

Participants encountered several challenges with bushfire maps during their experiences. These included issues with:

- Timely information (e.g., maps that were slow to update or didn't change for longer periods of time);
- Missing information;
- Inconsistent information across sources, platforms, and geographical boundaries;
- Inaccurate information; and
- Inaccessibility of map information (either due to internet/coverage, device, usability, or comprehension issues).

Those who constantly checked the maps were searching for updates, noting that they understood how fast fires can move and therefore, wanted to receive regularly updated information. A lack of timely information can leave participants confused about the state of the event, and often, when lacking information, respondents looked for additional information themselves.

Also, inconsistency of information across multiple map sources, platforms and geographical borders can create confusion and decisions to be postponed. In these instances, some maps provided different information (and sometimes more up-to-date information) than other map sources or platforms, making it difficult to understand which one was more accurate. Where participants could decipher which source or platform was timelier than others, they lost confidence in the maps displaying old or potentially inaccurate information.

A number of improvements were suggested by residents. Among these, participants expressed a strong interest in fire spread predictions and their associated confidence intervals being communicated in future bushfire maps (i.e., how the fire might spread over time). People also wanted information on:

- The current locations of the fire, including the fire front;
- Wind speed and direction;
- The type of fire and its intensity levels;
- The burnt areas and their spatial accuracy;
- Road closures; and
- The time of the last update and/or expiry time for the map and how often the maps would update.

Residents responded in different ways to protect themselves and their loved ones, based on the information provided to them, including maps. Those who evacuated mentioned the one cue or piece of information that prompted them to go. In addition to being told to evacuate by emergency officials and members of their social network, people were also prompted to leave by witnessing intense physical cues (e.g., heavy smoke or ember showers) and receiving or inferring information about the bushfire's movement (likely provided by maps).

Part 2: Example maps used in Victoria, NSW/ACT, and Tasmania

In Part 2 of the interview, participants examined two different types of bushfire maps. The interviewer asked them to describe what they saw; what captured their attention; what they thought the map was telling them; which areas were at the highest risk of harm and what people in those high-risk locations should do; and how useful the map would be in a bushfire event, whether they had confidence in the information provided, and what additional information or improvements they would suggest for the map. Appendix B shows the maps that were used in the study for each of the three locations, with the accompanying warning information. The findings from Part 2 are summarised, below.

Regarding map awareness, participants were mostly familiar with the maps shown to them during this part of the interview. Additionally, various types of map features captured their attention first, including warning polygons or red shaded areas and the grey or blackened areas. Respondents also interpreted the maps' symbols and features in different ways across all maps and locations. Comprehension issues included confusion about the triangle symbology (e.g., NSW/ACT Map 1), the meaning of the triangle location (across all study areas), the risks associated with grey/burnt areas (e.g., NSW/ACT and Victoria Map 2), the meaning of the warning polygons (e.g., Tasmanian maps), and the risks across the entire 'fire spread' or 'impact zone' areas (e.g., Victoria Map 2).



In terms of risk assessments, none of the maps facilitated participants in unanimously identifying one location of highest risk. Additionally, some respondents even noted that the maps did not provide them with sufficient information to make that assessment. Overall, the types of areas identified as risky often included warning areas or polygons (with the highest risk level), areas of potential fire spread, and areas with the highest number of fires in one location. Also, based on their risk assessments but regardless of map type, participants often identified a similar set of behavioural responses for those located in the risky areas: 1) evacuating the area if it was safe to do so and routes were available, 2) staying and defending, or 3) in lieu of a specific response, following the actions specified in their household bushfire plan.

Participants stated the reasons that they would use maps (regardless of map type – i.e., incident or prediction map). These included the following:

- to identify risk levels and/or where the risk was located (including where they were in relation to those locations, where possible),
- to make decisions about protective actions (e.g., whether to stay/go or to avoid the area if located elsewhere), and
- to identify possible routes out of the area and the safe areas to travel.

For fire spread prediction maps in particular, participants also stated that they would use them to monitor the fire spread over time (i.e., NSW/ACT Map 2) or were uncertain how they would use them since they covered such a large area and contained less local detail (i.e., Victoria Map 2). Some residents noted that they could use the prediction maps in conjunction with the local-area incident maps to make decisions on how to protect themselves. They also highlighted the importance of the base map information for context, and in particular, the ability for map users to locate themselves and understand their risk or the risk to others based on the mapped fire event.

In terms of feedback on the maps, participants expressed both higher and lower levels of confidence in specific maps based on a number of criteria. For example, residents linked higher levels of confidence with higher levels of trust in the map source and a higher understanding of the inherent uncertainty in bushfire maps products. On the other hand, participants expressed lower levels of confidence when they perceived the map information as out-dated, the maps lacked sufficient information or detail, information on the map was confusing, or the maps were too general in scale (and did not provide localised information). Finally, regardless of location, participants recognised the need to confirm the map's message with other sources of information before they could trust the information. This need for confirmation falls in line with warning research in hazards and disasters.

Across all maps, participants wanted more information. The two main types of information that residents requested were: wayfinding and navigation information and information on environmental conditions. Within wayfinding and navigation, participants requested the following:

- Information to assist them with self-localisation (e.g., city/town names, names of landmarks, topographic information, parks, road names, etc.),
- Traffic information and road closures,
- Evacuation options and safe refuge locations.

Information on environmental conditions included:

- Fire size/scale, intensity, activity (including burnt areas), location, spread and direction;
- Weather forecasts;
- Emergency response information.

While additional information can provide clarity, participants also requested map features that would improve use and comprehension, including a scale bar, compass, legend, increased resolution, and clear colouring. Colouring on maps can become problematic if the colours are too close in shade to other colours, they interfere with (or are indistinguishable from) other areas on the map, and/or are inconsistent with the other colour/rating systems for bushfires and other emergencies.

However, the inclusion of new information in future bushfire maps may be dependent on the map type and purpose. Wayfinding information like route status, evacuation options and safe areas for refuge might be better suited on a more localised incident map (e.g., Victoria Map 1) rather than a larger-scale, state-wide prediction map (e.g., NSW/ACT Map 2). The same can be said for emergency response information. It will be important for residents to understand the purpose of the landscape-wide prediction maps (i.e., to communicate risk on a broader scale), and to look to other mapping platforms (e.g., state agency hazard incident maps) for localised information to make appropriate protective action decisions.



Considering when and how to include this new information is important, since participants were overwhelmingly observed to infer the missing information themselves when it wasn't provided to them. Participants made inferences about future fire spread predictions in order to understand their fire risk, including the direction of fire spread; fire locations, including the location of the fire front; weather or wind conditions; and the scale of the event, the extent of damage and the resources required. In some cases, these assumptions may not be accurate. Overall, ***when desired information is not provided to participants, they will look for it elsewhere. In such cases, they will fill in the gaps with their own knowledge and/or experience, which may not always lead to accurate conclusions.***

Our findings have important implications for fire map design. In particular, for fire spread prediction maps, these findings highlight the importance of ensuring that map readers can understand their location in relation to the risk (i.e., self-localise). Additionally, participants provided a number of suggestions on ways to communicate the direction of fire spread in simple ways and include important information on the fire front and locations of fire activity (to assist them in understanding the risk and making the best protective action decisions for themselves and their loved ones). Participants also provided suggestions on different ways that fire spread prediction maps could clearly communicate risk and uncertainty, to be tested in Phase 2 of this project via laboratory experiments, surveys and focus groups.



End-user statement

Marc Unsworth, Lead Officer, Operational Communication Capability, Emergency Management Victoria, VIC

Bushfire maps, including incident and fire spread prediction maps, are a critical tool in communicating life-saving emergency information to the Australian public during bushfires. However, limited empirical evidence and guidance exist on appropriate predictive map design and use during bushfire events, especially in an Australian context. The research findings presented in this report provide a unique opportunity to understand how members of selected communities in Victoria, NSW/ACT and Tasmania use, comprehend, perceive, and act upon bushfire maps and associated warning messages. With findings from this research, in combination with the findings from other work packages within NHRA's Predictions in Public project, emergency and fire services agencies can design bushfire predictive maps and associated warnings to meet the needs of communities during fire events. This research can assist us in designing and disseminating maps to guide safe and effective early protective action decision-making in affected communities, and in turn, better protect people from injury and loss of life. Also, these and future findings from this NHRA project will be instrumental in the development of evidence-based guidelines and recommendations for how to design, communicate, and disseminate fire spread prediction maps to Australian communities exposed to bushfires.



Introduction

This research is a component of a wider program of research called *Predictions in public: understanding the design, communication and dissemination of predictive maps to the public* (Predictions in Public project).¹ The overall aim of the Predictions in Public research program is to optimise predictive map design and dissemination to ensure that these maps will support community protective action decision-making during a bushfire event. The research program objectives are:

- **Objective 1:** To understand how members of the fire and emergency services sector would prefer predictive maps to be distributed and used by members of the public.
- **Objective 2:** To understand how members of the public use, comprehend, perceive, and take-action in response to existing predictive map designs and other types of maps used by agencies across Australia.
- **Objective 3:** To develop a set of evidence-based guidelines/principles for the design and dissemination of predictive maps to the public based on existing research on hazard mapping.
- **Objective 4:** To work with the fire and emergency services sector to develop practical project outputs to translate the research findings into fire agency policy and practice.

The research program has three phases:

- **Phase One:** Existing agency use and public awareness of predictive service products in public information and warnings
- **Phase Two:** Standardised design, dissemination, and communication for predictive maps
- **Phase Three:** Communication, evaluation, and learning framework

The research project reported here is Work Package 4 in Phase 1 of the program. It addresses Objective 2, assessing the extent to which community members use, comprehend, perceive, and act upon bushfire maps and associated warning messages, including fire spread prediction maps.

¹ See <https://www.naturalhazards.com.au/research/research-projects/predictions-public-understanding-design-communication-and-dissemination>



Brief background

The 2019-2020 bushfire season was the first time that New South Wales (NSW) and the Australian Capital Territory (ACT) fire authorities disseminated fire spread prediction maps (or “red maps”) to the public (Owens & O’Kane, 2020). Other fire agencies have released similar maps previously, but only on an ad hoc basis, and Victorian fire agencies have sometimes released maps of potential impact zones (for example in East Gippsland during the 2019/2020 season). The novelty and popularity of these predictive products has prompted a growing interest in agencies across Australia, and in particular, the AFAC National Working Group for Public Information and Warnings (Warnings Group) and AFAC Predictive Services Group, to better understand how the public received, interpreted, and acted on these maps, and where/when these maps would be useful in the future.

The Bushfire and Natural Hazard CRC-funded Black Summer project, “Established and Emerging Users of Predictive Services in Victoria” found that there is much support amongst operations staff in Victoria for the dissemination of fire spread prediction maps to the public (Begg et al., 2021). Further, recent post-event inquiries have recommended greater use of fire spread predictions in public messaging (Government of South Australia, 2020; Neale & May, 2018; Owens & O’Kane, 2020). However, the translation of inquiry recommendations and internal support into action remains challenging, especially without evidence-based guidelines on: 1) how predictive maps should be designed and communicated, and 2) how and when they should be disseminated to the public. To develop such guidelines, a clear understanding of how community members use, comprehend, perceive, and act upon fire spread prediction maps is necessary; however, studies that provide such an understanding are missing from the literature, especially in an Australian context.

It is widely acknowledged that people’s decisions on how to protect themselves and others against the threats posed by fires is the result of a process (Lindell & Perry, 2012). The Protective Action Decision Model (PADM), a theory upon which we draw in this study, purports that individuals respond to fires and other hazards based on a series of pre-decisional and decisional processes. The model explains that once individuals are exposed to cues and information from their environment, they engage in pre-decisional processes requiring that they receive, pay attention to and comprehend the information before acting upon it. In addition, people must also perceive the threat and risk associated with the fire, as well as hold certain beliefs about the effectiveness of particular protective actions before deciding how and when to respond.

Hazard maps have the potential to increase comprehension and risk perception levels, and prompt safe and effective action by conveying spatial information in particular ways. While numerous researchers have expressed the need to explore the potential role of hazard maps in risk communication (Dransch et al., 2010; Maidl & Buchecker, 2015), only a few studies have explored the effectiveness of hazard maps for communicating bushfire warning information to the public; e.g., (Cao et al., 2016, 2017; Cheong et al., 2016). None have explored the role of displaying fire spread prediction maps in the protective action decision-making process. Therefore, the extent to which bushfire maps inform comprehension, risk perception and decision-making remains largely unknown.

In order to determine which maps will be most effective at communicating risks and eliciting a safe response, map makers need to understand the ways in which people use and understand map features and think about and respond to risky situations. This report discusses the findings from interviews conducted with members of the public to better understand how they use, comprehend, perceive, and take-action in response to existing incident maps and fire spread prediction maps used by fire and emergency agencies across Australia. These and future findings from this project will be used to develop evidence-based guidelines and recommendations for how to design, communicate, and disseminate fire spread prediction maps to Australian communities exposed to bushfires.



Research approach

We conducted this qualitative and interpretive research project in three locations across Australia that recently experienced a bushfire event: Cardinia Shire, Victoria (the 2019 Bunyip Complex fires); Southern ACT and Snowy Monaro Regional Council, NSW (2019-2020 Black Summer fires); and the Huon Valley Council, Tasmania (2019 Riveaux Road fire). We interviewed 94 participants across three locations using a semi-structured interview technique. The interviews explored the extent to which community residents used, comprehended, perceived, and acted upon bushfire maps, including fire spread prediction maps, in two scenarios: 1) during their previous experiences in actual fire events; and 2) when shown two types of maps and associated warning messages relevant to their state/location during the interview. The following sections explain the research approach and methods, including recruitment, the interview process, respondents, and data analyses.

Recruitment method

We developed a process to select three locations (local councils or shires) in Australia within which we would conduct the interviews. Our selection of participants is an example of purposeful sampling since we targeted communities identified by expert practitioners where residents were knowledgeable and experienced in key areas relevant to our study (Patton, 2015). We aimed to interview community members in three different states/territories to capture potential differences in map design across jurisdictions. Our criteria for selecting the three states/territories included:

- **Levels of ‘maturity’ with map development:** States/territories we chose differed on their levels of maturity regarding map development and dissemination to the public. We defined level of maturity as the number of years certain incident mapping platforms have been in use and whether or not (yes/no) fire spread prediction maps are disseminated to the public. This criterion allowed us to interview populations that have been exposed to different types of maps as well as different levels of complexity in map design. Since we were interested in interviewing community members about their experiences with bushfire maps during previous fires, we decided to select states/territories that had higher levels of maturity with map development.
- **New insights:** We wanted to choose states/territories where bushfire maps have not yet been studied. This criterion allowed us to contribute to the scientific literature and fill current research gaps.
- **Logistics/Engagement:** We also considered choosing states/territories based on their level of engagement within the project’s design (e.g., two members of the project team are Victorian state government employees (Dr. Chloe Begg, Country Fire Authority and Ms. Angela Gardner, Vic Department of Education)).

Based on these criteria, we chose Victoria because it ranked highly on ‘maturity’ with map development, new insights (since map use had not been studied there), and engagement in project’s development. We chose NSW/ACT because they also ranked highly on ‘maturity’ with map development (i.e., they are one of the few locations that have released fire spread prediction maps to the public) and the inclusion of neighbouring locations in the ACT would offer new insights to the project. Finally, we selected Tasmania due to its mid-level ranking in ‘maturity’ with map development (compared with Victoria and NSW/ACT) and its potential to provide new insights to this project.

Once we selected the states/territories, the project team worked closely with members of the project steering committee to identify shires within each of the chosen jurisdictions that: 1) had experienced a recent fire that affected people, in that the fire exposed the population to potential harm; 2) had not been ‘over-researched’ regarding bushfires or floods; and 3) had received sufficient media coverage and/or reporting to allow the team to understand the context surrounding the fire before conducting interviews. From these collaborative efforts with our project’s Steering Committee, we selected Cardinia Shire, Victoria; Southern ACT and Snowy Monaro Regional Council, NSW; and the Huon Valley Council in Tasmania as our study locations.

We developed and initiated a comprehensive recruitment approach within each location. We co-designed all recruitment materials with the local council and fire agencies before dissemination to residents. We advertised the study via local media (radio and newspapers), social media (e.g., local Facebook groups and via



NHRA's social media channels), emails from the local council and fire agencies, letter drops, posters, and in-person community meetings (attended by the project team). We also asked interviewees to let others in their social networks know about our study (i.e., conducted snowball sampling).

Our recruitment materials encouraged prospective participants to contact the research team to express their interest in participating. This could be done by directly contacting our team or registering their interest via a survey hosted online using the Qualtrics software platform. Potential participants accessed the Qualtrics survey by clicking a link in a social media post, scanning a QR code or typing in a URL available on the promotional materials. Once directed to the survey, an overview page was presented, informing prospective participants about the research, and outlining the timing and locations of interviews for each state and territory. The Qualtrics survey advised participants that they could book an interview through the online booking system or request that a research team member contact them to arrange an interview. Once past the first page, participants were directed to a screening page where they were asked two screening questions:

1) *Can you recall a recent experience (maybe in the last 3 or 4 years) where you were in an area threatened by a bushfire?*

2) *Are you 18 years or older?*

If prospective participants answered 'yes' to both questions, the survey directed them to a participant information page, which provided further details about the interview process and the voluntary and confidential nature of the interviews. Upon expressing interest in taking part, eligible participants were directed to the remainder of the survey, where they provided their first and last name, phone number and email address as well as their preferences for future correspondence in terms of the best time of day and whether they preferred to be contacted via phone or email. Participants then selected whether they would prefer a face-to-face or online interview and identified their state or territory. Their responses directed them to the appropriate booking page containing an embedded link to the online scheduling system. The online scheduling system was configured using the Appointlet online scheduling app, enabling participants and interviewers to manage their bookings directly.

On the booking page, participants could pick a location, time, and date from the available times to proceed with their booking or check a box indicating they wanted to be contacted by one of the RMIT researchers. The intake form collected the information required for the meeting: the participants' first and last names. Their phone number was also collected so the interviewer could send a confirmation text the day before the interview. Once the participants completed the booking, they received a confirmation email from Appointlet with meeting instructions, including a link to the Microsoft Teams meeting and guidance about accessing and joining the meeting if undertaking an online interview. This email contained a link to their booking, allowing the participant to reschedule or cancel their interview.

Once the participants completed the booking page in the survey, they were thanked for taking the time to register and advised that they would receive an email containing the participant consent form in the coming days. We configured the survey to send an email with the participant information sheet and consent form to the participant once the survey was completed. We also provided participants with the researchers' contact details, a link to the project page, and an opportunity to leave comments.

A total of 88 in-person and virtual interviews took place from 28 November 2022 – 18 April 2023. Since in six instances married couples were interviewed together, a total of 94 people were interviewed across the following three study areas:

- Victoria – 33 Cardinia Shire residents (30 interviews, 25 in person and 5 online)
- Tasmania – 32 Huon Valley Council residents (30 interviews, 26 in person and 4 online)
- NSW/ACT – 29 Southern ACT and Snowy Monaro Regional Council residents (28 interviews – 24 from NSW, 11 of which were online, and 4 from the ACT, 1 of which was online)

Interview approach and guide

Each participant engaged in one interview lasting approximately one hour in length - either in person or over the phone/online. Before the interview, participants filled out a short questionnaire that asked questions about their demographic characteristics, past experiences, perceptions of bushfire risk, and familiarity with maps. A copy of the questionnaire is included in Appendix A.

The semi-structured interview consisted of two parts. During Part 1 of the interview, the participant answered questions about a recent experience with bushfire (including the types of information they received



and what they did in response to that information) and how bushfire maps played a role in their decision-making (if at all). In Part 2 of the interview, participants examined two different types of bushfire maps. The interviewer asked them to describe what they saw; what captured their attention; what they thought the map was telling them; which areas were at the highest risk of harm and what people in those high-risk locations should do; and how useful the map would be in a bushfire event, whether they had confidence in the information provided, and what additional information or improvements they would suggest for the map.

The maps that participants examined in Part 2 were provided by the state/territory representatives on our project's Steering Committee and were relevant to that state/territory. In most cases (other than the NSW/ACT maps – because they encompassed such a large area), these maps did not contain the shire/LGA locations chosen for our study. Instead, the maps were developed as mock-ups of a bushfire in another location within their state to reduce the potential that interview responses drew on geographical or location-based knowledge and to reduce any potential trauma associated with seeing a map depicting a bushfire in their current location. Appendix B shows the maps that were used in the study, with the accompanying warning information. A copy of the interview guide is included in Appendix C.

In Victoria, participants also examined a third map in between Maps 1 and 2 (see Appendix B, Victoria Map 3). While participants viewed this map, the interviewer asked them to answer the following two questions to test if the extreme heat map prompted additional perspectives on risk:

- What do you notice on this map?
- How does it impact (if at all) your understanding of your overall risk and what people should do?

Respondents

Table 1 provides information about the 94 participants², including our sample's demographics, familiarity with maps, involvement with the emergency services, and their experience with mitigation actions prior to the bushfire. Across our entire sample, 50% of our participants were women and 50% were men. However, the proportions of men and women varied by location, with more men than women in NSW/ACT and more women than men in Tasmania. In Victoria, we had an even split of men and women in our sample.

Additionally, the sample skewed slightly older across all locations, with only 10% of our sample aged 35-44 years old. Even after attempting to recruit younger participants (e.g., via targeted Facebook ads), we were unable to recruit individuals aged 18-34 years for this study. When comparing our sample age ranges with data from the Australian Bureau of Statistics (2021), we note that the median age in Huon Valley Council [46 years] and Snowy Monaro Regional Council [43 years] is slightly higher than in Cardinia Shire [34 years].

Table 1 also shows that the majority of our sample (over 50%) had at least a Bachelor's degree and were frequent users (either daily or weekly) of any type of map, not specific to bushfires. When we asked whether they or anyone in their household was a current or previous member of an emergency service agency, 39% of our sample said yes. This also varied by location, in that a majority of our sample from NSW/ACT was intimately familiar with the emergency services. Finally, Table 1 shows that the majority of our sample, across all locations, had modified their home or land in some way to protect from bushfires.

Additionally, although not displayed in Table 1, our participants had extensive experience with previous bushfires, with 40% stating that they had been in at least five bushfires before the 2019-2020 fires. At least 60% had evacuated at least once due to bushfire and 40% had experienced some type of damage to their property/home prior to their most recent bushfire experience.

² Since participants may not have filled out all questions on the questionnaire, the numbers in Table 1 do not always add up to the total number of participants in each location.



Table 1: Summary statistics of the study's sample by variable and location

	Entire Sample		Victoria		NSW/ACT		Tasmania	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Gender								
Female	47	50	17	52	10	34	20	63
Male	47	50	16	48	19	66	12	38
Age								
18-24	0	0	0	0	0	0	0	0
25-34	0	0	0	0	0	0	0	0
35-44	9	10	2	6	3	12	4	13
45-54	12	13	2	6	3	12	7	22
55-64	34	37	12	36	11	44	11	34
65-74	25	27	10	30	6	24	9	28
75 or older	11	12	7	21	2	8	1	3
Education level								
Left school before Year 10	2	2	0	0	0	0	2	6
Completed High School Year 10	10	11	3	9	2	7	5	16
Completed High School Year 12	7	8	4	12	1	4	2	6
TAFE Qualification	18	20	5	15	9	33	4	13
Bachelor's Degree	31	34	11	33	9	33	11	34
Postgraduate Degree	24	26	10	30	6	22	8	25
Frequency of prior map use								
Daily	50	54	13	39	19	70	18	56
Weekly	27	29	14	42	7	26	6	19
Monthly	8	9	3	9	1	4	4	13
Yearly	2	2	1	3	0	0	1	3
Never	5	5	2	6	0	0	3	9
Emergency Services involvement								
Yes	39	42	12	36	18	67	9	28
No	53	58	21	64	9	33	23	72
Mitigation before the fire								
Yes	76	84	27	84	21	78	28	88
No	15	16	5	16	6	22	4	13



Data analysis

We used qualitative data analysis methods to organise and analyse the interview data. Almost all participants agreed to audio record their interview. These recordings were transcribed by a professional transcription company. As a first step to analyse the transcript data, we developed two initial sets of codes based on the questions in the interview guide; separate sets of codes for Parts 1 and 2. We revised the initial sets of codes after reviewing all the transcripts to add emergent codes to capture topics that participants discussed but were not specifically asked about in the interview guide. We developed a code book listing the codes, the definition of each code, and examples of where the code might be used to tag transcript data. Overall, our analysis was interpretive which meant that we drew on descriptive, analytical and inferential coding.

Next, three members of the research team began coding the transcripts for one state (Victoria). The team included two people who had conducted the interviews and one team member who had not conducted any interviews. During the coding process, the team met weekly to discuss the code list and if revisions or additions were required. In some cases, the team merged a few codes (if they were overlapping in purpose) and in others, codes were added or revised. The coders finalized the code list after coding 5-10 interviews for each state.

Intercoder reliability was also important during this process. Our team followed systematic processes for intercoder reliability of qualitative data, including having a minimum of two coders, at least one coder who was removed from data collection, at least one coder who had experience with coding qualitative data, and multiple coders who reviewed and coded the transcripts in each location. Additionally, all three coders focused on achieving a shared meaning of the codes through consensus (Cofie et al., 2022).

After completing the initial round of coding with the primary codes, two of the three coding team members reviewed the transcript data collected within each code and identified themes. In some cases, sub-coding was required to identify themes and in others, the data captured by the primary code was sufficient to identify larger trends. Team members also identified archetypal quotes from participants that explain and illustrate these themes. In this report, we present the findings from this analysis, and in particular, the themes explaining how participants used and made decisions based upon maps during an actual bushfire event and participants' understanding and perceptions of risk when viewing two maps relevant to the location depicted in a hypothetical scenario.

Ethics clearance

The RMIT ethics approval number for this research project is 25509. Since we were asking participants about previous experiences with fires, and those experiences could bring up past or present trauma associated with the events, we trained interviewers on how to interview disaster survivors and recognise participant discomfort during the interview process. We provided all interviewees with resources from the Australian Red Cross³ should they require support following the interview. Project team members also engaged in debriefing sessions to discuss particularly difficult interviews and were made aware of the resources available inside and outside of RMIT University for additional support.

³ Looking After Yourself and Your Family After a Disaster: https://www.redcross.org.au/globalassets/cms-assets/documents/learn/lookingafteryourselfandyourfamilyafterdisaster_1.pdf



Results

This section of the report presents the findings from both Part 1 and Part 2 of the interviews. The findings from Part 1 are presented first followed by the findings from Part 2.

Part 1 – Recent experiences with bushfire

The findings from Part 1, where participants discussed their experiences with bushfires in 2019 and 2020, are presented in this section. The section begins with exploring how people were first made aware of the fire event, followed by the different sources and channels of information they received (including maps), and how participants used maps during the fire. Then we discuss the challenges that participants encountered while using maps and their suggestions for improvements. This section ends with a description of how residents responded to the fire event, including how they protected themselves and their families.

First awareness

We first asked participants across the three states/territories how they were made aware of the bushfire that eventually impacted their location. Participants relayed that first awareness occurred through a variety of means, including from both physical and social cues. Across the three study locations, participants reported that witnessing physical cues like smoke, lightning strikes, spot fires and even flames nearby alerted them to the impending fire. Participants were also made aware of the fire by witnessing emergency response crews and vehicles responding to the event (either passing by their homes or as they were driving around their neighbourhood). Social cues also provided first awareness, particularly receiving alerts and warnings from their emergency services app or website and/or hearing about the fire from local media, social media, and neighbours, friends, and family. A resident in Victoria recalled that: *“the Vic Alert app...it “dinged”. I had it set to notify me if there was a fire or any emergency in a certain area.”* (A2).

In many locations, however, identifying a cue or series of cues that provided first awareness wasn't a simple exercise. For many respondents, fires were burning all around them throughout the fire season, and therefore, they were already monitoring the situation. In addition, it was often a combination of cues (both physical and social) that provided awareness of the event. Some described their continual movement across information sources and platforms; for example, witnessing a physical cue and then confirming that cue with additional information from apps, websites, and/or media sources. Another example was seeing information about the fire on the news and then getting a phone call from a loved one. A participant in Tasmania stated that:

“I first became aware of it just from probably the smell of smoke, then going onto the Tas Fire website to see where the smell of smoke was coming from. That's what we all do down here; as soon as we smell smoke, we go straight on to the TFS website and have a look [laughing], as you would if you lived in any regional area surrounded by mountains and trees.” (B31)

Participants then discussed the types of additional information that they received, including information about the bushfire, warning information, and what to do next.

Sources and channels of information – Maps and other information

A majority of participants used maps during their recent bushfire experience. Since we did not restrict our discussion to bushfire maps only, participants talked about using different types of maps, including maps showing warning information, fire spread predictions, bushfire hotspot locations, road closures, fire fighter operations, lightning strikes, weather information, and electricity outages. Several different mapping platforms were used to obtain this information. Participants in all locations mentioned using maps posted by their local fire agency (either on the agency's app or website). Additionally, participants, especially in Tasmania, mentioned using maps provided by the Bureau of Meteorology. The use of Google Maps was also widespread across the sample locations.

There were some differences in map usage across Victoria, NSW/ACT and Tasmania. In Victoria, most participants mentioned accessing maps from the VicEmergency app or the Country Fire Authority (CFA) website, either on their computers or phones. Additionally, some participants mentioned accessing maps from community Facebook pages: *“The ones that I saw on Facebook were ones that people had screenshotted off the VicEmergency and shared to Facebook for those that didn't have the VicEmergency app”* (A8). One



Victorian participant mentioned accessing information on electrical outages via the AusNet outages mapping platform.⁴ This participant had an app on their phone that would alert them when the power went out in their area.

In NSW/ACT, most respondents obtained information from fire agency apps and websites, including the Fires Near Me app, ACT's Emergency Services website, and the Rural Fire Service (RFS) website in NSW. Some who were monitoring the fire on the border between NSW and Victoria also used the VicEmergency app. One respondent in NSW downloaded multiple state/territory agency apps to their phone as the fires spread around them:

"I was keeping an eye on the Fires Near Me app as well, and then when the Victorian ones got bad, I downloaded the Victorian app, and then Canberra set fire so I downloaded their app and tried to keep track of what their fires were doing." (C28)

A few NSW/ACT residents mentioned their use of the bushfire.io mapping platform. Bushfire.io⁵ is a platform that began during the 2019-2020 bushfire season and provides mapping information via a web browser or mobile device application. It has evolved over the years to map information on a number of different hazards, and provides additional information, e.g., "3D wind" (wind direction superimposed on a 3D depiction of the terrain), via overlays. A few residents also mentioned the Windy app⁶ (a third-party weather app that can be downloaded on devices) and Digital Earth Australia (DEA) hotspots map⁷ (a national bushfire monitoring system produced by Geoscience Australia in collaboration with Digital Earth Australia, Landgate and the Western Australian government).

In Tasmania, the majority of participants mentioned accessing information on the bushfire via the Tasmanian Fire Service website. However, that was in conjunction with a number of other platforms, including the Windy app, DEA hotspots, the Bureau of Meteorology (including their lightning map), and maps displayed by ABC News. One person even mentioned consulting a map via a real estate website to understand the road network surrounding their location.

Across all three locations, participants spoke positively about community meetings. It was during these meetings that they had an opportunity to view agency maps and listen to experts explain the maps in terms of past, current, and future (i.e., predicted) bushfire conditions. Experts also provided information on weather conditions and predictions as well as identifying the safer places to travel and/or the places of last resort. Participants described these interactions as informative and reassuring. A participant in Tasmania mentioned that the community meetings provided helpful explanations that increased confidence in the information:

"a lot of the information about how good their maps were, came from outside of the map because you could relate what they were telling you to what the map was showing. There was a lot of information that wasn't per se on the map but because over time you got external information and watched the map develop, your confidence in it was high." (B30)

However, maps were seen by our respondents as 'one tool in the toolbox' of information sources to access and use when making decisions. As the bushfire spread, participants obtained additional information from a variety of sources and channels (over and above bushfire maps). A respondent from Tasmania described their usage of maps among all of the information sources available to them: *"it was again, this on-and-off and on-and-off routine and you ended up being quite obsessed in the end of checking alerts, checking maps, listening to ABC, phoning everybody, messaging everybody"* (B24).

Participants mentioned several other sources of information, including the following:

- Searching for the fire themselves (e.g., by driving around their neighbourhood and/or travelling to outlooks to get a better view of the fire);
- Speaking with emergency services' contacts – either via phone or walking/travelling to the local fire sheds for one-on-one conversations about the event;
- Obtaining access to radio communications (including via the scanner app);

⁴ <https://www.outagetracker.com.au/>

⁵ <https://bushfire.io/>

⁶ <https://windy.app/>

⁷ <https://hotspots.dea.ga.gov.au/>



- Tuning into local media (e.g., the ABC local radio station), especially in cases where mobile phone service and/or internet service was patchy; and
- Contacting neighbours, friends, and/or family, including via Facebook community groups or WhatsApp groups. One participant in Tasmania noted that:

“Our neighbours – we all got together; there’s about five of us – we all went and bought walkie-talkies and so that was our communication as to if someone went into town, they could find out information and then pass it on to the rest of us.” (B7)

Overall, participants obtained multiple sources of information via multiple channels during the bushfire event. However, trust in these sources influenced what respondents did next, and depending upon the participant, some sources of information were trusted more than others. For example, local media and social media community pages were trusted more often than mainstream media and social media posts. Information they considered trustworthy was also received via official authorities, e.g., NSW RFS Twitter posts, as well as personal social networks, which consistently kept participants informed throughout the event.

Map usage

Study participants used bushfire maps and other types of maps for different purposes. A common theme when viewing maps was participants’ interest in locating themselves in relation to the fire, topography, vegetation, and other key locations (e.g., roadways and water bodies). In these cases, also referred to as self-localisation, participants viewed the map to identify their current location and the location of the bushfire (or the bushfire front) as well as other key landmarks, to assess their risk. A participant in Tasmania noted that:

“... the best map that I actually started looking at was at the DEA hot spot map of Australia and that was fantastic because I could really drill in and actually see where the fires are in relation to our property because we were never really sure about how close they were, and wind direction, and of course fires can move pretty quick.” (B13)

Maps were also used to gather information about the bushfire event. The information that participants gleaned from the maps depended upon their location, and in turn, the maps that they consulted and/or had access to within that location. Across the sample, participants used maps to gather information about the bushfire itself, i.e., the boundaries of the bushfire and/or the bushfire extent, how close the bushfire was to their location, the active fire areas (including the bushfire front), and what areas had burnt. They also used maps to obtain information on the weather and wind conditions.

People looked to maps to try to understand what to do next. This included obtaining information on the level of threat/risk, the alert or warning level for different locations, instructions on what to do, locations of safe areas, and road information. Finally, they used maps to obtain information on firefighting resources and efforts, including the locations of firefighting aircraft, responding agencies, the number of units responding, water facilities, and other similar information.

Oftentimes, participants would revisit the map or set of maps several times during the event to monitor the extent of fire spread and to understand the fire’s spread rate and direction. They often did this by monitoring screenshots of the burnt area from updates of the map over time; i.e., a form of ‘map hacking’ used to increase the capabilities of the map beyond those provided by the mapmaker. People engaged in these activities to make judgements not only about their current risk level, but also about fire spread predictions (in cases where they lacked access to prediction maps). This was often the case when participants compared bushfire maps with maps showing wind direction over time.

“The maps were really good because the one I was using, it showed the wind direction and stuff, so I could see where the fire was ... and that was like ‘Gosh, we are dead in the path’, so it did, it helped, it just solidified our decision to go” (A18)

This type of cross-referencing of map information was common among participants in all three locations. Participants would often look to multiple mapping platforms for different types of information to understanding the full extent of their risk. This participant in NSW/ACT compared mapped fire information with weather information from the Bureau of Meteorology (BOM):

“I get notified if there’s a fire within 50 or 60 kilometres of me, and I look at it, and then I look at the BOM and see where the wind’s coming from, and then I look back at a fire map, and I spent a lot of time on the fire maps actually and I spent a lot of time checking it against the wind and the predicted wind direction.” (C12)



Maps were also used for confirmation. For example, participants used maps to confirm or explain the physical cues that they were seeing around them. For some, this provided reassurance that the authorities knew about it and were responding (when checking resourcing information). On the other hand, residents also consulted trusted sources to confirm what they saw on the map. One fire official in NSW noted that community members would ...:

"...always flag you down, especially in our area and say, 'Well, how's it going? We've looked on Fires Near Me and it says it's over there. ...And they got to the point saying, 'Fires Near Me says this. Is that really what's happening?'" (C19)

Finally, participants often used maps and mapped information to inform and/or warn others who may be at risk. Residents discussed how they would share maps with friends and loved ones through text, email, social media, and/or websites. Additionally, some mentioned that they would describe maps over the phone or encourage others to use maps. A participant in Victoria stated that: *"I think the main source we were getting information was from Facebook and people had shared a couple of maps ...of where fire areas were ..."* (A8)

Participants used maps at different times throughout the fire event and with differing levels of frequency. The time periods during which people checked maps more frequently included: periods when the fire hadn't spread to them yet (to obtain early information) or during the event, e.g., when the fire was moving faster, they were under Watch and Act or Emergency Warning conditions, and/or there was poor visibility in their area due to smoke. Another time when people used maps was after they had already evacuated. In these cases, people wanted information on the impact of the fire on their properties or their loved ones (especially if they were still in the affected area). After a Tasmanian participant had evacuated, they stated that:

"I also used that map because I was watching it come closer and closer, and then I woke up one morning and I looked at the map but this time, the farm, the back of the farm was in the blacked burned area. And so I had time to say... I just said to my husband, "Oh, the back of the farm's gone now" and so we had time to then say, and prepare the children. You can't ask for better than that. I used those maps to get myself okay so then I could look after these four children in my care, and so it wasn't then further trauma." (B8)

Many participants used maps on a very frequent basis – even mentioning using them between 20 to 50 times per day (C12). A participant in NSW/ACT described their frequent map usage in this way:

"Yeah, we were kind of living off them really. You'd see something or you'd go around to a neighbour's place and see it from a different angle, and you'd go and check the app again, just trying to get our heads around exactly what was happening – we were really living off it. It was used more – those apps were used more than the phone feature of the phone over those days." (C27)

Those who constantly checked the maps were looking for updates, noting that they understood how fast fires can move and therefore, wanted to receive regularly updated information. Frequent checkers mentioned being fixated, 'obsessive' (A17) and even anxious – trying to obtain updates constantly.

While it was common for respondents to use maps on a frequent basis, a minority described limited use of maps during their fire experiences. Their reasons for using maps less frequently or less often included: being too busy undertaking firefighting efforts or not having the proper device or being unable to use the device to view the maps. Additionally, some participants felt that maps were not needed in their situation. Instead, they were more comfortable relying on local knowledge and/or they could actually see the fire and therefore, did not feel like they needed to rely on mapped information.

Challenges with map usage and participant feedback

Another reason stated by some participants for not using the maps as frequently is because they ran into challenges when accessing and/or using the maps. Even when people did use maps frequently, they also mentioned challenges that they encountered when using the maps, some of which reduced their trust in the information.

Many participants across the three locations mentioned the importance of maps providing timely information. During their experiences, they encountered situations where the maps were slower to update or



did not change for a long enough period of time that made them question the currency of the information in the map. The absence of timely information became apparent when participants consulted multiple mapping platforms and even compared the information provided by the different sources. A participant in NSW/ACT highlighted that these experiences reduced their confidence in the mapped information:

“I felt like if I went to the Windy app, that was really current, and then sometimes when I’d be looking at the Fires Near Me app or the Emergency Services one, I’d be like ‘Is this old? Has this actually changed since this had been updated or is this up-to-date?’ I do think I had that feeling about ‘How much can I trust this information?’” (C27)

A lack of perceived timely information can leave participants confused about the state of the event. Oftentimes, when lacking information, respondents went to look for the information themselves (both physically and from other electronic sources).

Participants in all locations, depending upon the types of maps that they consulted, also mentioned information that might have been missing. With that said, a few participants mentioned that some mapping platforms contained too much information – making it difficult to focus on the information pertinent to them. An example of this is the VicEmergency app where participants positively recollected its former bushfire focus, and suggested that now that it maps multiple hazards, it can be difficult to focus on the hazards directly affecting them.

Another challenge faced by participants was the inconsistency of information across multiple map sources, platforms, and geographical borders. In these instances, some maps provided different information (and sometimes more up-to-date information) than other map sources or platforms, making it difficult to understand which one was more accurate. Where participants could decipher which source or platform was timelier than others, they lost confidence in the maps displaying old or potentially inaccurate information. A participant in NSW/ACT noted that: *“Well, the difference in different maps doesn’t lead to trust”* (C14/15). Participants were also challenged by situations when the maps provided different information than what they were themselves witnessing, which also led to lower levels of trust in the maps. Additionally, in NSW/ACT and Victoria, where predictions were provided during the 2019-2020 maps, a few participants mentioned that the maps were inaccurate when predictions did not materialise.

Finally, some participants mentioned accessibility issues with maps and mapped information. These issues stemmed from patchy internet service, not having the right device to view the maps, lack of usability of the apps that featured maps, and comprehension issues once they viewed the map.

Residents of the three locations suggested a number of ways that the maps could be improved. First, they had an interest in receiving more information on fire spread predictions. People were interested in understanding the current locations of the fire and spatial predictions on how the fire might spread over time. Participants were also interested in receiving additional information via their agency maps, including road closures, wind speed and direction, fire front location and predictions, the confidence levels of the predictions, the type of fire and its intensity levels, the burnt areas and their spatial accuracy, and the time of the last update and/or expiry time for the map. Regarding timeliness, people wanted a better understanding of how often the maps would update and when they should expect updates in the future. Additionally, some asked for more clarity on particular aspects of the map, namely the burnt area display. The conditions of the burnt areas were confusing to some – i.e., had the entire area burnt through or were there areas within that mapped region that could still burn? A participant in Victoria mentioned the following: *“The one thing that I think is really misleading, and for someone who has been through it, is just because that area is blacked out doesn’t mean that that whole area is burned out...”* (A3).

Even with suggestions for improvements, some participants recognised that their expectations may be too high regarding practical changes to future map design. They mentioned that near-real-time mapping and quickly disseminating accurate predictions can be difficult. With that said, there may be opportunities for educating the broader public about what information can be disseminated via maps and where challenges occur for Fire Behaviour Analysts and Public Information Officers (Neale et al. 2022). Our participants asked the following questions that are likely points of confusion for residents of many bushfire-prone areas and could possibly be further explained at upcoming community training and education meetings to reduce community confusion about bushfire maps:

- What do fire agencies base map predictions on?
- Why didn’t the situation (prediction) pan out in a particular fire event?
- How does information get from the ground to the map and/or app?
- Who is behind the modelling in our fire agencies?



- Why can't I get real-time information on the map?

Participants relayed to us the importance of post-fire briefings that could help answer some of these questions and even increase public confidence in future (predictive) maps. A NSW/ACT interviewee noted that: *That was the situation here, it was like 'Well, that didn't happen' so next time, do people believe that map? I think there needs to be a little bit more commentary around maps as well"* (C13). Honesty is key for a Tasmanian participant that stated: *"It's always good to be honest: They said, 'We're doing our best', and they were but they had multiple fires in multiple locations across the state and they didn't have the resources for it"* (B15).

And, among the challenges, participants also mentioned the aspects of bushfire mapping that worked well for them. Some provided kudos to their respective fire agencies for good coordination of information between ACT and NSW and for putting out prediction maps (e.g., NSW, BOM and CFA). Others mentioned that it was helpful to view the visual information provided by the maps on their phones. And, across all three locations, a common theme was how helpful the community meetings and local officials were in helping to explain the fire situation and what they should do in response. A participant in Victoria described that:

"There were daily community meetings after that point, so we probably got a better understanding after we'd had a couple of those sessions where they explained how the maps were being updated because ... I guess you expect them to use like real-time updates on the map ...once we'd had that explained to us a few times it was like 'Okay. Well, you can't...'" (A18)

Participant responses to the bushfire

Based on the information that people were receiving around them, and their personal knowledge and experiences with bushfire, participants responded in different ways to protect themselves and their loved ones. Some decided to stay behind and defend their homes and properties, while others left. Some families acted as a unit (in that they all took the same protective action) and others acted in different ways (e.g., one would stay behind, and all others would evacuate).

Different reasons were given by participants for their decisions to stay and defend their home or property. These included their previous experiences with bushfires; having previously planned to stay and therefore, were highly prepared to do so; having confidence in their abilities to stay and defend; perceiving an inability to evacuate due to responsibilities at home (e.g., to a farm or animals); being stuck there without available transit or routing options; and/or being in a location that was not warned or prompted to evacuate. A Victorian resident described how their previous experiences in the 2009 fire prompted them to prepare to stay for the next big event:

"We had the big scare in 2009 Black Saturday. ... we have got a fire bunker, there's a fire bunker next door, all our houses are sprinklered, we've got a dam, I've got fire pumps, I've got fire suits, I've got digital radio – I like to think I'm very prepared." (A11)

Participants also described their reasons to leave. The reasons included their concerns about the roadways being blocked or congested, a perceived inability to defend their home⁸ (or a concern that their home was too high a risk in bushfires), having previously planned to evacuate, and pressure from the authorities or others in their social network to evacuate. Like those who decided to stay, previous experience in fires was also a reason that people decided to evacuate. For example, the 2009 fires were so devastating that a NSW/ACT resident decided not to fight fires in the 2019-2020 fires. They described their reasoning as follows:

"...we've made a decision after 2009 that if the fire gets close, we're not going to fight it – we're just going to leave now – 2009 we tried to stay as long as we could, but the devastation was pretty bad." (C4)

Also, regardless of their decisions to stay or go, participants engaged in several different activities during the fire event. These included attending meetings, preparing the house (in case of fire), defending their property, warning or informing others about the fire, tending to the farm/animals, caring for loved ones, and gathering personal belongings. It is important to note that even people who elected to stay and defend prepared themselves and their families in case they needed to evacuate at the last minute.

⁸ Due to personal characteristics (e.g., age, ability) or resources.



Participants identified different “trigger” cues that served as the trigger or the final prompt that alerted them of the need to evacuate the area. People mentioned the following trigger cues:

- having police, other emergency officials, or members of their social network urging them to evacuate;
- receiving an official “order” to evacuate;
- receiving or inferring information about the bushfire’s movement from sources (i.e., its location and how fast it was moving, and/or wind changes); and
- witnessing intense physical cues (e.g., heavy smoke or ember showers).

A resident from Tasmania described their trigger cue in the following way: *“It takes a big thing for me to leave; it’ll take a big thing for me to leave. Like I said, strong winds with lots of embers in them, I will leave but before that, no”* (B29).



Part 2 – Example bushfire maps used in Victoria, NSW/ACT, and Tasmania

We discuss the findings from Part 2, where participants examined two or three different types of maps, in this section. This section focuses on map awareness, attention-capturing features on the map, map comprehension, perceptions of risk and behavioural intentions, map usage, and participant feedback and suggestions for improvement. Within each theme, the findings from NSW/ACT will be presented first, followed by Victoria, and then Tasmania. While we included larger versions of the maps studied in this part of the interview in Appendix B, smaller versions are also included in this section to assist the reader. We encourage readers to consult Appendix B for the scenario and emergency message text that accompanied each map.

Map awareness

In NSW/ACT, over half of the participants had seen a map similar to Map 1 (see Figure 1) prior to their interview. Map 1 provides a mock-up with similar features to those included in the maps accessible via the Fires Near Me app (now known as Hazards Near Me, since it incorporates other hazards in addition to fires). Participants who recognised this map made specific mention of the Fires Near Me app, saying that this map looked similar to the maps available via that app or they recognised certain features (e.g., the symbols or the thatching) as similar to those from the Fires Near Me platform.

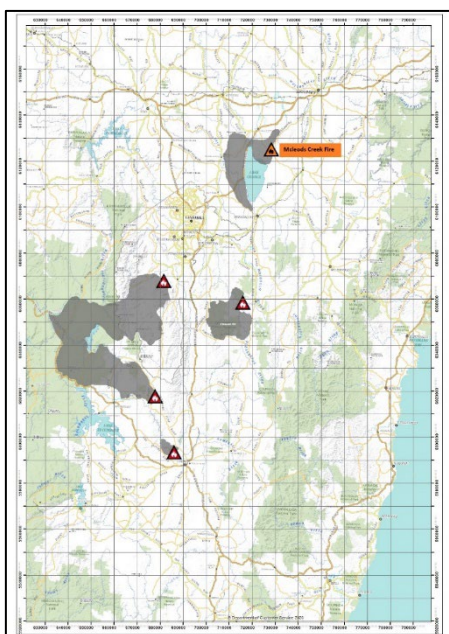


Figure 1: Map 1 shown to NSW/ACT interview participants

Also, almost all NSW/ACT participants had seen a map like the one displayed as Map 2 (see Figure 2) prior to the conduct of the interview. Map 2 is a mock-up of the types of fire spread prediction maps (or “red maps”) that NSW and ACT fire agencies released to the public during the 2019-2020 fires. Participants recognised this map as similar to one that they had seen during the 2019-2020 fires. Only a small number of participants (in this case, only five participants) had not seen this map before.

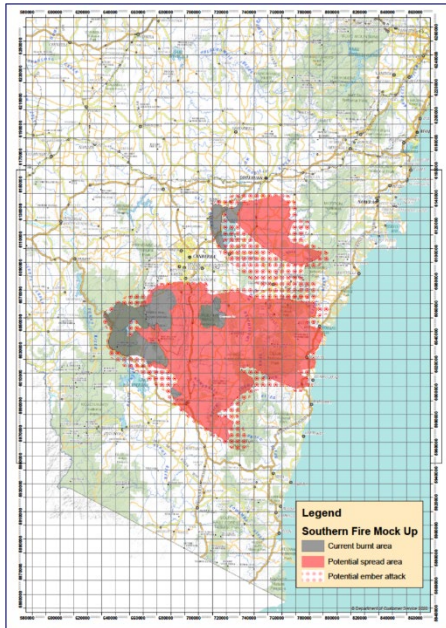


Figure 2: Map 2 shown to NSW/ACT interview participants

In Victoria, almost every participant had seen a map like the one displayed as Map 1 (see

Figure 3) prior to the interview. Map 1 is an example of a map that people could access on the VicEmergency platform. The map, issued by Victoria’s CFA, identifies the areas that are under “Emergency Warning” and “Watch and Act” guidance (also known as “warning polygons”). Participants specifically recognised this map as one they would normally access on VicEmergency and recalled using maps like this in previous bushfires. One participant noted that: *“I’m very familiar with these maps because we look at them all the time, every summer”* (A11).

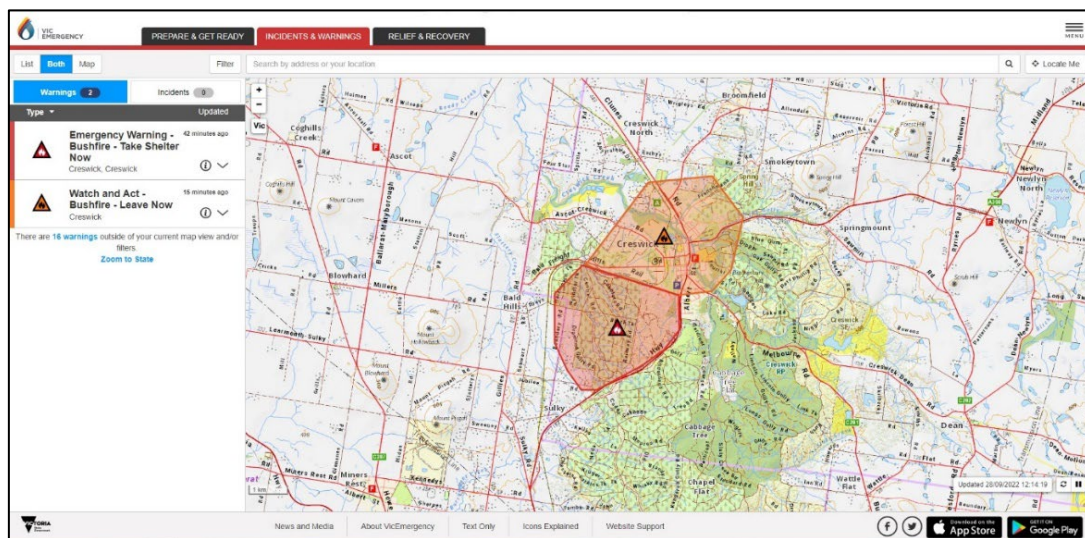


Figure 3: Map 1 shown to Victorian interview participants

Most Victorian participants were also familiar with Map 2 (see

Figure 4). Map 2 is a copy of the actual map that was released to the public by the Public Information Section of the State Control Centre during the Gippsland fires in 2019-2020. The map displays information about going, contained, and under control bushfires as well as information on the ‘potential impact zone’, which as



explained in the yellow box next to the map is “an area that is likely to be impacted by potential fire fronts moving into communities, spot fires and ember attacks, thick smoke, or fire closing major roads and isolating communities”. Some participants mentioned that they were specifically watching the bushfire event in Mallacoota during the 2019-2020 fires, and for that reason, were familiar with this map. Others noted familiarity with certain aspects or features of the map, including the bushfire footprint, and the locations of the bushfires on the landscape (via the red, blue, and yellow symbols). Less than a third of the participants did not have prior exposure to Map 2.

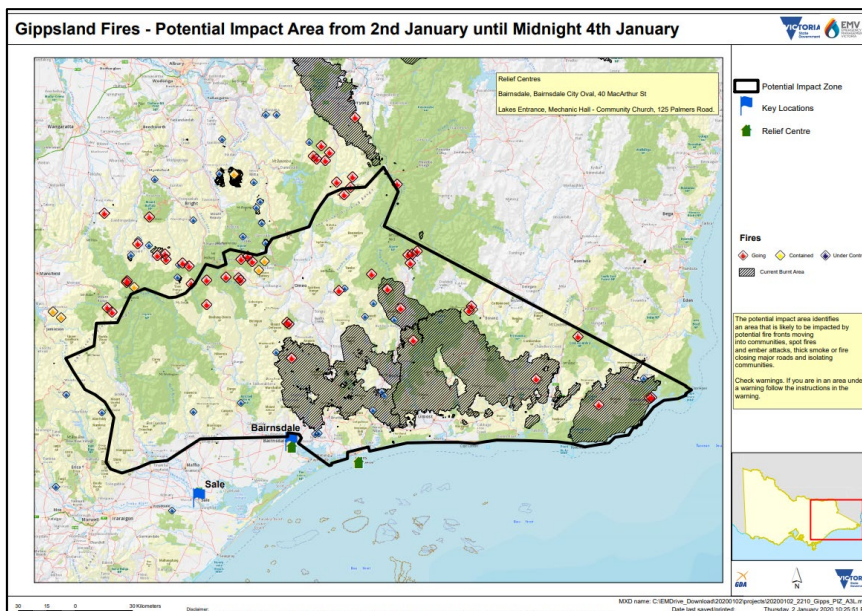


Figure 4: Map 2 shown to Victorian interview participants

In Tasmania, most respondents mentioned their familiarity with TasAlert or Tasmania Fire Service (TFS) maps (even noting similarities between the two). Map 1 (shown in Figure 5) was a mock-up developed within the TasAlert platform⁹. Like the information provided in Victoria’s Map 1, this map displays the warning polygon for the “Emergency Warning” called for this area by the TFS (see Appendix B for the key that also accompanied this map – linking the symbols with the type of watch/warning). Some Tasmanian participants thought that they had seen this map before in the 2019 fires, when only the original TFS map would have been available. Others said that they had not seen this map or were uncertain.

⁹ The TasAlert system has been in place for ~7 years; however, it was significantly reconfigured in 2022. Fire and flood information were published on this mapping platform starting in September 2022.

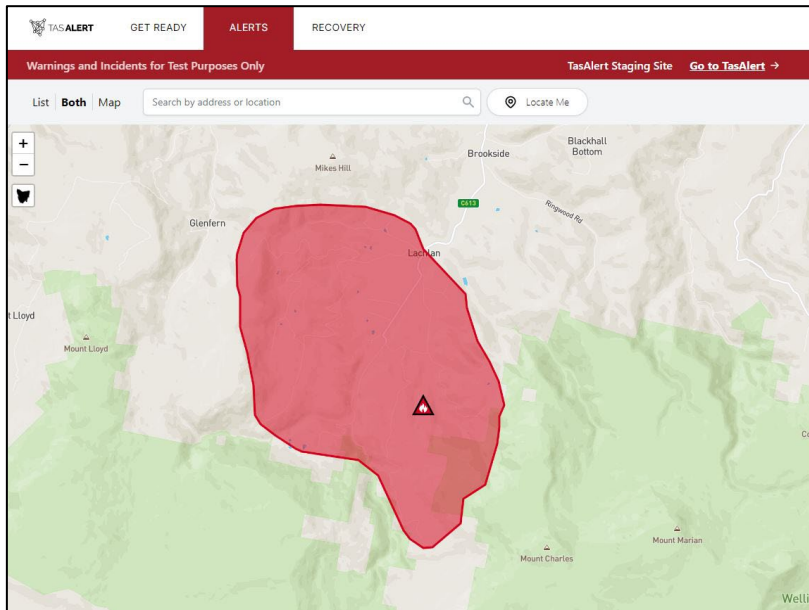


Figure 5: Map 1 shown to Tasmanian interview participants

Map 2 (shown in Figure 6) was also a mock-up developed within the TasAlert platform, which would not have mapped fire information during the 2019 fires. This map displays the warning polygons for the “Emergency Warning” and “Watch and Act” called for these two areas by the TFS (see Appendix B for the key that also accompanied this map – linking the symbols with the type of watch/warning). Only a few of the Tasmanian participants said “yes”, i.e., that they had seen a map like it prior to their interview. Instead, most were uncertain or answered “no”. In cases where people had not seen this map before, the participants referred to the fact that they had not seen a map with orange on it, multiple colours, “side by side warnings” (B6), or overlapping/two incident levels. Participants relayed that they had only ‘seen the red’ before. In other cases, people were uncertain.

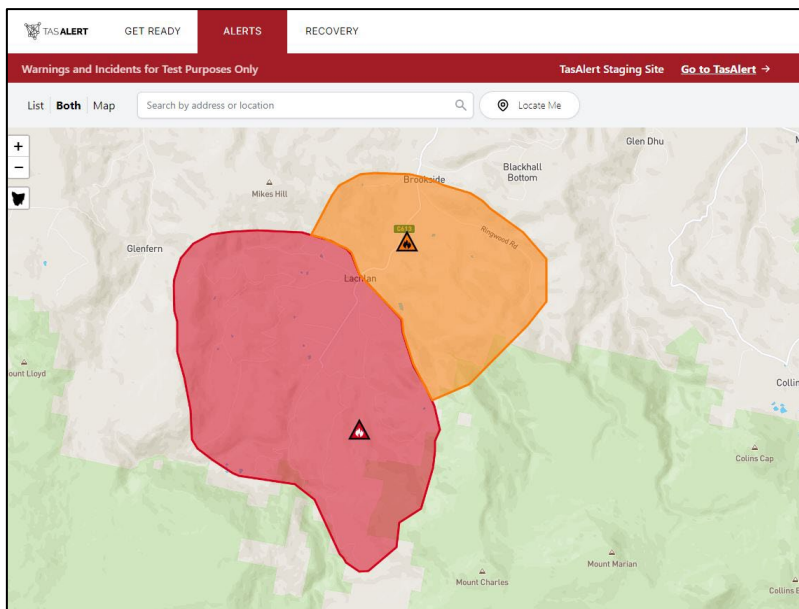


Figure 6: Map 2 shown to Tasmanian interview participants



Map features that capture attention

Various features on the maps captured participants' attention during our interviews. For the NSW/ACT maps, the most frequently identified attention-capturing features on Map 1 were the orange label (that read "McLeods Creek Fire") and the orange and black triangle. One resident noted that: *"Bang. There's an incident there....The symbol clearly dictates to me that it is a fire"* (C20). For Map 2, the features that captured attention were the red shaded and red dotted areas, with one participant referring to the colour of these features as *"the red danger colour"* (C14/15).

In Victoria, most participants identified the red and orange areas and/or the accompanying triangles (i.e., warning symbols) as the features that grabbed their attention first in Map 1. However, during their discussions of these elements, some did not realise at first that the two warning polygons on Map 1 were actually different colours (orange and red). To some respondents, they looked like the same colour. For Map 2 in Victoria, a third of the participants identified the burnt/blackened areas (including the scale or size of those areas) and another third highlighted the large number of the red icons (or active fire symbols) as what grabbed their attention.

In Tasmania, most participants identified the larger polygons as what captured their attention first. In Map 1, they referred to the larger red area, noting that red was a danger or an alert colour. For Map 2, participants highlighted the two larger areas (red and orange) as what captured their attention first. A few specifically noted that the brightness and contrast of the colours (and in particular, the red colour) against the map's background made it easy to see.

Map comprehension

Participants also shared with us what the overall map and the particular map elements meant to them. Since their responses were specific to each map, this section is organised by location and map number (1 or 2).¹⁰

NSW/ACT, Map 1: Overall, participants understood this map to be showing the fire extent and/or locations of five fires across the larger landscape. Some specifically mentioned that two of the fires looked like they were 'joining up' in the western-most location, since there was a grey area with two different triangle symbols. One resident explained this further:

"indicating that there are three significant areas of fire, and then one smaller one, and it looks like the furthest west is actually a complex of two fires because there's two triangles, and it looks like they've joined at the western end of those two fires so that if I hovered over those triangles, I would get information, but they would suggest one, two, three, four, five fires, and the big complex to the left is joined up." (C10)

On this map, participants primarily discussed the two main hazard symbols: the triangle symbols and the grey areas (or polygons). Participants explained what each feature meant to them. First, for the triangle symbology, most associated the triangles with the presence of a bushfire or a warning associated with a bushfire, and that the red and black triangle represented the most extreme level of warning. Additionally, while some were unsure which colour related to which warning level, participants expressed wanting to click or hover over the symbols for more information. There was also confusion among some participants about what the triangle represented, for example, the warning level, intensity of the bushfire, type of fire, or the bushfire's containment status. One participant asked us during the interview:

"Does the colour reflect the area or the severity of the bushfire, or does it mean something else? Are they talking about this one is nearly under control, this one's out of control? Are they trying to convey that message?" (C20)

Participants also explained how confusion about particular map symbols can lead to doubt and eventually lower their confidence in the map's information. Additional confusion was mentioned about whether the red and white symbol represented a situation that was more dangerous than the orange and black symbol (or vice versa).

Participants also questioned whether the triangles' positions on the map meant something regarding the bushfire. Some ideas were that the triangle may refer to the position where the bushfire started, the location

¹⁰ In Victoria, participants were also shown a Heat Map (see Appendix B), which is referred to as Map 3 in this section.



of the active fire, and/or the direction of bushfire spread/travel. A participant stated the following about the triangle's location:

"I'm assuming that's where it's burning, but I think before I thought about it a little bit more I thought maybe that's where the original fire was, like where it started but I've kind of changed my mind on that after reading that they're burning in an easterly direction." (C27)

Among the participants, the grey areas or polygons were associated with the area that was burnt, fire-affected and/or currently burning, or the extent of the bushfire (i.e., size and shape). Participants mentioned their uncertainty about what the grey area signified, i.e., were they fires that were currently active, smouldering, or those that were completely burned out?

Finally, participants mentioned that a legend would have helped with comprehension of the map's features and that while the McLeod fire was labelled, the fire names or labels were missing for the other fires displayed on the map.

NSW/ACT, Map 2: First, looking at the map generally, participants understood this map to communicate areas at risk and/or places to which the bushfire may spread. Similarly, some participants simply read from the legend on the map that the map showed predictions, i.e., areas of potential fire spread and ember attack. Explaining further, many noted that this map simply showed the sheer scale of the risk, saying that: *"...this is such a huge scale, pretty dire if they thought the fire was going to burn down to the coast – from Canberra down to the coast" (C27)* and *"...that's a pretty bad day" (C8).*

Next, focusing on specific map elements, participants walked us through what the red areas, red dots, and the grey areas meant to them. Some also commented on the legend and the map colouring.

For the red areas (i.e., those areas depicting potential fire spread), participants generally understood these as areas with the potential to catch fire, areas showing the extent of fire risk (under the worst-case scenario), and places where people should evacuate and/or implement their fire plan. For some respondents, the size and/or extent of the fire was used to understand the magnitude of the risk. There was also a general understanding among residents in our sample that these spread areas were affected by wind and weather conditions, firefighting efforts, and that these predictions were uncertain.

However, there was also some confusion about the risk associated with the red areas. Participants were unsure about the fire intensity in these areas, asking questions like: Which red areas are potentially more 'at risk' now and over time? One resident said that: *"I don't have any sense of intensity being different in any one area over another" (C10).* Other questions were raised about whether the spread areas were more dangerous than ember attack areas (e.g., C20).

Next, participants generally understood the 'red dotted' areas (i.e., depicting potential ember attack) as locations to where the fire may spread or areas ahead of the fire where new fires may start (e.g., around houses). Participants also understood that these areas were driven by wind conditions and by the fire itself. Like the red areas, participants asked additional questions about the risk associated with these areas. Also, many associated these red dotted areas with an equal or lesser probability of fire when compared with the red areas.

Like Map 1, participants were unsure of the risk associated with the grey areas on Map 2. It was unclear to participants if these areas were burnt (partially or completely) or still burning. They also asked how much in those locations was still burning? Additionally, participants wanted information on the locations of the active fire fronts, the active fire areas, and the unburnt areas in response to viewing this map. For example, a participant explained that:

"Not knowing those areas exactly, so whilst the fire may have already gone through, if they're heavily wooded areas, fire can turn back on itself and if things haven't burned fully, they can be under attack again. Without knowing the extent of what's burned there and what's actually there, they could still be at risk." (C11)

In many cases, respondents used the map's legend to understand the symbols in Map 2. Some participants noted specifically that this legend was a positive addition to the map, even referring to it as *"handy" (C23)* and mentioned that Map 1 would have benefited from a similar legend.

Finally, participants, although not specifically prompted to do so, commented on the colours used in Map 2. Many thought that the use of red and grey colours was a positive thing. Residents used terms like *"logical"* and *"clever"* (C10) when referring to the colour scheme. One participant said that: *"Well, grey means burned"*



area; that’s a logical colour because it’s the colour of ash, the red is danger and that’s a logical use of the colour” (C7). With that said, others mentioned overlay issues with this map that could lead to lower levels of comprehension. For example, a resident thought that the red dots were “distracting” and that: “It’s bad because you can’t read anything under it ...” (C1). Another mentioned that the overlay of red (for the potential spread area) and green (forested areas from the base map) may cause confusion to viewers. As shown in Figure 7 (annotated to identify an example), a respondent explained that the blending of colours makes some areas within the potential fire spread area appear darker in colour (yellow arrow) compared to others (purple arrow) and could mistakenly lead people to think that the areas of darker red may mean higher risk to people.

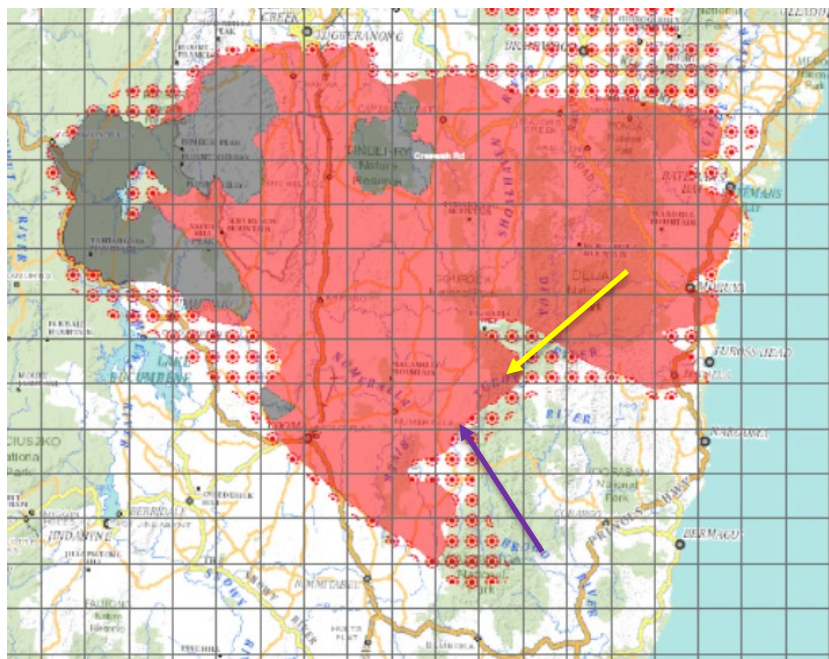


Figure 7: Modulation of red colour (potential fire spread) by the green symbols (forested area) from the base map. Yellow arrow shows how the red/green overlap produces a darker red symbol compared to an area where the base map is white (purple arrow).

Victoria, Map 1: Broadly, residents understood this map as providing warning information; and in particular, the locations under a Watch and Act or Emergency Warning. Additionally, participants mentioned that the map indicated that there was a fire in the area and/or showed the areas that were impacted by fire.

When speaking about specific map symbols, most respondents understood that the polygons meant warning or risk areas. Also, they understood that the red and orange areas represented different warning levels or levels of risk, with some specifically mentioning that the red area was in “dire straits” (A14). The location of the fire was generally assumed to be within the red polygon; however, the exact location of the fire was unclear to many. Additionally, a few people used the polygons to infer the direction of the fire spread; expecting that the direction of spread would be from the red polygon toward the areas in orange.

However, there were a few comprehension issues associated with Map 1. First, some people thought that the polygons outlined the size and/or extent of the fire. One participant walked us through the map as follows: “okay, so the red is telling me that’s... again, without... being the lay person, would tell me that that’s where the fire is, the size of that fire” (A28). Others had trouble differentiating the colours of the red and orange polygons, explaining that the colours looked the same to them.

Regarding the triangles, most participants associated these with the bushfire-related warnings; e.g., that red signified that “it was too late to leave” (i.e., stay) and orange signified to evacuate. Some discussed the maps’ (usual) interactive elements, in that they were used to being able to click on the symbols to find out more information about the risk. While some participants noted that the triangles did not show the fire’s location; others mistakenly assumed that the fire was located at the triangle’s position or were unsure.



Victoria, Map 2: To most participants, Victoria's Map 2 communicated the sheer number of fires in the landscape or that there were a lot of areas under threat or already burned. In addition, participants connected this understanding with the instruction to stay out of those risky areas or to leave if they were located within or nearby them. A resident relayed their concern in the following way: *"if you get trapped in those areas... I've been up through some of those roads – you're in trouble"* (A29).

Going through each map symbol, participants discussed what the thick black line, the grey/shaded areas and the various map icons meant to them. First, many respondents were unclear about the meaning of the thick black line (i.e., the potential impact zone) on Map 2. One resident explained their confusion as follows:

"I'm not quite sure what the black line means because you've got fires in and out. I know that's New South Wales and things like that but I'm not sure what the black one means." (A6)

Many mistakenly assumed that the thick black line represented a border or geographical boundary of Victoria, Gippsland, East Gippsland, a Gippsland firefighting area, or a jurisdictional area of some type. This may be due to the fact that participants understood that part of the line was determined by the state border between Victoria and NSW but were unsure about what the rest of the line represented. After some participants read the yellow box in the legend that defined the potential impact zone,¹¹ they then identified it as an area under threat, or potentially affected (in that a fire could spread there). However, many were still confused as to why there were active fires (i.e., red icons) *outside* of this boundary area. Upon further thought, multiple theories were expressed as to why there were fires located outside of the potential impact zone. Participants thought that these fires could have:

- Belonged to a different region
- Been burning towards the impact zone in a southeasterly direction
- Escaped from the impact zone
- Started since the impact zone was created.

For the grey shaded (or burnt) areas, many associated these with areas that have been burnt through, are actively burning, or have been impacted by the fire. Residents also inferred the large scale of the event from the size of this area. However, as in previous maps, there were differing perspectives on the risks associated with the grey areas. The most common judgement was that these areas could still be burning or could burn again and/or were at risk of trees falling or road blockages. In other words, people should keep out of these *"danger zones"* (A9). However, a smaller number of participants viewed these areas as safe and locations that offered refuge from the fire because they assumed that they were burnt through and could not burn again. Others were unsure of the risk represented in these areas, especially since the red diamond icons (i.e., the 'going' fires) were located on top of the grey areas. One participant further described their confusion:

"...it says here "Leave if you can" and it says "The ones that are able to safely leave are encouraged to do so today or early on Friday". Well, I don't know which communities are safe to leave. I don't know how to tell." (A14)

The fire icons in Map 2 represented fires that were going (red), contained (yellow) and under control (blue), as shown in

Figure 8. Participants often used these icons to assess which areas were riskier and where to go for safety; often referring to the areas with a higher number of red icons as higher risk or worsening conditions.

¹¹ Map 2's legend defined the potential impact zone as: "an area that is likely to be impacted by potential fire fronts moving into communities, spot fires and ember attacks, thick smoke, or fire closing major roads and isolating communities."

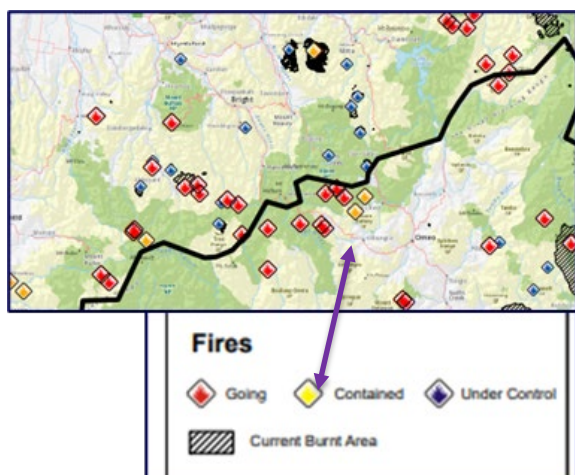


Figure 8: Display of the fire icons on Map 2 and section of the legend defining these symbols

The red icons were primarily associated with fires that were ongoing, active, currently burning, and/or dangerous, and participants noted that these icons were easily distinguishable and eye-catching on the map. The yellow icons were generally assumed to mean a fire kept in an area and/or one that could jump a containment line, and the blue icons were associated with a fire being managed, not actively out-of-control, or stopped but not out. Participants identified some difficulties comprehending the yellow and blue icons, specifically. Some noted that the 'contained' fire icons were confusing since the legend symbol was yellow, but the icons looked orange when displayed on the map (Figure 8). Additionally, the meaning of the 'under control' icons was not as intuitive as the red or yellow icons since 'blue' was a different colour than they were used to seeing in an emergency context. Participants also noted that the blue icons were difficult to see when located within the grey (or burnt) areas, and generally more difficult to notice across the map because they were smaller in size than the red and yellow icons.

Additional icons on Map 2 included blue flags (i.e., key locations) and the green houses (i.e., relief areas). Most participants associated the blue flags with safe areas, the presence of fire fighters, and/or support or refuge for evacuees (noting that they were located in major towns). However, some respondents were uncertain about what to do in relation to these icons (e.g., move away or towards these areas?). The green houses were associated with evacuation and/or places of safety, emergency shelters, information, and support. However, some respondents were concerned that these icons blended into the base map (since they were different shades of green) and others were confused that one of the relief centres was placed in the ocean (A1, A3).

Victoria, Map 3: Victorian participants also viewed a third map (in between viewing Maps 1 and 2), shown in Figure 9. Map 3 is an example map that people could access on VicEmergency that adds an "Extreme Heat" advisory to the bushfire warning polygon map (Map 1). During the interview, Victorian participants were asked what they noticed on this map, which led them to discuss the different map elements and what they meant to them.

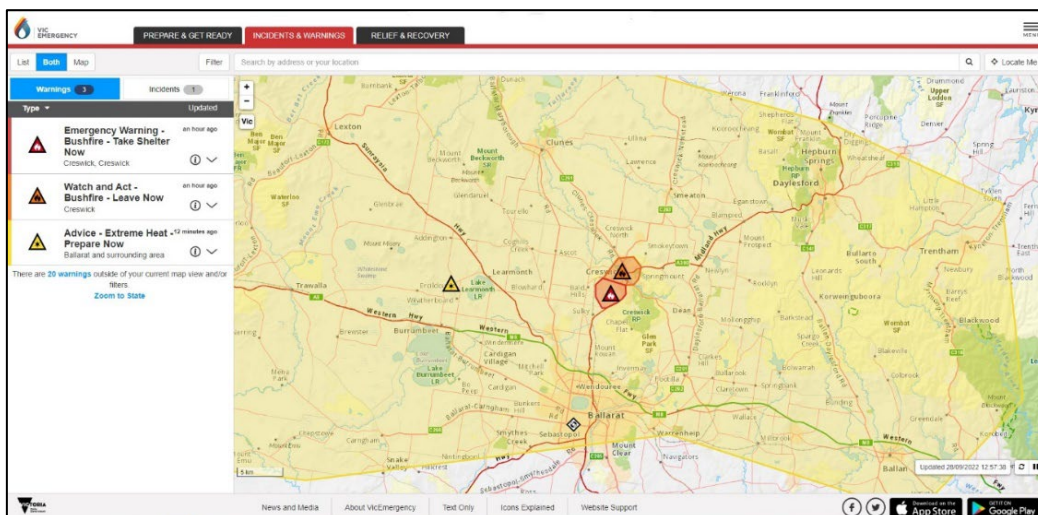


Figure 9: Map 3 shown to Victorian interview participants

Only a few participants linked the yellow polygon semantically with an extreme heat advisory. Most misinterpreted this area as the predicted fire zone, an area without flooding, a flood warning, or the location of a state forest. One respondent explained: *Yeah, it means there’s not a fire; it just means to me it’s stable, and it’s very clear to me – it’s got shades of green where I guess there are more trees and green areas*” (A12). For those who linked this yellow area with a heat advisory, some were confused about how extreme heat can be localised to one specific area within a larger region. One resident explained their confusion in the following way:

“it’s unusual to have an extreme heat day there [pointing to a map location within the yellow polygon] and quite cool conditions here [pointing to a map location outside of the yellow polygon] – it’s not very far away.” (A13)

Additionally, most participants noticed the triangle within the yellow polygon. Some associated it with extreme heat, while others were unsure what it meant (e.g., noting that they had not seen that symbol before) and said they would click on the symbol for more information.

Tasmania Map 1: When asked about the overall message that Map 1 from Tasmania conveyed, most participants mentioned various aspects of the bushfire, including the fire’s size, boundary, location of the fire front, and its current or initial location. Others correctly identified that the map was conveying warning areas and/or specific areas at risk, including the community of Lachlan.

When discussing specific symbols on the map, only one-third of the Tasmanian sample associated the red area (or polygon) with a warning area, potential impact area, and/or a serious alert requiring immediate action to find out more. These respondents recognised this as a warning or potential impact area because of the (large) size of the polygon. Another one-third of the sample misinterpreted the red area as the extent or edge of the fire, burnt ground or a mixture of burnt and active areas. In addition, some pointed to areas of the red line surrounding the polygon as the location of the fire front. One resident explained that: *“Yes, ... this red line is the front. So, to me, that just says “Okay. This is all burning. That’s the front – you don’t get right in front of any of that area”* (B10). The remaining third of respondents were uncertain what the red polygon represented. One participant spoke aloud as they viewed the map, referring to the older TFS maps which showed burnt areas: *“Oh, okay...I’m looking at this thinking like in the old form of map, we’re looking at burned ground”* (B22/23).

When viewing Map 1, many residents requested additional information, including the location of the actively burning fires, the burnt areas, the areas where the fire is under control and the predicted fire direction. An interest in more information about the burnt areas came up repeatedly since they recalled having access to this information in the pre-TasAlert TFS maps:

The first question that comes to my mind is why is this marked in red and there is no black area? I’m used to there being a black area showing the burned; I’m not used to a red area. Is this what you’re showing me now a proposal as to how one way that it could be, or is this a real screenshot from something? (B9)



“The maps ...you know, we were talking about with the bushfire here in 2019, they actually used a very dark grey shading to show the burned area, and I know they still do that today...” (B24)

Map 1 also contained a red triangle, and the participants’ interpretation of this symbol varied. A majority of the respondents encountered comprehension issues when interpreting the triangle. They thought that the triangle identified the fire location – with most assuming it was the starting (i.e., ignition) location, some assuming it was the most active fire location, and others being uncertain (e.g., they initially thought it was a meaningful location and then changed their mind after viewing the map’s legend). A minority of residents correctly recognised the triangle as a warning symbol, and a few recognised the symbol as a clickable “link” from which they could obtain more information. One resident elaborated: *“What it means to me is the triangle with the fire is a priority symbol, it’s a warning symbol and it’s also a hyperlink to additional information”* (B20).

Tasmania Map 2: Like Map 1, when asked about the map’s overall message, participants either mentioned the depiction of two different warning areas (which is what the TasAlert map is meant to communicate), two different fires, or a fire spread prediction (i.e., with the fire likely to travel from the red to the orange polygon).

While some understood that the red polygon indicated an Emergency Warning and the orange polygon a Watch and Act warning, participants encountered comprehension issues for this map that were similar to those they experienced when viewing Map 1. One resident explained their interpretation of Map 2 as follows:

“Well, it tells me that the redder colour is where the fire has burned. It would appear the active fire front is on the junction between the two, and the expectation is that it will continue on out through the proposed development area. If you’re anywhere immediately under that orange colour, then you would definitely be on a “get the hell out” or “act”.” (B30)

With that said, viewing Map 2 helped some to recognise that the red in Map 1 (and Map 2) was a warning area and not the fire’s extent. One participant noted that: *“Oh, now I understand. That was actually the “Emergency Warning” area versus the “Watch and Act” area, and I’ve totally misunderstood it (Map 1) as fire extent”* (B15).

Regardless of how the polygons were interpreted, a majority of residents discussed how the red and orange polygons showed the direction and movement of the fire. One resident explained their thoughts on fire spread predictions while viewing this map:

“The red blob means there’s a bushfire, it’s active in the entire area. Orange blob means it’s probably heading in that direction, or at least ash, and smoke, and embers are heading in that direction.” (B18)

Like Map 1, comprehension issues also arose regarding the triangle symbols and their locations; however, a few participants understood (after seeing Map 2) that they were warning symbols. For those who were uncertain, they raised the following question: if the triangles’ locations were not meaningful, why then weren’t they located in the centre of the polygons?

Many participants also mentioned wanting fire location information when discussing Map 2. They recalled that the older TFS map had included this information and questioned why it was not provided to them in this map (or in TasAlert maps)? One resident explained why fire information was so important to understand:

“Well it says to “Evacuate now” – just go, but you don’t know where the fire is; the fire’s not marked. There’s a point where it’s too late to evacuate, when the fire’s just about on top of you, and this map doesn’t show you that, so it’s pretty useless. I mean, you have no idea where the fire is because they haven’t mapped it, and yet, the TFS would have that information for sure because they’re basing all of their fire-fighting information on where the fire is and what it’s doing. So, if the information is there, why isn’t it on this map?” (B29)

Participants also wanted to use fire location information to help them identify what routes to take to leave, as evidenced by another Tasmanian respondent:

“If it was me, and I know which way the fire was travelling – I’d need to know that because then you’d actually stay ahead of the fire, or if the actual front of the fire had passed by and was moving towards



Brookside which is the north, then you'd know to actually head south, head away from it, or indeed, to actually stay in this area and fight the embers, the residual embers, or any spot fires that had started because the main fire had passed through. It looks like it's heading towards Brookside, passing over Lachlan, or through Lachlan, heading towards Brookside, in which case the front of the fire has bypassed you if you're in this area. Again, it's where wind comes in – very important.” (B7)

Map perceptions of risk

Next, we asked participants which area of the map is at the highest risk of harm and why. Their responses varied depending upon the location and the map they were viewing. Therefore, this section is organised by location (NSW/ACT, Victoria, and Tasmania), as well as map type, Maps 1 and 2.

NSW/ACT Map 1: Many thought that the localities to the east of the fires were at the greatest risk of harm. This assessment was linked to participants' judgements that the fires were moving eastward; made either by reading the warning text, assuming a westerly or northwesterly wind, using local knowledge of weather patterns, or assuming that the triangles were indicating active fire areas and inferring the fire's direction of travel from west to east. The NSW locations that residents identified as risky areas were Cooma (and in particular, the southern parts of Cooma) and Bungendore (in the northern parts), Braidwood Rd, Tarago, Tuggeranong Valley, and Captains Flat, as well as the southern portions of Canberra in the ACT. Other participants thought that the areas at highest risk were those affected by McLeod's Creek fire (i.e., the places named in the warning text) and/or the areas identified via the orange symbols on the map. These individuals discussed that the orange really stood out on the map, and its differentiation could be signifying a higher risk. One resident in NSW/ACT explains this in the following way: *“I look at that one with the different indicator and the orange pop-up and think that's trying to indicate that there's a greater risk there” (C10).*

Only a few participants mentioned other areas on the map (e.g., near or between the red triangles or the outskirts of the grey areas) or noted that there just wasn't enough information provided by the map to identify areas at higher risk.

Participants mentioned the types of information that should be provided on a map to assist individuals in identifying higher risk areas, including:

- Wind direction and weather conditions,
- Location of the active fire areas and/or the fire front,
- Fire direction and speed of travel,
- Location of controlled/contained areas, and
- Additional information on road closures and firefighting activities.

A NSW/ACT participant described how they arrived at their assessment of higher risk areas, demonstrating the assumptions that they made to identify these areas and noting the need for active fire front and wind condition information:

“Anywhere downwind of the fires, particularly an active fire front and we don't have any information on active fire fronts. We would assume in this area it would be everywhere vaguely to the east of all of those fire areas, especially normally to the south-east but you wouldn't take any risks for anything to the east and then also you'd have to be cautious north if you... for the wind change that you often get, but that's all not communicated by the map – obviously that would be presumption that people make if they know enough.” (C8)

Also, according to participants, crucial information for their risk assessments are warning information, fire history (i.e., the locations of burnt areas), and their own knowledge of the local area, landscape, and locations of communities and farms.

NSW/ACT Map 2: For Map 2, one-third of participants thought that the red areas (i.e., potential fire spread areas) were at the greatest risk of harm. Within this group, some respondents expressed that the ember attack areas were equally or slightly less risky, or weren't sure about the differences in risk between the two areas. Some people identified more specific regions within the red areas as being at the highest risk. These were generally areas that were closer to the burnt or grey areas, e.g., Tarago; areas located on the western side of the potential spread area; or those areas downwind from the fire front. One participant discussed their assessment of risky areas as follows:



“I’d say the red closer to the grey area. I mean, it’s saying here “burned area”, so I’m assuming that the red area close to the grey area I would be in a greater threat than down in this part here because to me, this red area is not on fire according to that legend. So if I was in potential spread area and close to the grey area, I would say, ‘Oh, I’m really in big trouble here.’” (C20)

Almost as many participants (i.e., close to one-third) thought that the places to the east of the fire were at the greatest risk of harm due to the west-to-east direction of predicted fire spread, the location of predicted ember attacks, and their knowledge of the location of high population areas on the South Coast of NSW. Their risk assessments extended to other larger population centres located on the map, such as Cooma, NSW and Canberra, ACT, and smaller farming communities not shown on the map (or more difficult to see due to the map’s red “dots” [potential ember attack]) such as Nimmitabel, Numeralla, and Countegany (all in NSW). A respondent in NSW/ACT identified the area at the highest risk of harm as follows, considering locations where larger numbers of people would be located:

“To the east of the big fire down south because ... that’s the Monaro Highway that runs down the middle of that fire. You’ve got more population as you get closer to the coast, so I think that’s Batemans Bay on the right, very far east, the population along all the way down that coast area is huge. For it to go right to the coast there, that’s a lot of risk, very, very risky. Yeah, a lot of settlements all along there with urban developments around Batemans Bay plus, if it was January, you’d have a lot of holiday makers there as well so, potentially you have people caught.” (C25)

Only a few participants mentioned other areas on the map (e.g., unburnt areas between the fires, the eastern edges of the grey areas, and the interface between the red and grey).

Overall, participants mentioned the types of information that should be provided on a map to assist individuals in identifying higher risk areas, including:

- Wind direction and weather conditions,
- Location of the active fire areas and/or the fire front,
- Timing of the fire spread predictions (i.e., how long before the fire reaches a given location),
- Levels of intensity/risk within the red areas (potential spread areas) and grey areas (burnt areas), and
- Types of vegetation within the ember attack areas.

Also, according to participants, crucial inputs into to their risk assessments are warning information and their own knowledge of the local area, landscape, and locations of communities and farms.

Victoria Map 1: For the first Victorian map, almost all participants identified the entire red area/polygon as the location of the highest risk of harm, i.e., the area on the map that warns people located within the red polygon that it is too late to leave. One participant explained their reasoning in this way:

“The emergency warning. The one where you’re advised not to leave – obviously that’s where the fire is – it’s more dangerous if you try to leave now because there’s no safe exit so you’re safer to stay in your property or go to a fire evacuation point in town whereas I look at the other one, the “Watch and act” which is the yellow one, isn’t it, yeah. That is your final warning – you’ve got to go now or stay.” (A16)

Only a few within this group mentioned that the areas near the triangles were riskier or that both the red and orange areas were equally at risk. Also, only a few participants mentioned needing additional information before they could make their risk assessment.

Participants mentioned the following types of information should be provided on a map to assist individuals in identifying higher risk areas:

- The location of the active fire areas and/or fire front information,
- Fire and wind directions,
- Fire intensity,
- Road type (sealed/dirt), and
- Fuel moisture/vegetation types.



Victoria Map 2: Many participants identified the northwestern area of this map as being at the highest risk of harm. This region is located on the northern and southern sides of the northwest section of the thick black line (i.e., the potential impact zone) where there is a higher concentration of red icons (i.e., ‘going fire’ symbols) within the green shaded areas of the base map. This area was considered as a high-risk area by Victorian participants because of the significant number of ‘going’ fires and the challenging topography of this location. Participants identified the topography as challenging since it contained high country with dense forests, making the fires harder to control, and a limited road network, making it more difficult for people in communities such as Bright and Mt Buller to evacuate. One participant associated higher risk with areas where fires could join together:

“Just because especially over here, there’s a lot more spot fires that are going that could join together. They’re all quite close – when you look in this area, they’re all quite close to each other so they’re going to join and the same with up there so where here, there’s a couple but there’s burned area in between them and those two are in burned areas so they’re not going to go far.” (A8)

Some participants associated any areas mapped with red ‘going fires’ icons with higher risk, without identifying specific areas on the map. One participant explained: *“I feel like any area where there’s a little red triangle, where there’s an active fire, you are at a location where you are potentially at the most risk ...” (A3).*

Only a few mentioned that the major towns and communities along the coast (e.g., Bairnsdale, Orbost, Cann River, and Mallacoota) were at higher risk because of the higher concentration of fires in this location and/or the potential for fires to join together, as well as the proximity of the fires to populated areas with limited means of escape. A few respondents mentioned the grey shaded areas as higher-risk or that they needed additional information to make their assessment. The potential impact zone did not seem to influence people’s risk assessments, as only one participant mentioned this zone as the location of highest risk.

Overall, participants mentioned the types of information that should be provided on a map to assist individuals in identifying higher risk areas. These included:

- The fire and wind direction and speed,
- Access to evacuation routes,
- Topography,
- Local conditions, and
- Level of resourcing of firefighting efforts.

Tasmania Map 1: Half of the Tasmanian participants thought that Lachlan, Tasmania, and other townships (i.e., people located near the red area on the map) were at the highest risk of harm. These included townships to the north of the red area, which were specifically highlighted in some cases. Others labelled the entire red area as risky, with some noting that the areas nearer to the triangles were riskiest.

To identify these areas, people relied on their local knowledge of general wind direction and topography, the warning text provided during the interview, and/or the shape of the polygon. A participant explained the uncertainty in their thought process in the following way, based on the assumption that the red polygon is indicative of fire spread:

“...they’re saying it’s an intense fire; it says the fire’s travelling towards Lachlan so it must be southerly there because Lachlan is at the top. Maybe it’s coming from the south-east because the spread is bulging on that side, so it’s coming that way but it’s saying it’s as early as 2:00. Right? Yeah, that’s what it’s saying to me; the fire’s coming in a certain direction, it’s coming out of the hills and it’s heading that way... That’s the way the fire’s heading as far as I can tell and I’ve got my hand coming up from a south-easterly direction. Is that right? I don’t know. That’s how I would read that map.” (B20)

Some participants also mentioned that they did not have sufficient information to make the assessment or that they would need to consult other platforms to understand the wind direction before making an assessment about risk.

Participants mentioned the types of information that should be provided on a map to assist individuals in identifying higher risk areas, including fire and wind directions and speed, location of active fire fronts and areas, highly populated locations, and available roads and evacuation routes.



Tasmania Map 2: Over half of Tasmanian participants thought that the red area (i.e., warning polygon) was the area at the highest risk of harm. Within this group, most thought that the entire red area was at risk. However, some identified specific areas within this region, including Lachlan, Tasmania; areas near the red triangle; and areas between the red triangle and Lachlan. A few thought that the orange area could be equally risky, depending on the wind conditions. One participant explained why they identified areas near the triangle as more risky, even though they were uncertain about the triangle's meaning: *"I would say the red area obviously, and where the triangle is, is that the start of the fire or is that the most severe area..."* (B21).

Only a few mentioned Lachlan, Tasmania, or other towns specifically (e.g., Blackhall Bottom, Glen Dhu or Brookvale), the orange area (e.g., where the fire was spreading), or the interface between the red and orange areas, or were uncertain about the areas at risk. Participants mentioned the types of map information necessary to assist individuals in identifying higher risk areas, included wind speed and direction, the size and location of the active fire fronts and areas, and warning information.

Behavioural intentions

We also asked respondents what the people located in these high-risk areas should do next and why. Their responses under this theme varied depending upon the location and the map they were viewing. Therefore, this section is organised by location (NSW/ACT, Victoria, and Tasmania), as well as map type, Maps 1 and 2 (and 3, for Victoria).

NSW/ACT Map 1: Some respondents in NSW/ACT (approximately one-third of the sample) said that those in the areas of highest risk should evacuate. If they were personally in this situation, some respondents said they would leave unless there was a significant reason to stay (e.g., helping family or friends to defend their property). Others said that they would leave depending upon the type of property in which were staying, e.g., whether it was surrounded by bushland. In their personal decisions to leave, inexperience with the area and experience with previous fires played a role. First, a person who was inexperienced with the area in Map 1 said that:

"...So the instruction said to head south along Bungendore Road towards Bungendore; not knowing the area, I'd probably follow that instruction, even though every other man and his dog would be following that instruction too but yeah, not knowing the area, I would probably head south along Bungendore Road towards Bungendore like it said to do, unless I was confident and knew another way out." (C28)

Also, a person reflected on the 2009 Victorian fires, stating that:

"If it was me, I'd follow advice and I'd be leaving. I'm not a hero. I come from Victoria. And my mum has always lived there. I drove through Victoria after the 2009 fires and have a vivid recollection of those. If anyone says 'Watch and Act', then I will leave." (C2)

Others (a little less than one-third of respondents) said that the protective action decision was a personal choice, and when asked what people in the risky areas should do, they were adamant that the choice was entirely up to the people located in those areas. In their opinion, if residents were well-prepared; confident in their abilities; fit to act; and equipped with appropriate knowledge, training, equipment, experience, and support, then they could choose to stay and defend. A resident explained their situation to us as follows:

"Well, I mean, I'm never going to do what they're saying here. I'm not going to read out and agree with what you've said here but that's people's choice. We would have our fire units packed and ready to go, we would have everyone knowing what they're doing and which building they're in charge of, we would have, before, cleaned our gutters, blocked them up, filled them with water, we would have taken everything off all the verandas – we would have been at that for days. I'm not getting my documentation, my medication, and getting in the car." (C1)

Other participants explained that, in response to the situation on the map, the people in risky areas should implement their fire plan, whatever that may be. If their plan is to stay and defend, then they should get ready to do that. If their plan was to leave, then they should evacuate immediately.



NSW/ACT Map 2: The most common response from residents after viewing Map 2 was that people in high-risk areas should evacuate (approximately one-third of the NSW/ACT sample). Within this group, residents thought that people should be preparing to evacuate and leaving if it was safe to do so, as well as keeping in contact with their local emergency services agency. A few thought that people in risky areas should have already evacuated and even that it was too late to leave.

Small groups of others mentioned different behavioural responses that should be taken by people in risky areas. The behavioural responses included enacting their fire plan (to stay or go), seeking out advice and information from other sources (e.g., radio, media, neighbours) and continually assessing the situation, or being on alert. One resident mentioned, in reference to seeking out additional information, that:

“They should look at the advice, find out what the advice says. If it’s saying ‘Implement your fire plan’ – that’s what you do. If it’s saying ‘It’s too late to leave’, well, you can’t. You just listen to advice; they should definitely listen to the radio, keep on top of any comms from the RFS.” (C12)

Another resident suggested the following, before revealing that their fire plan would be to stay and defend: *“With no other information provided, I would just be on alert” (C10).*

Victoria Map 1: One-third of Victorian participants thought that people in the areas of highest risk should evacuate, or that they should have evacuated already. Acknowledging Victoria’s “leave early” policy, one participant stated that: *“... you would hope that they’re not even there. Not knowing what the fire danger rating was for that day...” (A28).* Some even suggested that leaving from within the red polygon was the preferred action (even though the warning stated that it was ‘too late to leave’). A participant explained their perspective about the red polygon area:

“I guess it depends how long it’s been too late to leave because like I said, it popped up when we were getting in the car and I understand why they say that because if you’re driving along and the road’s on fire but I guess knowing where you are makes a difference possibly – like the area, and then yeah, how long it’s been emergency warning, like that level for, whether you’d... it’s hard to make a judgement call, but yeah, possibly also depend on what sort of set-up you’ve got where you are.” (A2)

Falling in line with the warning guidance, others (i.e., another one-third) said that people in the highest risk area should either take shelter in their house or start actively defending the house against the bushfire. Defensive actions, based upon participants’ responses, included clearing the areas next to the house and/or on their property, filling up the gutters with water, shutting the windows and curtains, putting wet towels around the doors to stop smoke from entering the house, making sure all animals are safe, and donning protective gear, among others.

A few residents mentioned that people located in the risky areas should implement their fire plan, whatever that may be. One participant explicitly noted what they would do if they were staying with loved ones: *“If it was family, I would go along with what their plan was. If the general consensus was to leave, I would leave, but if their well-prepared, well-thought-out plan was to stay, I would help.” (A30).* Additionally, residents noted that the actions necessary depend on the type of warning areas – in that people within the red polygon should take shelter and those within the orange should leave. Only a few people noted that there was critical information missing from the map (i.e., fire location and direction) and that they would seek out additional information to inform their evacuation plan or survival strategy.

Victoria Map 2: In reference to Map 2, most people (almost half of the sample) said that people in risky areas should leave if it is safe to do so. One resident explained their thinking as follows:

“I would be taking the advice to get out if they could. I don’t think anybody ever wants to be in a bushfire last place of resort – that just sounds like my nightmare. I think the advice is pretty good and comprehensive to say, “Pack this, here’s a list of options you can go to if you don’t have relatives that you can get to”. Yeah, it was kind of a nice, practical list of options I guess and me personally, I’d definitely be taking those options and not staying and defending.” (A18)



Individuals also expressed that, before leaving, it was important to prepare and to assess if the roads were safe for evacuation, especially in areas with limited routes.

Another group (almost half of the participants) mentioned that people should be prepared and following their fire plan or follow the instructions provided by emergency officials. This could involve monitoring other mapping platforms along with Map 2 to obtain more specific or localised information. One participant said that: *“They should be listening to their VicEmergency app. It must have been called Vic Ready...Have the news on, have the radio on, and being alert, and following whatever advice for their area is”* (A9).

Only a few people mentioned that the decision on what to do depended on having additional, specific information about the fire, include weather information that they could obtain via weather apps.

Victoria Map 3: The most common response (by one-third of participants) was for people in the risky areas to prepare and take the precautions necessary to manage the risks associated with extreme heat. These actions included having extra water, staying indoors, looking after pets, and travelling early in the day (or later at night) or avoid travelling altogether, if possible. One participant explained in more detail what they would do to protect themselves and their animals:

“...all the windows and doors, everything is shut, the air-conditioning is on, and just staying inside for the day and keeping cool and making sure the pets... we also bring all the cats and all the dogs – we even had one day when all the chooks were in the laundry as well. Not too happy about that but yeah, we bring all the animals in on an extremely hot day like that.” (A9)

If not already there, others mentioned that they would avoid travelling to the area exposed to the extreme heat advisory because of the significant risks associated with that hazard. For example, locations they would avoid included Ballarat, Lake Learmonth, or the location of the yellow triangle.

A smaller group said that the map did not inform them of their risks from extreme heat or change their responses at all. For them, extreme heat was common, especially during bushfire season, and they did not need a map to tell them when the temperature would be higher. Instead, they would know by the forecast and feeling the heat.

Only a few people were confused about what an extreme heat advisory represented (in terms of their risk and behavioural response) or mentioned that the advisory did not provide a full understanding of the risks without additional information, such as wind or humidity.

Tasmania Map 1: When viewing Map 1, most Tasmanian residents (over two-thirds) said those in the area of highest risk should leave, or that they should have left already. Many reasons were given for this perspective, including that they did not want to be a liability for fire fighters if in need of rescue, that they were not prepared to stay and defend, and/or that the warning message or map conveyed a need to leave. Nevertheless, one resident thought that the advice about what to do (in the warning text) was inconsistent with the message conveyed by the map:

“I mean it does say, ‘If you’ve built to current standards you can stay and defend’, but I guess that would... to be honest, that’s a little confusing possibly because I think ‘evacuate now’ means you need to go.” (B19).

Others who favoured leaving specifically mentioned the difficulties that they or others have encountered when defending their property. One resident mentioned that his friends’ harrowing experience had influenced his decision not to stay and defend: *“I mean, I don’t think I’d ever really try and fight a fire after seeing footage of some mates that lived in [nearby location], fires went through there. That was hectic. Man, that was intense”*(B10). Another respondent mentioned having a young family, *“so it’s important to get out of [the] danger zone, smoke inhalation sucks. When the fire’s that close, you just can’t see anything and getting information can be difficult”* (B18).



Only a few mentioned that the appropriate action was to implement their fire plan. Also a few mentioned that this decision was a personal choice and if people were well-prepared and if their house was built to bushfire standards, then they may choose to stay and defend or seek refuge within their home.

Tasmania Map 2: Similar to Map 1, the most common intended behavioural response for people located in risky areas was to evacuate (by over half of participants). Within the group, some residents said that people should leave now or that they should have left already; even in the orange areas, according to a few participants. One resident explained that:

Well, they should have already evacuated or be evacuating now, however, also generally if you're in that 'Evacuate now' area, if you haven't already done it, often it's too late. So, make sure you're going ASAP or find somewhere safe." (B1)

Others noted that if they couldn't defend, they should evacuate. When considering where they would go, some mentioned that the map didn't assist them in identifying safer routes of travel.

Only a few respondents mentioned the following behavioural responses: follow their fire plan, monitor the situation for additional information or stay to defend or shelter. Additionally, a few said they would need additional information to make a protective action decision, including the location of the fire, wind direction, and route accessibility. One participant explained that: *"Well, if they're telling you to evacuate, so they should be getting up and going, but then if they don't know where the fire actually is, how do they know which are the safer routes out of here?" (B27).*

Another resident expanded upon this in the following way:

"Well it says to 'Evacuate now' – just go, but you don't know where the fire is; the fire's not marked... But because you don't know where the fire is on this map, you can't make the decision whether it's too late to evacuate or you've still got time to get out." (B29)

Map usage

We also asked respondents how they might use a map like this in a bushfire event. Their responses varied depending upon their location but were similar across maps in each location; therefore, this section is organised by state/territory (NSW/ACT, Victoria, and Tasmania).

NSW/ACT Maps 1 and 2: The majority of participants in this location would use Maps 1 and 2 to identify their levels of risk and/or where the risk was located. They also mentioned using the map to make decisions about protective actions (e.g., whether to leave and/or protect the house, and what to do next, or to avoid the area if they were located elsewhere). For evacuees, they noted that they could use this map to identify possible evacuation routes out of the affected area. Only a few mentioned that they would not use Map 1 in a bushfire since it did not provide them with sufficient information. Elaborating on this perspective, one participant highlights the personal responsibility necessary to make a stay/go decision:

"I look at the maps, but I wouldn't use it to determine whether I stay or go...My response to myself and to close friends and family was "Walk out your door and go and have a look yourself. Have a look at the weather, sniff around, is your house ready, are you able to fight? If you're not and you don't feel comfortable and you're so stressed because the map's not giving you enough, leave. Get in your car and go. But that's me. I'm more about individual responsibility; this shouldn't be up to the government or any authority to determine what you do." (C25)

Another participant discusses how they might use Map 2 to prepare and evacuate:

"To plan how you're going to leave, which way you're going to go, and if your house is going to be within that mapped red area, or the red spotted area, obviously how serious you have to be with your preparation before you leave. Obviously if you're in the red area, you really need to be... either area to be honest, you need to take it pretty seriously and do a bit of prep before you leave, but I'd be keeping an eye on this map, and the other one." (C28)



Some participants mentioned using Map 2 to monitor the fire spread over time, i.e., monitoring the map at different times and/or refreshing the map to look at how fast the grey area moved each time period.

A few participants mentioned that they wouldn't use Map 2 unless it was regularly updated or stated that they would rely on their own senses and the conditions around them to protect themselves (rather than relying on map information).

Victoria Maps 1 and 2: For Map 1, the majority of respondents stated that this map would help them make decisions to stay or go and to avoid or find a way out of affected areas. To evacuate, one participant specifically mentioned using this map in conjunction with a navigation map especially in conditions where they are unfamiliar with the area:

"I would be using this map in conjunction with a navigation app to move away I guess because I wouldn't trust myself to read this map to actually navigate out if I was driving because it's quite small and I don't know those roads...and the warning, the text warning, was quite helpful in that it said, 'Head to Daylesford'." (A18)

Very few mentioned that they wouldn't use this map in a bushfire event, and instead, planned to rely on advice from the emergency services and/or neighbours to decide on the best protective actions to take.

Similarly, about half of the respondents mentioned that they would use Map 2 to understand the areas at risk, the locations to avoid, and identify evacuation routes and/or safe locations. Others were uncertain about how they would use the map, since it covered a larger area and contained less local detail. They highlighted the importance of localised information (e.g., provided by VicEmergency, Map 1) for protective action decision-making. One participant noted that: *"There's a lot going on in this map, there's a lot, and obviously it's such a broad picture – ... I'd probably be trying to zoom it in a bit and try not to look at the whole picture because it's a bit daunting"* (A18). Others mentioned potentially using this map alongside VicEmergency to understand the conditions and make decisions. For example, one resident explained that:

"You probably need to have a couple of different... you need the local map, and then you need a bigger, general map, but you can't find a road in that. It's too hard to find, and it gets confusing; you've got smoke and everything going – it's confusing, so you need to have something that's going to help you with where the roads are so you need a local map with roads to get out of that area, but then you need this [Map 2] to tell you which way to go." (A4)

Tasmania Maps 1 and 2: The majority of participants would use Maps 1 and 2 to understand the locations of highest risk and where they were located in relation to those places to decide on the best protective actions for themselves and their families. If outside of the affected areas, they would also use these maps to avoid high-risk areas. Participants mentioned using Map 1 to evacuate and/or identify evacuation routes. After viewing Map 1, a participant explained that: *"I would use it to make decisions around when to evacuate and how high risk it is, and where it's located in relation to where I am, or where's family, and how to get out of the area"* (B3). Participants viewing Map 2 also mentioned the importance of using the map to monitor the areas at risk (especially if located within the orange polygon) and refreshing the map over time to understand fire spread/movement.

Many participants mentioned how important it was to be able to see the road names and locations for travel and evacuation purposes. On these maps in particular, some noted that the map's overlay of the warning information made viewing road information difficult. One resident stated that:

"What it's really bad for is what areas are being affected by the fire because you can't see, what roads are being affected by the fire, and if you can't see the roads clearly, then you can't make a decision on whether you're going to be able to get out or not safely on that road." (B29)

Only a few people wouldn't rely on this map, but instead noted that they would consult other maps and information (e.g., wind and weather forecasts) and/or the fire brigade and police officials for information on how to protect themselves during a fire.

Entire Sample: Across all maps and map types, the base map features were important. The base maps in this study provided residents with essential contextual information about the bushfire emergency, including information about the road network, town names and locations, and the locations of water bodies and national parks, to name a few features of interest. Across the three study locations, participants used the



base map to understand the landscape (e.g., the vegetation, parks, and population centres) and locate themselves and/or contextualise their risk and the risk to others. For example, people used the base map features to understand where the fire might be spreading and where one might relocate to reach safety.

Participants provided several examples of how they continually located themselves or wanted to be able to locate themselves in relation to the bushfire threat on all maps provided to them in Part 2. A series of quotes are provided below to show the range of experiences with **self-localisation**.

NSW/ACT sample:

- *“I’m seeing the burned area, I’m seeing the potential spread, which helps me decide where I am relative to that, and where I should evacuate to.” (C4)*
- *“And as a private person, that’s showing me that where my property is which is right there, it’s getting more and more vulnerable...” (C18)*
- *“My first thought was to look down in my location.” (C27)*

Victorian sample:

- *“... if that was here, I would look at that map and know straight away where I am because I know my area.” (A12)*
- *“I think all you want to know is where is the fire in relation to my property – that’s what it’s all about.” (A13)*
- *“Well, you need to be able to see the roads – which roads you’re talking about, where exactly so that you can locate yourself.” (A25,26)*

Tasmanian sample:

- *“That I’ve got a very big hot spot to the north of me. I can actually see my property. Yeah. Yeah, I’m on the edge of it,” (B4)*
- *“I would look at that [red polygon] and immediately look at the place names around, trying to work out how far away I was or people I needed to know about were.” (B18)*
- *“...if I was able to zoom in and out on that – I’d be able to determine pretty quickly whether I was involved in that area and whether I should go, or even if I was on the skirts of that area, I’d be having to watch it pretty quickly.” (B28)*

To our participants, helpful base maps were ones that included clear place names, landmarks, and road names. Residents highlighted specific maps, e.g., NSW/ACT Map 1 or Tasmania Map 1 where they had difficulties seeing town and/or road names, making it difficult for them to self-localise and understand their risk in relation to the fire event.

Participant feedback and suggestions for improvement

Participants were also asked whether they would have confidence in the information provided by each map, and why or why not. Participants expressed higher levels of confidence in specific maps when they also had higher levels of trust in the map source (i.e., fire agencies) and/or the participants understood the inherent uncertainty in particular map types. Higher levels of confidence were expressed by certain participants across all maps; however, Victoria’s Map 1 achieved consensus among its residents, in that this map was generally perceived as trustworthy.

Participants across all three locations expressed support and trust for fires agencies, including CFA, NSW RFS, ACT RFS, and TFS. A participant in Tasmania specifically highlighted the importance of a trusted source and commended the TFS for how they handled the Riveaux Road fire. TFS’ acknowledgement after the bushfire that they could have done things differently and learned from the previous event, went a long way with this resident.

Understanding uncertainty also influenced participants’ confidence levels. For example, one NSW/ACT participant stated, in response to viewing Map 2:

“They’re never going to be 100 percent accurate because you can’t predict; you can’t predict the weather, you can’t predict wind changes and the fires create their own weather so they could go wild and go in a completely different direction. This is just the best guesstimate really.” (C28)



Similarly, some participants recognised certain maps as a starting point, acknowledging that the map's information is not real-time (C20) or that bushfire conditions can change quickly, making it difficult to update the maps accordingly. Additionally, a few in NSW/ACT recognised the different purpose of the larger-area maps (i.e., showing fires across the landscape) when compared with more localised information provided by incident maps. From this participant's perspective, Map 1 is meant to "...give you a general drift of which way the fire is occupied and which way it's burning. [It is] a general guide as to where the fire is..." rather than specifics on a particular location (C29), which was sufficient for them.

When participants expressed lower levels of confidence regarding map information, the following reasons were given: the information was not updated (or not updated frequently enough), the maps lacked sufficient information or detail, certain map features were difficult to comprehend, and the maps were too general (and did not provide information about events at the local level). Overall, participants had lower levels of confidence (or were uncertain or conflicted about their confidence levels) with NSW/ACT Map 1, Tasmania Maps 1 and 2, and Victoria Map 2.

Regardless of location, participants recognised the need to confirm the map's message with other sources of information. Participants in Victoria, for example, mentioned still wanting to look out the window to confirm event details (A14) or look for other sources, including their own judgement (A3).

Additional Information

Participants identified improvements that could be made to the maps to increase their use and users' levels of confidence, including the addition of specific types of information. The types of additional information highlighted as missing from the maps included information to support wayfinding and navigation, and environmental conditions. They also discussed improvements to map accessibility, timeliness, comprehension, and use.

First, participants mentioned missing **wayfinding and navigation information**, including information to assist them with self-localisation, traffic information and road closures, and evacuation options and safe refuge locations. To localise the threat, participants advocated for additional indicators to help put the map into context, e.g., road names, city/town names, names of landmarks, topographic information, parks, and even farm names (for more localised maps). Some participants also mentioned wanted to be 'localised' (i.e., have their current position placed on the map) when visiting the map, similar to features offered by VicEmergency. They also identified issues with the map colours/overlays which made it difficult in some instances to see the underlying base map information. A participant viewing NSW/ACT Map 2 suggested the following:

"make the red more transparent so you can still see the roads more easily because of course the roads being the only way of egress, it's important to know which main roads are being impacted. We're probably looking at Brown Mountain, you're not able to travel down." (C3)

Also mentioned was an interest in information on traffic conditions and road closures. This could include information on which roads/routes are clear for evacuation and which ones are affected by fire and/or have been closed by emergency services. A participant from NSW/ACT noted that: "*Road closures are absolutely essential – big red markers on the legend or the key saying, 'If you see these lines, you cannot use that road'*" (C10). Participants suggested that evacuation options or routes, especially for tourists, and safe areas for refuge (e.g., evacuation centres) would be helpful information as well.

Many participants described a range of **information on environmental conditions** that would be important to include on a map. In this context, environmental conditions include information on:

- The scale or size of the fire (in number of hectares and/or mapped),
- The fire's intensity (i.e., how active the fire is in particular locations and the locations where it is under control);
- Fire activity (including burnt areas);
- Fire front location, spread and direction (i.e., predictions) and areas for potential ember attack;
- Weather forecasts (including wind speed and direction); and
- Emergency response information (including the number of responding vehicles, their locations within the affected areas, and areas of intervention [e.g., backburning, containment lines]).

Fire spread predictions were consistently mentioned across the three locations. While viewing the prediction map (Map 2), Victorian participants still requested additional information on the direction of fire movement:



“the direction of the main fire, obviously it’s going to swirl around because of topography but to somehow, along with the symbol of fire, have the direction of movement of that fire... I think having the arrow of the direction of the spread.” (A28)

The same is true for information on the active fire front location, which was missing for NSW/ACT participants, even among their prediction map (Map 2). Additionally, almost every participant we interviewed wanted additional map information regarding wind speed and direction. Without that information, some noted that they would look for it elsewhere, for example, this resident from Tasmania:

“I’d have to go to the weather maps at BOM and see what the current... the weather, the wind direction and strength for all the little areas that that map that they have, which really needs to be combined with this to make it useful...Wind strength.” (B29)

Victorian participants commented that even though this information wasn’t displayed on their first map, some commented that they could get wind forecast information on Vic Emergency and requested similar information for Map 2. Also, even NSW/ACT participants who viewed the prediction map (Map 2) expressed an interest in wind forecasts since they were interested in any expected wind changes in the hours to come. One NSW/ACT participant suggested a way to display wind forecast information over time, as follows:

“Wind direction arrows but then that’d need to be a timelapse thing... what the current wind direction is but you’d need to be able to slide it to see what the predicted wind direction is over the next 24 hours or whatever, and wind strength, not just direction.” (C12)

Participants suggested other improvements to the maps. Many participants across the three study locations discussed the importance of displaying **timely information on the maps**. Here, timely information is defined as frequent updates, with clear timestamps identifying when the map was produced and the length of time for which the map is valid. Participants were interested in understanding the fire’s progress over time by comparing historical information with current information to understand fire spread rates. Frequent updates were defined differently for different people, with some mentioning 15-30 minutes (which are not a realistic expectation based on fire modelling capabilities), 3-hour, or 6-hour intervals. Also requested for the prediction maps were broad timelines for how the fire may progress across the landscape over specific 6+ hour intervals.

Finally, participants mentioned various **map features** that would have improved the map’s use and comprehension. These included a scale bar, compass, legend or key (to further explain the elements on the map), the ability to zoom (and increased resolution after zooming), and clear colouring. The ability to zoom would be most relevant to incident maps, rather than landscape-scale prediction maps since the goal of the former is to provide more localised information to users. Similarly, a few NSW/ACT participants specifically requested a more dynamic, interactive type of map rather than only static information. The request for clear colouring arose after viewing maps where colours were difficult to differentiate (e.g., the polygons in Victoria Map 1) or where there were issues reading text or base map features under dominating overlays (e.g., NSW/ACT Map 2 or Tasmania Maps 1 and 2).

The concept of consolidation of map information was also prevalent among the three study locations. Participants continually suggested mapping platforms should include or consolidate information from other maps to avoid people having to use multiple platforms for the same event. This could include putting fire information from neighbouring states onto the same map as well as different types of relevant information (e.g., road status, wind speed and direction, etc.) on one platform. A participant in Victoria explained that:

“In an emergency situation, you don’t want to be trying to think of another website or going and you’re jumping from one website to another, so you know, the traffic emergencies in a bushfire situation, I think that should be on the maps as well.” (A16)

Finally, residents overwhelmingly requested maps with fire spread predictions and found the concept of a prediction maps very useful. Some participants recognised the need for landscape-scale maps that show, on a broader scale, the size of the event and the potential for worst-case conditions. With that said, participants had a number of suggestions on the ways in which uncertainty could be displayed in these larger-scale maps. As our sample was quite experienced with fires and maps, there was a fairly good understanding of uncertainty among some of our participants, and their suggestions for mapping of uncertainty will be discussed in the Discussion Section of this report (Implications for fire spread prediction maps).





Discussion

Previous experiences with maps (Part 1)

Across the three study locations, trends were identified based on participants' fire experiences and, in particular, their use of maps during fire events. At the onset of the event, people were first made aware of the fire via a number of means, including both physical and social cues. However, first awareness was also complicated by the many fires to which they were exposed over the course of that fire season.

Throughout the event, residents used different types of maps on a fairly frequent basis. Most participants mentioned using maps posted by their local fire agency (either on the app or the agency's website), maps from the Bureau of Meteorology and Google, as well as third-party mapping platforms, like the Windy app, DEA hotspots map, and bushfire.io. Maps were only one tool in their information 'toolbox', since they often used maps in combination with other information sources provided via different sources and channels. One such example were community meetings, where they had an opportunity to view the maps and listen to fire agency experts explain the maps in more detail.

Participants used maps for different purposes. These included:

- To self-localise, or identify where they were in relation to the fire event;
- Gather information about the fire event (i.e., fire and weather conditions) and what to do next;
- Monitor the extent or rate of spread using the burnt area;
- Cross-reference map information with other sources;
- Confirm or explain the physical cues that they were seeing around them (however, residents also consulted trusted sources to confirm what they saw on the map);
- Make judgements about fire spread predictions and risk levels;
- Inform or warn others who may be at risk; and
- Monitor the impact of the fire on their or others' properties (e.g., after they evacuated).

Participants encountered several challenges with bushfire maps during their experiences. These included issues with timely information (e.g., maps that were slow to update or didn't change for longer periods of time); missing information; inconsistent information across sources, platforms, and geographical boundaries; inaccurate information; and inaccessibility of map information (either due to internet/coverage, device, usability, or comprehension issues).

A number of improvements were suggested by residents. Among these, participants expressed a strong interest in fire spread predictions being communicated in future bushfire maps.

Residents responded in different ways to protect themselves and their loved ones, based on the information provided to them, including maps. Some decided to stay and defend, while others evacuated – either together as a family unit or separately. Reasons for their decisions included previous experiences with fires, plans and pre-fire preparations (to either stay or go), perceived abilities to stay and defend (or evacuate), and pressure from authorities or loved ones.

Engagement with example maps (Part 2)

We also identified trends from interviewee responses in Part 2. Regarding map awareness, participants were mostly familiar with the maps shown to them during this part of the interview. Depending on the map, various types of map features captured their attention first, including warning polygons or red shaded areas (i.e., since the colour indicated danger) and the grey or blackened areas. Respondents also interpreted the maps' symbols and features in different ways across all maps and locations. Comprehension issues included confusion about the triangle symbology (e.g., NSW/ACT Map 1), the meaning of the triangle location (across all locations), the risks associated with grey/burnt areas (e.g., NSW/ACT and Victoria Map 2), the meaning of the warning polygons (e.g., Tasmanian maps), and the risks across the entire 'fire spread' or 'impact zone' areas (e.g., Victoria Map 2).

In terms of risk assessments, none of the maps facilitated participants in unanimously identifying one location of highest risk. Additionally, some respondents even noted that the maps did not provide them with sufficient information to make that assessment. With that said, participants identified certain larger areas as riskier



than others, including the warning polygon with the highest warning level (e.g., Victoria Map 1 or Tasmania Map 2), the red potential spread areas (e.g., NSW/ACT Map 2), or the areas with the highest number of ‘going fires’ (e.g., Victoria Map 2). Else, they identified smaller areas within these larger regions (e.g., the red areas closest to the grey polygons on the NSW/ACT Map 2). Other locations mentioned were areas with higher populations or where fires had the potential to join together. To identify the areas at risk, especially on incident (non-predictive) maps, people used the warning text, their own knowledge about weather patterns, or inferences they made from the map to try to understand fire direction and in turn, the locations of highest risk.

Based on their risk assessments, participants often identified a similar set of behavioural responses for those located in the risky areas: 1) evacuating the area if it was safe to do so and routes were available, 2) staying and defending, or 3) in lieu of a specific response, following the actions specified in their household bushfire plan. Another behavioural response mentioned was the option to monitor the situation and obtain information from additional sources or channels before making a decision. The decision to evacuate was often based on the instructions given in the warning text and/or the scale of the event. Respondents often noted that the choice to stay and defend was a personal one – and if residents were well-prepared; confident in their abilities; fit to act; and equipped with appropriate knowledge, training, equipment, experience and support, then they could choose to stay and defend. Participants were conflicted on the appropriate behavioural actions for people located in areas where it was ‘too late to leave’. Finally, in extreme heat situations, actions listed by Victorian respondents included having extra water, staying indoors, looking after pets, and travelling early in the day and avoiding travelling altogether, if possible.

Participants stated that they would use the maps shown to them for different purposes. Regardless of the map type (i.e., incident map or fire spread prediction map), residents generally stated the following reasons:

- to identify risk levels and/or where the risk was located (including where they were in relation to those locations, where possible),
- to make decisions about protective actions (e.g., whether to stay/go or whether to avoid the area if located elsewhere), and
- to identify possible routes out of the area and the safe areas to travel.

For fire spread prediction maps in particular, participants also stated that they would use them to monitor the fire spread over time (i.e., NSW/ACT Map 2) or were uncertain how they would use them since they covered such a large area and contained less local detail (i.e., Victoria Map 2).

For the larger-area/landscape-scale prediction maps, residents noted that they could use them in conjunction with the local-area incident maps to make decisions on how to protect themselves. They also highlighted the importance of the base map information for context, and in particular, the ability for map users to locate themselves and understand their risk or the risk to others based on the mapped fire event.

In terms of feedback on the maps, participants expressed both higher and lower levels of confidence in specific maps based on a number of criteria. For example, residents linked higher levels of confidence with higher levels of trust in the map source and a higher understanding of the inherent uncertainty in bushfire maps products. On the other hand, participants expressed lower levels of confidence when they perceived the map information as out-dated, the maps lacked sufficient information or detail, information on the map was confusing, or the maps were too general in scale (and did not provide localised information). Finally, regardless of location, participants recognised the need to confirm the map’s message with other sources of information before they could trust the information. This need for confirmation falls in line with warning research in hazards and disasters (Dwyer et al. 2022).

Across all maps, participants wanted more information. Even though we showed them static maps, in some cases, they mentioned the expectation to hover over or click on particular features of the map to obtain additional information. The two main types of information that residents requested were: wayfinding and navigation information and information on environmental conditions. Within wayfinding, participants requested information to assist them with self-localisation, traffic information and road closures, and evacuation options and safe refuge locations. Information on environmental conditions included: fire size/scale, intensity, activity, location, spread and direction; weather forecasts; and emergency response information. While additional information can provide clarity, participants also requested map features that would improve use and comprehension, including a scale bar, compass, legend, increased resolution, and clear colouring. Colouring on maps can become problematic if the colours are too close in shade to other colours, they interfere with (or are indistinguishable from) other areas on the map, and/or are inconsistent with the other colour/rating systems for bushfires and other emergencies.



However, the inclusion of new information in future bushfire maps can be dependent on the map type and purpose. Wayfinding information like route status, evacuation options¹² and safe areas for refuge might be better suited on a more localised incident map (e.g., Victoria Map 1) rather than a larger-scale, state-wide prediction map (NSW/ACT Map 2). The same can be said for emergency response information. It will be important for residents to understand the purpose of the landscape-wide prediction maps (i.e., to communicate risk on a broader scale), and to look to other mapping platforms (e.g., state agency hazard incident maps) for localised information to make appropriate protective action decisions.

Considering when and how to include this new information is important, since participants were overwhelmingly observed to infer the missing information themselves when it wasn't provided to them. Participants made inferences about future fire spread predictions in order to understand their fire risk, including the direction of fire spread; fire locations, including the location of the fire front; weather or wind conditions; and the scale of the event, the extent of damage and the resources required. In some cases, these assumptions may not be accurate.

As an example, from the size and shape of the grey polygons in NSW/ACT Map 1, participants often inferred information on future fire spread predictions. One resident walked us through their thought process and the assumptions they made when information was missing:

“Assuming that the grey is what has been burned, I can see the extent of the fire damage, from my knowledge of weather patterns in January, I can see where it’s likely to move to. And I know which of my acquaintances and colleagues have been affected.” (C7)

Similarly, a participant viewing the two warning polygons on Tasmania Map 2 explained how they inferred fire direction: *“The two areas: overlapping fire, it’s obviously the direction the fire’s going – even if I didn’t realise that that was, you know, now “Watch and act” – obviously that’s the fire direction” (B5).*

Other participants used the base map (and other information) to infer fire threat and risk. For example, a respondent in NSW/ACT suggested that the north-eastern parts of Canberra would be under threat since it was heavily wooded after viewing Map 1. Another inferred the fire risk based on their local knowledge of population centres: *“The one that’s probably more dangerous to everybody would be the [fire] at Lake George because there’s a lot more population around down near Bungendore now...” (C29).*

In another example, where fire location was missing, residents of Tasmania and a few in Victoria assumed that the fire was located where the triangle was positioned (in Map 1). A Victorian respondent explained their thoughts about the fire location in the following way:

“[The red triangle?] Yes, that’s where the fire is actually burning. This part is in urgent danger now, right now, but the fire is expected to move that way, or, another option is that that means there’s a small fire there, maybe, that may get bigger. I don’t know.” (A7)

Additionally, a majority of participants in Tasmania assumed the triangle identified the fire’s location (Map 1), with one resident stating that: *“Maybe the little triangle in the middle of it which I assume is point of origin, but I’m not sure on that” (B15).*

In summary, **when desired information is not provided to participants, they will look for it elsewhere. In such cases, they will fill in the gaps with their own knowledge and/or experience, which may not always lead to accurate conclusions.**

Implications for fire spread prediction maps

Since the goal of this project is to provide guidance on the design of fire spread prediction maps that account for public perceptions and understanding, this section will briefly discuss the implications of this study’s findings for future fire spread prediction map design. This section will align with the two main relevant principles identified in Dwyer et al. (2022):

- Principle 2: Ensuring that map readers can understand their location in relation to the risk (self-localisation) and the information that is displayed on the map can support appropriate protective actions
- Principle 3: Communicating risk and uncertainty (showing location, directionality and timeframe of the hazard)

¹² That is, unless the widespread nature of the fire activity would require evacuees to travel a long distance to find a safe area to stay.



Under **Principle 2**, our respondents provided many examples of the importance of self-localisation to understand their risk and the risk to others from the fire event. In addition, participants provided a list of different types of information that they would find valuable in bushfire maps. However, as mentioned in the previous section, only a select number of those may be relevant and valuable to include on a larger-scale, state-wide prediction map. Therefore, in this section, we focus on the information that should be included in prediction maps to support protective actions.

The first type is a simple way to communicate the direction of fire spread. A participant in Tasmania elaborated on this point as follows: *“the direction of fire spread which could just be a simple arrow or a couple of arrows– this is where it’s really travelling”* (B15). Another also mentioned *“just a couple of arrows so that you can see where... [to go when] trying to escape...”* (B17).

Another type is information on the fire front and the locations of the most fire activity. Additionally important for prediction maps is information on the burned/burnt areas and a clear understanding of the risks to people within these mapped areas. A resident from NSW/ACT provided the following suggestion on how to display fire front and fire direction information:

“You know, if that fire front was a 20-kilometre or a 10-kilometre front, they could have a red line or another colour to say, ‘Here is the front’ and make people aware that this is what has burned, here’s the front, this is where it’s going. Even if they had some arrows on it to say, ‘This is the direction it’s heading’...” (C13)

Communicating risk and uncertainty (**Principle 3**) is a vital component of any fire spread predictions map. Our respondents also provided examples relevant to this principle. First, NSW/ACT residents discussed ways to provide clarity on which potential spread or ember attack areas are more at-risk now and then over time. The first suggestion is via shading with associated timing information:

“...you could have three tones of colour and you could have 12-hour, 24-hour, 48-hour and do it by degrees with the colour fading so that we’re saying, ‘This is a high prediction in the next 24 hours. We’re not quite sure but we think this could be a lower... but we’re still thinking it will travel here, here, here’, and then as it moves across those colours keep fanning out and that would give you, ‘Oh well, that’s the 12-hour zone, that’s the 24-hour zone, that’s the 36-hour zone’. Then you’d go, I’ve got 24-hours to prepare.” (C1)

Another suggestion involves shading with likelihood ratings:

“...the ember attack areas could also have some kind of likelihood rating, like ‘It’s 90 percent likely that the fire’s going to go where we’ve got the darkest red, it’s 75 percent likely that it’s going to go where the eastern-most ember attacks are, and then there is still a chance that we’ll get a wind change and those ember attack areas to the south are like a 50 percent chance... So there’s some kind of grading there ...” (C27)

Another suggestion was provided by a Victorian resident that included a colour-coding system with specified zones:

“I would prefer to see rather than this black line, is the colour-coding system like before where, okay, we’ve got an active fire here – I would like to see a red zone around there, or the yellow zone, and red, orange, yellow sort of thing. That would mean much more to me because I know ‘Okay. It’s yellow so that area there, they’re watching, waiting, but that whole area’s orange so don’t go near there’.” (A6)

And, finally, two Tasmanian respondents offered their thoughts on communicating risk and uncertainty. The first suggestion involves the provision of dynamic and interactive information, and the second suggestion includes lines (of varying definition or clarity to identify uncertainty).

Dynamic/interactive information: *“...if you could actually see it progressing or something like that, that would be quite helpful... you know when you’re on an airplane and you can watch the flight progression, you can see it slowly edging... something like that would be really good rather than having to keep re-updating the whole screen to see if it’s moved...”* (B21)

Lines: *“It’s sort of suggesting maybe a straight line is an accurately mapped boundary with some level of maybe GPS 20 metres or from an aircraft or something, but maybe a wiggly line as an approximate boundary because probably we don’t know where the boundary is in some of that terrain”* (B15)

In summary, participants identified suggestions for future fire spread prediction maps. These maps should:

- Ensure that readers can self-localise



- Communicate the direction of fire spread in a simple way; e.g., via arrows
- Include information on the fire front and locations of the most fire activity (including burnt areas and the risks to people within these mapped areas)
- Communicate risk and uncertainty via a number of possible ways: shading with timing information, shading with likelihood ratings, a colour-coding system with specified risk zones over time, dynamic or interactive information, and lines of varying definition or clarity to display uncertainty.

These suggestions, in conjunction with the survey results of Work Package 3 and the literature review from Work Package 1, will be considered in the development of the maps that are tested with the public in Phase 2 of this project.



Next steps

This research provides critical insights into existing map design across three locations in Australia. The public continues to rely on maps, alongside text-based warnings to inform their perceptions of risk and support their protective action decision-making. However, there are comprehension issues that affect assessments of risk and map usage, that will need to be addressed in future maps. Additionally, participants provided a number of suggestions on how to improve incident and fire spread prediction maps for use in future fires. The results of this study in conjunction with the other work packages in Phase 1 of this project will be used to develop future design of predictive maps that will be further tested and improved under Phases 2 and 3 of the Predictions in Public NHRA program of research.

Completion September 2023	Phase 1: Understanding the status quo. What do agencies aim to achieve by using existing map-based bushfire risk information during an emergency? How do members of the public comprehend and intend to use existing products?
July 2023 – December 2024	Phase 2: Developing and testing new national predictive map concepts. How should predictive bushfire spread maps be designed, communicated, and disseminated across Australia?
January 2025 – December 2025	Phase 3: Development of fit-for-purpose outputs. How can the results of the project be directly translated into agency policy and practice?



References

- Australian Bureau of Statistics. URL: <https://www.abs.gov.au/census> (Accessed 16 August 2023).
- Begg, C., Dwyer, G., Neale, T., & Pollock, I. (2021). *Established and emerging uses of predictive services in Victoria* (697.2021). Bushfire and Natural Hazards CRC.
- Cao, Y., Boruff, B. J., & McNeill, I. M. (2016). Is a picture worth a thousand words? Evaluating the effectiveness of maps for delivering wildfire warning information. *International Journal of Disaster Risk Reduction*, *19*, 179–196. <https://doi.org/10.1016/j.ijdrr.2016.08.012>
- Cao, Y., Boruff, B. J., & McNeill, I. M. (2017). The smoke is rising but where is the fire? Exploring effective online map design for wildfire warnings. *Natural Hazards*, *88*(3), 1473–1501. <https://doi.org/10.1007/s11069-017-2929-9>
- Cheong, L., Bleisch, S., Kealy, A., Tolhurst, K., Wilkening, T., & Duckham, M. (2016). Evaluating the impact of visualization of wildfire hazard upon decision-making under uncertainty. *International Journal of Geographical Information Science*, *30*(7), 1377–1404. <https://doi.org/10.1080/13658816.2015.1131829>
- Cofie, N., Braund, H., & Dalgarno, N. (2022). Eight ways to get a grip on intercoder reliability using qualitative-based measures. *Canadian Medical Education Journal*. <https://doi.org/10.36834/cmej.72504>
- Dransch, D., Rotzoll, H., & Poser, K. (2010). The contribution of maps to the challenges of risk communication to the public. *International Journal of Digital Earth*, *3*(3), 292–311. <https://doi.org/10.1080/17538941003774668>
- Dwyer, G., Begg, C., Griffin, A., Gardner, A., Dootson, P., Kuligowski, E., and Neale, T. (2022). Draft evidence-based principles for predictive bushfire map design, communication, dissemination and education, Internal Report, Predictions in Public Project, Natural Hazards Research Australia, Australia
- Government of South Australia. (2020). *Independent Review into South Australia's 2019-2020 Bushfire Season* (p. 180).
- Lindell, M. K., & Perry, R. W. (2012). The Protective Action Decision Model: Theoretical modifications and additional evidence. *Risk Analysis*, *32*(4), 616–632. <https://doi.org/10.1111/j.1539-6924.2011.01647.x>



Maidl, E., & Buchecker, M. (2015). Raising risk preparedness by flood risk communication. *Natural Hazards and Earth System Sciences*, 15(7), 1577–1595. <https://doi.org/10.5194/nhess-15-1577-2015>

Neale, T., Miller, G., Begg, C., Dootson, P., Kuligowski, E., Griffin, A., Dwyer, G., and Gardner, A. (2022). Predictions in Public: Understanding the design, communication and dissemination of predictive maps to the public - Work Package 3 summary report, Natural Hazards Research Australia, Australia

Neale, T., & May, D. (2018). Bushfire simulators and analysis in Australia: Insights into an emerging sociotechnical practice. *Environmental Hazards*, 17(3), 200–218. <https://doi.org/10.1080/17477891.2017.1410462>

Owens, D., & O’Kane, M. (2020). *Final Report of the NSW Bushfire Inquiry* (p. 436). New South Wales.

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (Fourth edition). SAGE Publications, Inc.



Appendix A – Pre-interview Questionnaire

Code: _____

Pre-Interview Questionnaire:

1. Age

What is your age?

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65-74
- 75 or older

2. Education

What is your highest level of education?

- Postgraduate award (e.g., Masters degree, graduate diploma, graduate certificate)
- Bachelor degree
- TAFE qualification (e.g., Certificate II, III, or IV)
- High school (to Year 12)
- High school (to Year 10)
- Left school before Year 10

3. Insurance

Please indicate the level of insurance you hold for each of the following:

- | | | | | |
|-----------|--|---------------------------------------|---------------------------------------|------------------------------|
| House: | <input type="checkbox"/> Fully insured | <input type="checkbox"/> Underinsured | <input type="checkbox"/> No insurance | <input type="checkbox"/> N/A |
| Contents: | <input type="checkbox"/> Fully insured | <input type="checkbox"/> Underinsured | <input type="checkbox"/> No insurance | <input type="checkbox"/> N/A |
| Vehicle: | <input type="checkbox"/> Fully insured | <input type="checkbox"/> Underinsured | <input type="checkbox"/> No insurance | <input type="checkbox"/> N/A |
| Farm: | <input type="checkbox"/> Fully insured | <input type="checkbox"/> Underinsured | <input type="checkbox"/> No insurance | <input type="checkbox"/> N/A |

4. Service

Are you or is anybody in your household a current or previous member of an emergency service agency (e.g., Fire Service, State Emergency Services (SES) etc.), either as an employee or a volunteer?

- Yes
- No



Code: _____

5. Past Experience

Please answer the following as best you can.

- How many bushfires have you experienced? _____
- How many times have you evacuated because of a bushfire? _____
- How many times have you had property damage from a bushfire? _____

6. Mitigation

Have you ever modified your home or land to protect from bushfires?

- Yes
- No

7. Risk perception

a. **Before** your recent bushfire experience (set of 4 questions):

What did you think was your home's bushfire risk level?

No risk	Very low	Low	Moderate	High	Very high	Extremely high risk
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

What was the possibility of your home being threatened by a bushfire?

None	Very unlikely	Unlikely	Moderately likely	Likely	Very likely	Extremely likely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

How dangerous could a bushfire close to your home have been for you and the members of your household?

Not at all	Very minimally	Minimally	Moderately	Dangerous	Very dangerous	Extremely dangerous
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

How concerned were you about a possible bushfire threat to your home?

Not at all	Hardly at all	A little	Somewhat	Moderately	Very concerned	Extremely concerned
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Code: _____

b. Since your recent bushfire experience (set of 4 questions):

What do you think your home's bushfire risk level will be this upcoming bushfire season?

No risk	Very low	Low	Moderate	High	Very high	Extremely high risk
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

What is the possibility of your home being threatened by a bushfire?

None	Very unlikely	Unlikely	Moderately likely	Likely	Very likely	Extremely likely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

If there was a bushfire close to your home, how dangerous could this be for you and the members of your household?

Not at all	Very minimally	Minimally	Moderately	Dangerous	Very dangerous	Extremely dangerous
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

How concerned are you about a possible bushfire threat to your home?

Not at all	Hardly at all	A little	Somewhat	Moderately	Very concerned	Extremely concerned
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

8. Frequency of map usage

How often do you use any type of map for any purpose, either on a screen or printed on paper?

- Daily
- Weekly
- Monthly
- Yearly
- Never



Appendix B – Maps and accompanying warning text

New South Wales/ Australian Capital Territory Map 1

Scenario: It is the middle of January in the school holidays. Recent months have been very hot, dry and windy. You live in a property to the east of Braidwood Road just north of Tarago. Tomorrow will be another dangerous day as hot, dry and windy conditions have been forecast, with an EXTREME Fire Danger Rating issued. There continues to be significant bushfire activity in the area. Please review the following maps issued by the Rural Fire Service.





Name Watch and Act - Mcleods Creek Fire (Goulburn Mulwaree LGA)

Summary Firefighters are working to control a fire burning between the village of Gundaroo and Lake George. The fire is burning in an easterly direction towards Braidwood Road.

The fire is currently 496 hectares and is out of control.

Body

Residents east of the Federal Highway in the villages of Currawang, Tirrannville, Springfield, Lake Bathurst and Tarago should enact their survival plan. If your plan is to leave, leave now in a southerly direction along Braidwood Road towards Braidwood or Bungendore. Fire activity across the fireground is increasing.

Make sure you take important items with you such as:

- Important documents and identification
- Medications and prescriptions
- Food and water for your family and pets
- Chargers for electronic devices

There is a heightened level of threat. Conditions are changing and you need to start taking action now to protect you and your family.

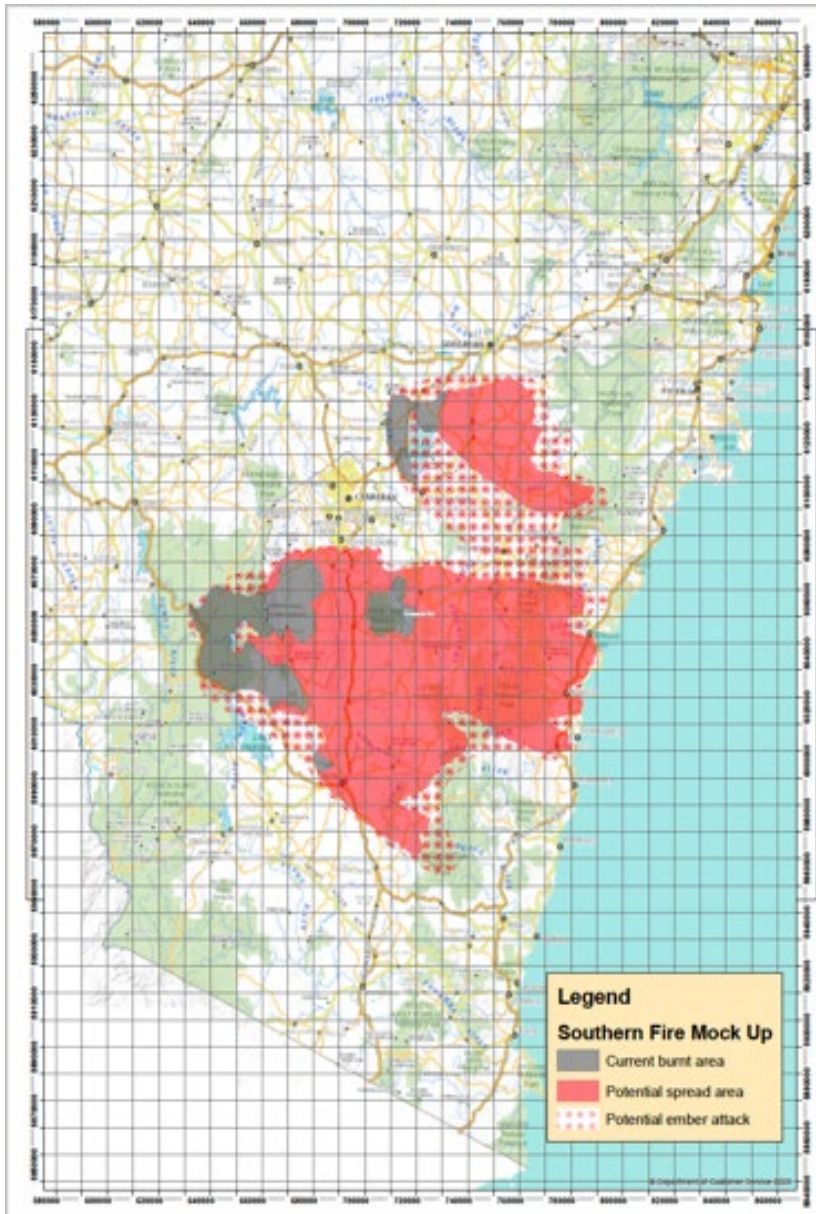
***Actions**

-If your life is at risk, call Triple Zero (000).-If the fire impacts on your location, seek shelter and protect yourself from the heat of the fire.-If your plan is to leave or you are not prepared, consider leaving if it is safe to do so. Go to a safer location away from the fire.-Roads may be dangerous, and could be cut by fire without warning. Only travel if you know it is safe.-Stay up to date on the situation by monitoring local radio, the RFS website, Fires Near Me NSW smartphone app or social media.



New South Wales/ Australian Capital Territory Map 2

Scenario: It is the middle of January in the school holidays. Recent months have been very hot, dry and windy. You live in a property to the east of Braidwood Road just north of Tarago. Tomorrow will be another dangerous day as hot, dry and windy conditions have been forecast, with an EXTREME Fire Danger Rating issued. There continues to be significant bushfire activity in the area. Please review the following maps issued by the Rural Fire Service.

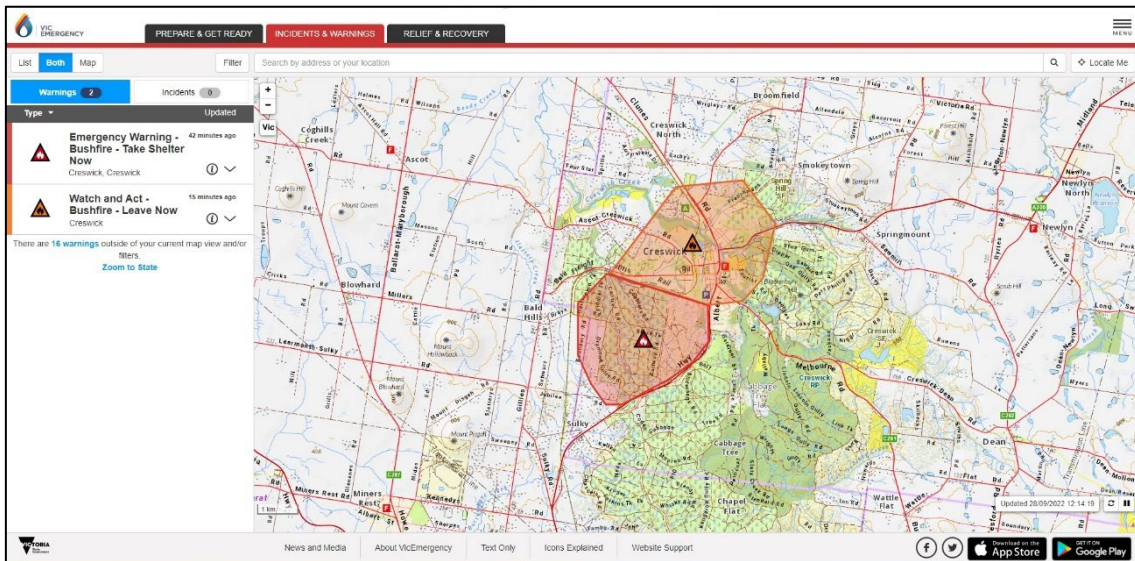


NOTE: no accompanying text to this map



Victoria Map 1

Imagine you are visiting Creswick, Victoria and you are given this map and warning information about a bushfire in the area from Victoria's official emergency information app, VicEmergency.





9/28/22, 12:20 PM Community Notification Sign-off

EMERGENCY WARNING - BUSHFIRE - Take Shelter Now

This Emergency Warning is being issued for Creswick

- There is a bushfire at Creswick that is out of control.
- The bushfire is travelling from Diamond Gully Road in a north-easterly direction towards the Creswick township. The fire started near Diamond Gully Road and Grays Road.
- This message is for people along Hyde Park Road and Bald Hills Road, Creswick and the bushfire could impact anytime within the next 30 minutes.

You are in danger and need to act immediately to survive.

The safest option is to take shelter indoors immediately. It is too late to leave.

What you should do:

You should move indoors:

- Protect yourself by wearing long sleeves and trousers, made from pure cotton or wool. Wear leather boots.
- Bring your pets inside.
- Close all exterior doors, windows and vents and turn off cooling systems.
- You must take shelter before the fire arrives. The extreme heat is likely to kill you well before the flames reach you.
- Shelter in a room that has two exits, such as a door or window including one directly to the outside. It is important to be able to see outside so you know what is happening with the fire.

If your home catches on fire:

- Move away from the rooms that are on fire, closing doors behind you.
- As soon as the bushfire has passed the house, or conditions inside become unbearable, you need to get out and go to an area that has already been burnt. Staying inside a burning building will almost certainly end in death.
- It may still be too hot to remain outside, so you will need to seek shelter in another structure or last resort option.

If you cannot get indoors, last resort options include:

- Shelter in the middle of a large open area like a ploughed paddock, football oval or sporting reserve.
- Get into a large body of water like a dam, lake, river, the ocean or in ground pool.
- Try to protect yourself from the fire's heat.

If you are travelling:

- If you are travelling, do not enter the warning area. U-turn to safety.
- If you are currently driving slow down and turn on your headlights. Smoke will make it difficult to see.

If you are caught in fire in your car:

- Park behind a solid structure to block the fire's heat or pull over to cleared area.
- Try to position the car towards the approaching fire.
- Turn on your hazard lights and headlights. Close all windows.
- Turn off the air-conditioning and shut all the air vents.
- Turn your car engine off.
- Get down as low as possible below window level and cover up with a pure woollen blanket.

This message was issued by Country Fire Authority

https://app.training-prod.cop.em.vic.gov.au/sadisplay/community_notification_preview.html 1/2

9/28/22, 12:20 PM Community Notification Sign-off

The next update is expected by [warning next update] or as the situation changes.

Use multiple sources to stay informed:

- www.emergency.vic.gov.au (<https://emergency.vic.gov.au/respond/>)
- VicEmergency Hotline (<https://vicemergency.zendesk.com/hc/en-gb/articles/115001055007-What-is-the-VicEmergency-Hotline->) - **freecall** 1800 226 226
- VicEmergency app (<https://vicemergency.zendesk.com/hc/en-gb/articles/230492807-What-is-the-VicEmergency-app>)
- Facebook (<https://www.facebook.com/vicemergency>) or Twitter (<https://twitter.com/vicemergency>) (#vicfires)
- Tune in to ABC Local Radio, commercial and designated community radio stations, or Sky News TV.

Accessibility:

The following services can help you, or someone you know, access information during an emergency.

- To access this information in other languages call the Translating and Interpreting Service (<https://www.tisnational.gov.au/>) on 131 460 (**freecall**) and ask them to call VicEmergency Hotline.
- If you are deaf, hard of hearing, or have a speech/communication impairment contact National Relay Service (<https://www.infrastructure.gov.au/media-technology-communications/phone/services-people-with-disability/accesshub/national-relay-service>) on 1800 555 877 and ask them to call the VicEmergency Hotline.



⚠ WATCH & ACT - BUSHFIRE - Leave Now

This Watch & Act message is being issued for Creswick.

- There is a bushfire at Creswick that is out of control.
- The bushfire is travelling from Diamond Gully Road in a north-easterly direction towards the Creswick township. The fire started near Diamond Gully Road and Grays Road.
- Hyde Park Road and Bald Hills Road, Creswick could be impacted by the bushfire anytime within the next 30 minutes.

Don't wait, leaving now is the safest option - conditions may change and get worse very quickly. Emergency Services may not be able to help you if you decide to stay.

By choosing to stay, you and your family may be at risk of serious injury or death.

What you should do:

- Monitor changes to the situation. Increased wind speed, change in wind direction, smoke or poor visibility can indicate the situation is changing.
- Protect yourself and your family.
- If you are away from home, do not return.

If the situation changes or you feel unsafe you should leave:

- Take your pets, medications, mobile phone and charger.
- Many people have died trying to leave at the last minute during fires.
- Travel to the home of family or friends that are away from the warning area or Daylesford

Emergency services may not be able to help you if you decide to stay.

Impacts in your area:

- Check the [VicTraffic](https://www.vic.gov.au/traffic) website ([traffic.vicroads.vic.gov.au/](https://www.vic.gov.au/traffic)) or call 13 11 70 for road closures.

This message was issued by Country Fire Authority.

The next update is expected by [\[warning_next_update\]](#) or as the situation changes.

Use multiple sources to stay informed:

- www.emergency.vic.gov.au ([https://emergency.vic.gov.au/respond](https://www.emergency.vic.gov.au))
- [VicEmergency Hotline](https://www.vic.gov.au/vic-emergency-hotline) ([https://vicemergency.zendesk.com/hc/en-gb/articles/115001055007-What-is-the-VicEmergency-Hotline](https://www.vic.gov.au/vic-emergency-hotline)) - [freecall 1800 226 226](https://www.vic.gov.au/vic-emergency-hotline)
- [VicEmergency](https://www.vic.gov.au/vic-emergency-app) app ([https://vicemergency.zendesk.com/hc/en-gb/articles/230492607-What-is-the-VicEmergency-app](https://www.vic.gov.au/vic-emergency-app))
- [Facebook](https://www.facebook.com/vicemergency) (<https://www.facebook.com/vicemergency>) or [Twitter](https://twitter.com/vicemergency) (<https://twitter.com/vicemergency>) (#vicfires)
- Tune in to ABC Local Radio, commercial and designated community radio stations, or Sky News TV.

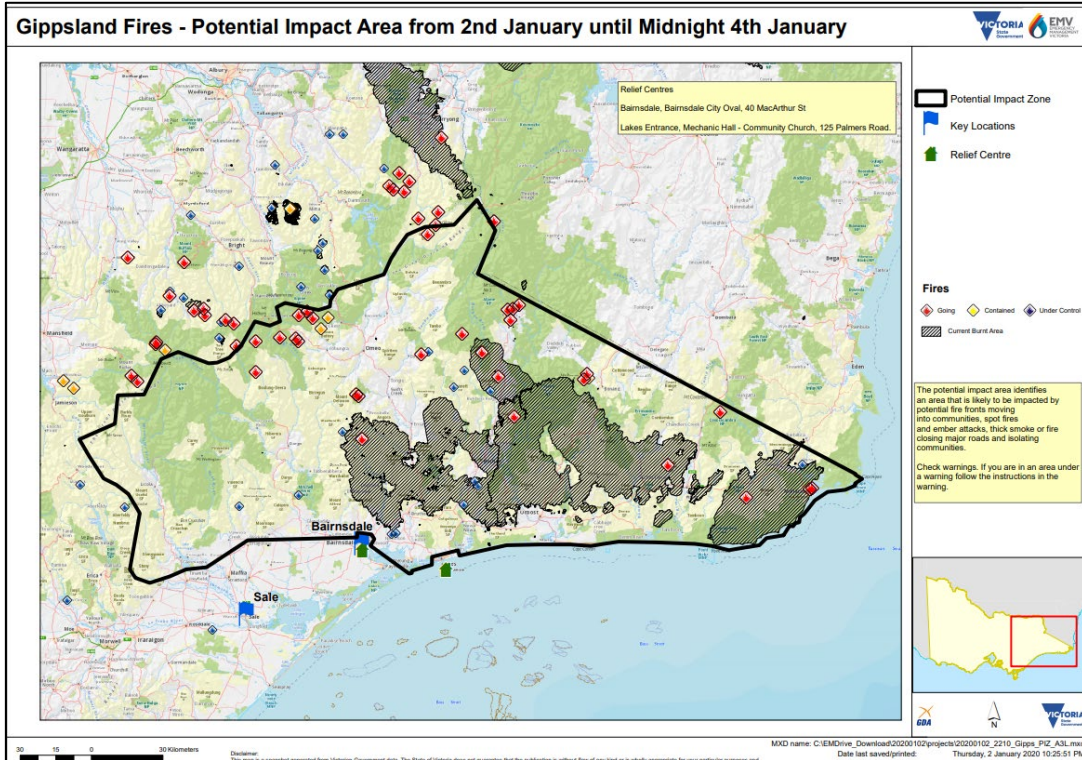
Accessibility:

The following services can help you, or someone you know, access information during an emergency.

- To access this information in other languages, call the [Translating and Interpreting Service](https://www.tisnational.gov.au) (<https://www.tisnational.gov.au>) on 131 450 ([freecall](https://www.tisnational.gov.au)) and ask them to call [VicEmergency Hotline](https://www.vic.gov.au/vic-emergency-hotline).
- If you are deaf, hard of hearing, or have a speech/communication impairment contact [National Relay Service](https://www.nra.gov.au) ([https://www.infrastructure.gov.au/media-technology-communications/phone/services-people-with-disability/access/national-relay-service](https://www.nra.gov.au)) on 1800 555 677 and ask them to call the [VicEmergency Hotline](https://www.vic.gov.au/vic-emergency-hotline).



Victoria Map 2





11/29/22, 9:19 PM

Worsening Fire Conditions Forecast in East Gippsland | Emergency Victoria

Worsening Fire Conditions Forecast in East Gippsland

POSTED:
2 January 2020

There are hot, dry and windy weather conditions forecast for Friday and Saturday. Under these conditions all of the fires currently burning are likely to grow significantly and may become uncontrollable. New fire starts are likely as a result of lightning which is forecast to be a risk. Any lightning strikes in dry, drought affected forests have the potential to quickly become fires that threaten lives and homes.

Now is the time for people in East Gippsland to take action to keep themselves safe. If you are able to leave safely you should do so tonight or early tomorrow morning. If you are unable to leave you should take actions to prepare to shelter.

People who are in East Gippsland, in the Great Dividing Range area including Omeo, Swifts Creek and Ensay, should take the opportunity to leave today and travel to Wangaratta or Wodonga.

If it is safe for you to leave you can travel to friends and family outside the potential impact area or travel to Bairnsdale. You can choose to stay in built up areas of Lakes Entrance.

East Gippsland communities could be impacted today by a fire front, spot fires and ember attacks on homes, or major roads being closed resulting in communities being isolated. If the fires cross or threatens the Princes Highway it will be closed.

Leave if you can:

Communities in East Gippsland who are able to safely leave are encouraged to do so today or early on Friday.

Travel to family and friends who are outside of the area. You can also travel to a relief centre.

You can find out which relief centre is closest to you by visiting:

https://www.emergency.vic.gov.au/relief/#relief_centres

(https://www.emergency.vic.gov.au/relief/#relief_centres)

Before you travel check that your planned route and destination are not currently under threat of fire. While travelling in the area you should monitor weather conditions by listening to local or ABC radio as the situation may change quickly.

When travelling take care on the roads and drive to the conditions. Smoke from these fires may impact visibility when driving.

There are a number of major and local roads currently closed as a result of the fires. Further road closures may occur, including on roads that have recently been reopened, if they are threatened or impacted by fire.

When you leave:

When you leave you should take the following items with you:

- Cash
- Clothing for 3 days
- Medicine for 3 days
- Phone and chargers
- Toiletries

<https://emergency.vic.gov.au/news-and-media/worsening-fire-conditions-forecast-in-east-gippsland>

1/3



11/29/22, 9:19 PM

Worsening Fire Conditions Forecast in East Gippsland | Emergency Victoria

- Important documents
- Mementos and photos
- Pets essentials, including leash and carriers
- Make sure you have enough petrol in your car

If you are unable to leave:

If you are unable to leave the area you should move to built up areas if it is safe to do so.

Prepare to shelter by taking the following steps:

Have clothing that will protect you including a top with long sleeves and trousers. If you can wear clothing made from pure cotton or wool. Wear sturdy shoes or boots and heavy duty gloves.

Gather wool or heavy blankets.

If you currently have power you should charge you mobile phone.

Useful items to gather now includes a torch, batteries, a radio, a phone charger (or in car phone charger), battery back up packs, food and water, medical supplies and a first aid kit.

Consider your pets – gather their food and water.

Move flammable items away from your home including furniture, doormats, wood and BBQs.

A Neighbourhood Safer Place, also known as a Bushfire Place of Last Resort, is for when all other bushfire plans have failed and only if it is nearby. They do not guarantee safety but may offer some protection from flame and heat. Travelling to a Neighbourhood Safer Place can be dangerous.

If you aren't able to shelter in a building, other last resort options include:

Shelter in the middle of a large open area like a ploughed paddock, football oval or sporting reserve.

Get into a large body of water like a dam, lake, river, the ocean or inground pool.

Try to protect yourself from the fire's heat.

Everyone in East Gippsland or who has left East Gippsland should register with Register.Find.Reunite online at register.redcross.org.au. This will assist both the emergency services and allow your loved ones to know you are safe.

Victorians are reminded to connect to multiple sources for emergency information, including the VicEmergency app, www.emergency.vic.gov.au (<http://www.emergency.vic.gov.au>), tuning in to ABC radio or other emergency broadcasters including commercial and community radio stations or Sky TV or by phoning the VicEmergency hotline on 1800 226 226 and following VicEmergency on Facebook and Twitter.

You can view a map of the area here: https://files-em.em.vic.gov.au/public/CommNews/Community-Newletters/20200102_2210_Gipps_PIZ_A3L.pdf?v=202001022234 (https://files-em.em.vic.gov.au/public/CommNews/Community-Newletters/20200102_2210_Gipps_PIZ_A3L.pdf?v=202001022234)

<https://emergency.vic.gov.au/news-and-media/worsening-fire-conditions-forecast-in-east-gippsland>

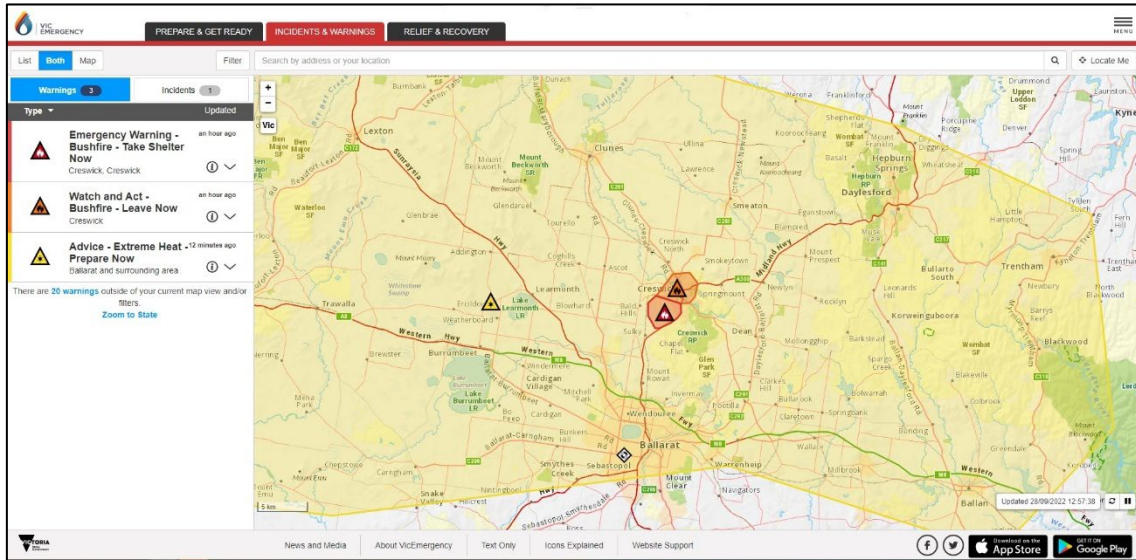
2/3



Victoria Map 3

This map was shown in between Map 1 and 2 in Part 2 of the interview and interviewers asked only two questions:

- What do you notice on this map?
- How does it impact (if at all) your understanding of your overall risk and what people should do?





⚠️ ADVICE - EXTREME HEAT - Prepare Now

This Advice message is being issued for extreme heat in Ballarat and surrounding area

- Heatwave conditions have been forecast for today.

Symptoms of heatstroke include turning pale, a rapid or irregular heartbeat, dizziness, nausea and fainting. You may

Protect your health:

- Heat can make anyone sick.
- People over 65 years old, the very young and those with a pre-existing medical condition are most at risk.
- Heat-related illness can range from mild conditions, such as a rash or cramps to heatstroke - which is life threatening.

• also stop sweating. This is a medical emergency and you should call Triple Zero (000) immediately.

Prepare now to survive the heat. Be aware of the risk of heat-related illness and plan ahead to keep yourself and others safe.

What you should do:

- **Drink water:** Always take a bottle with you.
- **Hot cars kill:** Never leave kids, adults or pets in cars. The temperature inside a parked car can double within minutes.
- **Keep cool:** Seek out air-conditioned buildings, use a fan, take cool showers and dress in light, loose clothing made from natural fabrics.
- **Plan ahead:** Schedule activities in the coolest part of the day and avoid exercising in the heat. If you must go out, wear a hat and sunscreen and take a bottle of water with you.
- **Help others:** Look after those most at risk in the heat - your friends and family or your neighbour living alone, the elderly, the young, people with a medical condition and don't forget your pets.
- Know the symptoms of heat-related illness and monitor your health.
- Plan ahead and keep up to date with weather forecasts. To find out more information visit: www.betterhealth.vic.gov.au/health/healthyliving/heat-stress-and-heat-related-illness (<https://www.betterhealth.vic.gov.au/health/healthyliving/heat-stress-and-heat-related-illness>).

This message was issued by Chief Health Officer.

The next update is expected by 29/09/2022 12:50 pm or as the situation changes.

Use multiple sources to stay informed:

www.emergency.vic.gov.au (<https://emergency.vic.gov.au/respond/>)
VicEmergency Hotline (<https://vicemergency.zendesk.com/hc/en-gb/articles/115001055007-What-is-the-VicEmergency-Hotline->) - **freecall** 1800 226 226
VicEmergency app (<https://vicemergency.zendesk.com/hc/en-gb/articles/230492607-What-is-the-VicEmergency-app-a>)
Facebook (<https://www.facebook.com/vicemergency/>) or **Twitter** (<https://twitter.com/vicemergency>) (#surviveheat)
 Tune in to ABC Local Radio, commercial and designated community radio stations, or Sky News TV.

Accessibility:

The following services can help you, or someone you know, access information during an emergency.

- To access this information in other languages, call the **Translating and Interpreting Service** (<https://www.tisnational.gov.au/>) on 131450 (**freecall**) and ask them to call **VicEmergency Hotline**.
- If you are deaf, hard of hearing, or have a speech/communication impairment contact **National Relay Service** (<https://www.infrastructure.gov.au/media-communications-arts/phone/services-people-disability/accesshub/national-relay-service>) on 1800 555 677 and ask them to call the **VicEmergency Hotline**.



Tasmania Map 1

Imagine you are visiting Lachlan, Tasmania and you are given this map about a bushfire in the area.

The screenshot shows the TasAlert website interface. At the top, there are navigation tabs: "TAS ALERT", "GET READY", "ALERTS" (which is selected), and "RECOVERY". Below the tabs is a header with "Warnings and Incidents for Test Purposes Only" on the left and "TasAlert Staging Site" and "Go to TasAlert" on the right. A search bar with "Search by address or location" and a "Locate Me" button is present. The main map area shows a topographic map of the Lachlan region in Tasmania. A large red area is overlaid on the map, indicating a bushfire warning zone. A black triangle with a white flame icon is placed within this red area. Labels on the map include "Lachlan", "Brookside", "Blackhall Bottom", "Mikes Hill", "Glenfern", "Mount Lloyd", "Mount Charles", "Mount Marian", and "Wellin". Below the map, there are two tabs: "WARNINGS (13)" (selected) and "INCIDENTS (4)". Two alert cards are visible under the "WARNINGS" tab:

- Bushfire Emergency Warning - Lachlan and surrounds - Evacuate now** (3 hours ago)
 - Zoom To
 - Lachlan and surrounds
 - More Information
 - Share Warning
- Bushfire Watch and Act - Lachlan and surrounds - Monitor conditions as they are changing** (a few seconds ago)
 - Zoom To
 - Lachlan and surrounds
 - More Information
 - Share Warning



Emergency Warning

BUSHFIRE EMERGENCY WARNING – MT CHARLES ROAD, JEFFEREYS TRACK, WHITE TIMBER ROAD, UPPER SWAMP ROAD, LOWER SWAMP ROAD, AND SURROUNDS – EVACUATE NOW

This is a bushfire emergency warning message for MT CHARLES ROAD, JEFFEREYS TRACK, WHITE TIMBER ROAD, UPPER SWAMP ROAD, LOWER SWAMP ROAD, AND SURROUNDS.

There is a bushfire near MT CHARLES ROAD, JEFFEREYS TRACK, WHITE TIMBER ROAD, UPPER SWAMP ROAD, LOWER SWAMP ROAD, AND SURROUNDS that is out of control.

MT CHARLES ROAD, JEFFEREYS TRACK, WHITE TIMBER ROAD, UPPER SWAMP ROAD, LOWER SWAMP ROAD, AND SURROUNDS is expected to be at extreme risk as early as 2.00pm.

The fire is travelling towards Lachlan.

Burning embers may threaten your home before the main fire arrives.

Smoke and ash may make it difficult to see and breathe.

Tasmania Fire Service and Tasmania Parks and Wildlife Service is attending. Conditions are expected to worsen.

What to do:

If your home is built using contemporary bushfire design standards, is well prepared and you can actively defend it, it may provide shelter.

If your home is unprepared, go to a safer location now only if the path is clear.

There is a nearby safer place at Gleeson Park, Lachlan.

If you have made a bushfire plan, use it now.

If you don't live near Lachlan, stay away.

For fire updates, listen to ABC Local Radio or visit TasALERT.com

Community Information:

For information on current road closures, visit the Tasmania Police website: police.tas.gov.au/community-alerts/

People at higher risk from the effects of smoke, including those with medical conditions, are advised to have a personal plan for avoiding smoke and managing their health. Advice is available from the Department of Health [health.tas.gov.au/health-topics/environmental-health/air-quality/or Asthma Australia asthma.org.au/about-asthma/triggers/bushfires-and-smoke/](http://health.tas.gov.au/health-topics/environmental-health/air-quality/or_Asthma_Australia_asthma.org.au/about-asthma/triggers/bushfires-and-smoke/)

If there is a fire and your plan is to evacuate or leave, the best option is to stay with family or friends.

Alert Level:

EMERGENCY WARNING

Type:

Bushfire

First Reported:

Cyclone Ridge, Buckland

Location:

Going

Status:

Not reported

Size:

Last Updated:

06-Jan-2021 13:09

Agency:

Tasmania Fire Service



Tasmania Map 2

Imagine you are visiting Lachlan, Tasmania and you are given this map about a bushfire in the area.

The screenshot displays the TasAlert interface. At the top, there are navigation tabs: 'TAS ALERT', 'GET READY', 'ALERTS', and 'RECOVERY'. Below these is a red banner with the text 'Warnings and Incidents for Test Purposes Only' and 'TasAlert Staging Site' with a 'Go to TasAlert' link. A search bar and 'Locate Me' button are present. The map shows Lachlan, Tasmania, with a large red area (Evacuate now) and an orange area (Monitor conditions) around it. Below the map, there are two alert cards:

- WARNING (13)**
 - Bushfire Emergency Warning - Lachlan and surrounds - Evacuate now** (3 hours ago)
 - Zoom To: Lachlan and surrounds
 - More Information | Share Warning
 - Bushfire Watch and Act - Lachlan and surrounds - Monitor conditions as they are changing** (a few seconds ago)
 - Zoom To: Lachlan and surrounds
 - More Information | Share Warning
- INCIDENTS (4)**



Watch and Act

BUSHFIRE WATCH AND ACT – LACHLAN AND SURROUNDS – MONITOR CONDITIONS AS THEY ARE CHANGING

This is a bushfire watch and act message for Lachlan.

There is an uncontrolled bushfire in the Wellington Range near Lachlan.

This fire is expected to put Lachlan at high risk by 4.00pm.

The fire is travelling towards Lachlan.

Embers, smoke, and ash may fall on Lachlan and threaten you and your home before the main fire arrives.

Tasmania Fire Service and the Tasmania Parks and Wildlife Service are attending. Conditions are expected to worsen.

What to do:

If you have prepared your home and can actively defend it, it should provide shelter.

If you are going to leave, make sure you have a clear path to a safer place.

There is a nearby safer place at the Gleeson Park, Lachlan.

If your family has made a bushfire plan, use it now.

If you do not live near Lachlan, stay away. The roads could be very dangerous.

For fire updates, listen to ABC Local Radio or visit TasALERT.com

Community Information:

For information on current road closures, visit the Tasmania Police website: police.tas.gov.au/community-alerts/

People at higher risk from the effects of smoke, including those with medical conditions, are advised to have a personal plan for avoiding smoke and managing their health. Advice is available from the Department of Health health.tas.gov.au/health-topics/environmental-health/air-quality, or Asthma Australia asthma.org.au/about-asthma/triggers/bushfires-and-smoke/

If there is a fire and your plan is to evacuate or leave, the best option is to stay with family or friends.

Alert Level:	WATCH AND ACT
Type:	Bushfire
First Reported:	
Location:	Wellington Range, Lachlan
Status:	Going
Size:	Not reported
Last Updated:	06-Jan-2021 11:48
Agency:	Tasmania Fire Service

Issued At: 01/01/2021 11:00am

Incident number: 20022246



Appendix C – Interview Guide

Natural Hazards Research Australia Bushfire Maps project – Year 1 Interview Guide

Kuligowski – Revised 22_6_22

Part 1: Recent experiences with bushfire

I'd like to talk to you about your experience with bushfires.

Context/screening questions (1,2)

1. Can you recall a recent experience (maybe in the last 3 or 4 years) where you were in an area that was threatened by a bushfire?
2. If so, please tell me more about *when and where the fire occurred*.

Prior risk perception:

3. Prior to this event, what did you think about the bushfire risk of that area?

Initial cues (channel/source):

4. Now, related to your recent experience with a bushfire, how did you first become aware of the fire? (*Probe - who were you with, where were you?*)

Cues/Warnings (+Channel/source):

5. After first becoming aware, please walk me through what additional information you received about the event (*Probes – information about the fire, what to do next, emergency warnings?*).
 - a. How did you receive/get the information (for each instance)? (*Probing for channel and source - media, friends/family, officials, cues from the fire itself*)

Cues - Maps:

6. Do you remember seeing or using any maps (of the fire or warnings or both) for your area? If yes, where did the map come from (**source**) and how did you access it (**channel**)? (*Probe: did you use your phone to see it?*)
7. How did you use the map or map products during the event (if at all)? (*Or, what did you use the map for? or what information did you get from the map?*)

Behavioural response + perceptions of threat/risk

8. How did you (and your family) respond to the fire? (*Probe: did you evacuate, defend in place, help others and then leave, etc.?*) and **why** did you make that decision (or series of decisions)?
 - a. Please describe the moment you realised that you needed to take some type of action. (*Probe: What were you thinking, feeling, doing, etc.? Did you feel at risk at any point in time?*)

Next, I will ask a few additional questions about the map(s) (if used)

Evacuation Decision-making

9. If at all, how did the map help you in the decision(s) you made that day (or over the course of the fire event)? (*Probes: did it influence a decision to stay/go/wait, decision to take a route or avoid a certain route, prepare their property, seek additional information, check in with other people [family/friends], etc.?*)

(If it didn't help, probe how any other information may have helped them)

Perspectives on hazard adjustment/stakeholders

10. *[If not already answered in Q9]* Overall, what did you think about the map? How helpful was it to you (and why)?
 - a. If it wasn't helpful, why not? *[e.g., not easy to understand, I didn't trust the map, missing information on X, etc.]*



Part 2: Now I have some questions for you regarding the types of bushfire maps used in your area.

- Map A is shown first: Simple map from that jurisdiction (e.g., one fire/hazard; showing only one warning stage, etc.) and then the participants are asked Q1-11 below related to Map A.
- Map B is shown next: A more complex map also from that jurisdiction (e.g., showing multiple fires or hazards; fire spread predictions, etc.) and then the participants are asked Q1-11 below again related to Map B.

NOTE: Please see ethics application attachment: "Example Maps" for potential maps to be tested in this part of the guide.

Hypothetical scenario (instructions to participants): Imagine you are visiting [PLACE on map] and you are given this map about a bushfire in the area. Please answer the following questions regarding this map...

1. Have you ever seen a map like this before? If so, where and when (*if not already discussed in Part 1 of the interview*)?
2. Overall, what is this map telling you? What information are you getting from this map, if any? (*Probe: information regarding their own safety, what they should do next, etc.*)

Attention - pre-decisional process:

3. What captures your attention at first? Why? What do you see next?

Comprehension/perceptions of threat and risk:

4. Please walk me through each element on the map. What does each mean to you? (*Probe specific things on the map – e.g., what do the polygons mean to you?*)

Threat and risk perception:

5. Which area of the map is at the highest risk of harm? Why? Please explain.

Behavioural response/intention:

6. What should the people located in this area [identified in Q5] do next? Why? (*Probes: seek additional information OR contact family members OR prepare the house/to leave OR leave immediately...or a combination of these?*)

Perspectives on hazard adjustment/stakeholders:

7. How might you use this map in a bushfire?
8. Would you have confidence in the information provided in this map? Why or why not?
9. Is the information in this map useful? Is it easy to understand? Why or why not?
10. What types of (additional) information would be helpful to include in this map, in your opinion?
11. How might you improve this map for future use?