Natural Hazards Research Australia

Predictions in Public: Understanding the design, communication, and dissemination of predictive maps to the public

Work Package 7 Development of fire prediction map concepts

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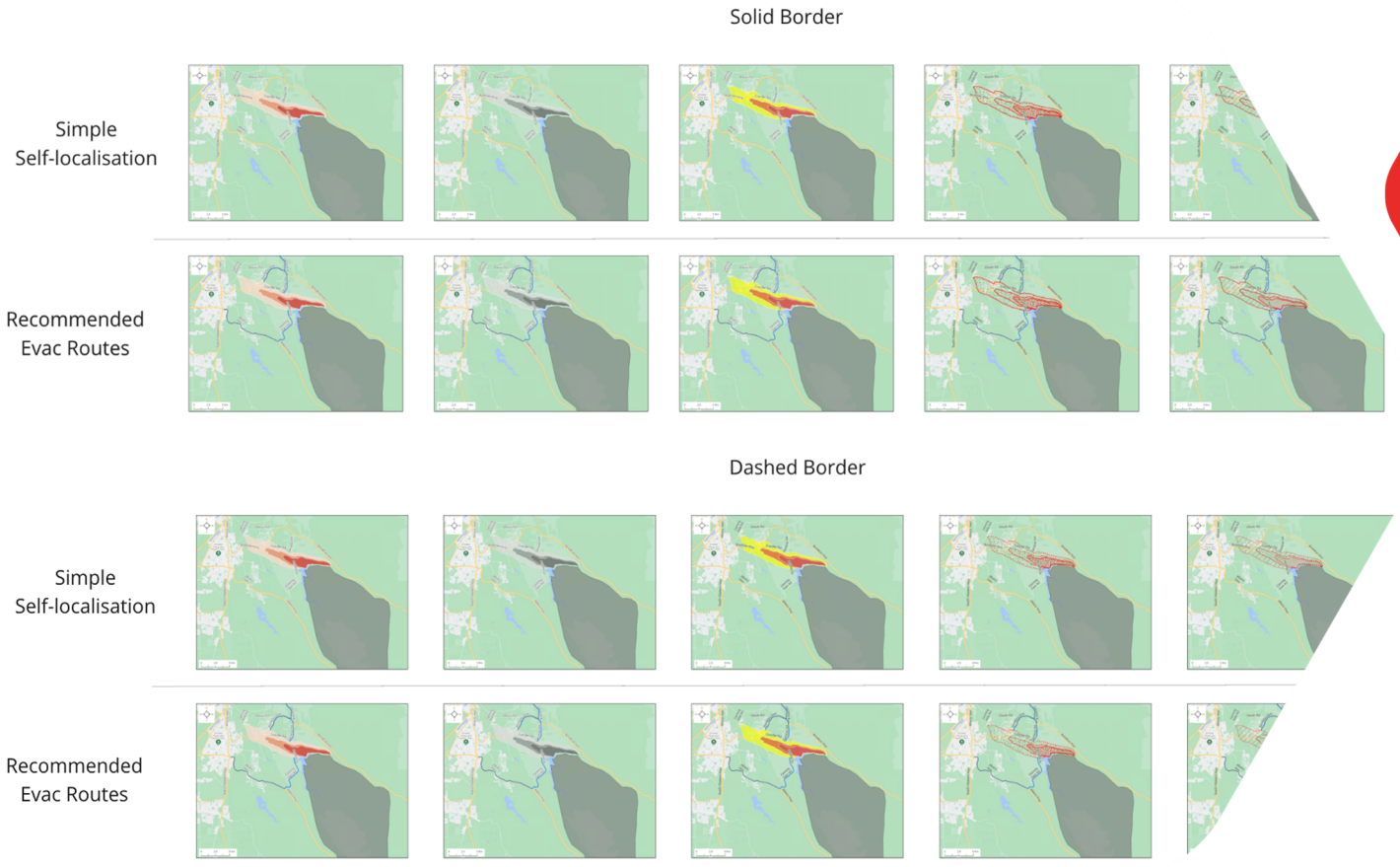

Version	Release history	Date
1.0	Final document	06/06/2025

Australian Government

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

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.

Publisher:
Natural Hazards Research Australia

ISBN: 978-1-923057-32-6

Report number: 52.2025

June 2025

Cover image: Amy Griffin

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Acknowledgements

The project team would like to acknowledge members of the project's Steering Committee of end-users for this Natural Hazards Research Australia (the Centre)-funded project. The researchers thank the member agencies for collaborating with the research team throughout Phases 1 and 2 of the project and in the development of the fire spread prediction map concepts. The research would not have been as relevant and successful without such a high level of engagement. The project team would also like to acknowledge the work of Jennifer Dubois (research assistant) who greatly helped the production of maps in the many design ideas and iterations explored in this work package; Jackson Parker (Western Australia (WA) Department of Fire and Emergency Services (DFES) who produced the bushfire spread prediction data that was used in the maps; and Deanna Pullella (WA DFES) who developed the Australian Warning System (AWS) warning areas and accompanying warning text for the five time points of the simulated bushfire scenario.

Executive summary

The *Predictions in Public* project aims to use collaborative processes and empirical evidence to define how future predictive products should be crafted to promote safe and effective public response during a bushfire emergency.

The research conducted in Phase 1 of the project focused on understanding current practice. Specifically, the research aimed to understand current agency practice as well as community comprehension and use of existing incident warning products. This was done to ensure that any future predictive products can complement those existing products.

Research conducted in Phase 1 (Work Packages 1 – 6) provides a strong foundation from which the project can move into Phase 2 (Work Packages 7 – 14) and develop and test fire spread prediction map concepts with communities across Australia. The aim of the research conducted in Phase 2 is to promote a nationally consistent approach to the use of fire spread prediction maps in communication with members of the public during an emergency. This will be achieved by providing evidence and guidance to emergency management agencies based on the research findings.

This document provides an overview of the collaborative process that the research team undertook to develop the fire spread prediction map concepts together with the project's steering committee. It illustrates the iterative nature of this development and presents the initial map concepts. These concepts will further be developed and refined throughout Phase 2. In a first step, they will be presented to the project Steering Committee, comprised of members of the AFAC Predictive Services Group and the AFAC Warnings Group for endorsement. They will then be tested and refined through a range of empirical studies with community members across Australia.

The initial fire spread prediction map concepts presented in this document, reflect decisions made by the project team (i.e., the research team and the project Steering Committee) based on discussions about the findings of Phase 1.[1] At the end of Phase 1 the project team selected 6 principles from the evidence-based principles developed in Work Package 2 to focus on during the empirical studies in Phase 2 of the research. These principles were selected because they represent important agency decision points. These decision points currently lack evidence which can be used to support and inform them.

To develop the initial map concepts presented in this document, the research team worked with the Steering Committee through a series of workshops. The workshops provided an opportunity for all members of the project Steering Committee to provide structured input that helped to gain further information to support the development of the map concepts. Based on the results of the workshops, draft research questions for each of the selected principles as well as a set of initial fire spread prediction map concepts have been developed. These research questions will be address and the initial map concepts will be tested through the first three empirical studies conducted as part of Phase 2:

- Focus groups in three locations (Work Package 8)
- A national community survey (Work Package 9)
- Eye-tracking studies (Work Package 10)

Based on the collective results of these three empirical studies, the research team will work with the project Steering Committee to refine the fire spread prediction map concepts and test these refinements with community members again in a wider range of scenarios in a national community survey as well as in interviews with specific community members.

[1] See https://www.naturalhazards.com.au/resources/publications/report/predictions-public-phase-1-report

End-user statement

Deana Pullella, Team Leader, Public Information | Media and Corporate Communications, Department of Fire and Emergency Services, Western Australia

Fires can be difficult for many people, including those who live in areas of high risk and where bushfires are more prevalent. Many people often struggle to decide what actions to take when faced with a bushfire emergency which is why emergency services encourages all Western Australians to have a Bushfire Plan, and to follow official information in public warnings. This research allows us to test if producing fire spread prediction maps might help people to take the most appropriate action to stay safe. The *Predictions in Public* project and the regular fortnightly meetings of the project's Steering Committee have allowed us as jurisdictions to contribute to solving the challenge of developing a set of design principles for fire spread prediction maps that is workable for all jurisdictions to achieve a nationally consistent approach. This is not straightforward given the differences that exist among jurisdictions in how fire maps are produced and disseminated. The opportunity to provide input into the design of the maps and the studies testing their effectiveness has meant that different jurisdictions can gain insights that are relevant to their own operational contexts.

Introduction

Predictions in Public: Understanding the Design, Communication and Dissemination of Predictive Maps to the Public (*Predictions in Public*) project is a research project which uses co-design principles (i.e., collaboration, inclusion and flexibility) to address a current challenge faced by the Australian emergency management sector.[2] The use of predictive fire spread maps to communicate with the public was identified as a challenge fire agencies are currently grappling with due to a number of factors:

- advancements in technology increased our opportunities to create and access situational intelligence
- increase in public expectations related to being able to access real-time data
- recommendations from reviews, inquiries and royal commissions continuously call for improvements in the timeliness and quality of warning products
- use of fire predictions received increasing attention since the 2019/2020 fire season when "Red Maps" were released to the public in New South Wales (NSW) and the Australian Capital Territory (ACT) which gave rise to questions about the value of producing fire spread predictions during future fire seasons across Australia
- previous Victorian research shows while operational staff agree that providing the public with quality real time information is important, concerns remain regarding how to effectively embed predictions into existing warning products and when and how to release them to the public.[3]

The project design was created through discussions and support from the AFAC Predictive Services Group and the AFAC Warnings Group.[4] As a result, *Predictions in Public* aims to develop a clearer understanding of the role of fire predictions in agency communications with the public during an emergency.

The overall aim of the project 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 to practical project outputs to translate the research findings into fire agency policy and practice.

The project has been divided into three phases (see also Appendix A):

- **Phase 1:** Understanding current agency practice and community comprehension and use of existing public-facing map-based products (i.e., incident warning maps and fire spread prediction maps). (Work Packages 1-6, completed)
- **Phase 2:** Developing and testing national public-facing fire spread prediction map concepts. (Work Packages 7-14, in progress)

[2] See https://www.naturalhazards.com.au/predictions-in-public
[3] Begg C, Dwyer G, Neale T & Pollock I (2021) *Established and emerging uses of predictive services in Victoria*, Bushfire and Natural Hazards CRC, Melbourne. https://www.bnhcrc.com.au/publications/biblio/bnh-8189
[4] AFAC is the Australian and New Zealand National Council for fire and emergency services

- **Phase 3:** Developing practical outputs for agency use. (Work Packages 15-18)

This document provides an overview of the collaborative process used to develop fire spread prediction map concepts with input from the research team and project Steering Committee. It also presents the initial fire spread prediction map concepts developed to address the research questions developed through this collaboration. The fire spread prediction map concepts presented in this document are initial concepts and are still open questions that will be resolved as the project moves through the upcoming Phase 2 work packages.

The development of fire spread prediction map concepts: a collaborative process

Building on the research team and the project Steering Committee's work in Phase 1 of the project,[5] a series of additional workshops were held to discuss and develop fire spread prediction map concepts. This section outlines the approach used to ensure national agreement on the map design elements that will be tested with communities in Phase 2, creating a stronger evidence base for the project's design principles (see Work Package 2). The principles are one of the practical outputs that will be delivered by the project. They were identified as a practical use of the research findings by the project Steering Committee at the beginning of the project. They have also provided a useful approach to scoping and structuring the research design.

Six principles were selected for further research as it was agreed that these principles represent important decision points for agencies and that there would be benefit in obtaining better evidence to support and inform future decisions related to those principles. The six principles that were selected to structure the design of the Phase 2 studies are:

- **Principle 1:** Maintaining clear triggers for map production, dissemination and updates
- **Principle 2:** Ensuring 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
- **Principles 3:** Communicating risk and uncertainty (showing location, directionality and timeframe of the hazard)
- **Principle 4:** Ensuring predictive maps complement incident warning maps
- **Principle 5:** Ensuring that maps are accessible to a wide range of audiences
- **Principle 6:** Ensuring cross-border coordination regarding authorisation of map dissemination to the public.

To develop the fire spread prediction map concepts, four workshops and a series of one-on-one meetings were held with the research team and the project Steering Committee (April-September 2023). This section provides an overview of these workshops and their outcomes to demonstrate the iterative nature of the design process.

Workshop 1: Scenario development

The aim of workshop 1 was to enable each jurisdiction to develop up to three scenarios that they believe demonstrate the appropriate use of public-facing fire spread prediction maps.

Workshop participants worked together on a Miro board to complete this task. Each jurisdiction completed their own table. Some tables were not complete by the end of the session and follow up emails were sent and meetings were set up to work with jurisdictions to complete the task.

It was decided that the research team would wait to see the results of the Miro board exercise to inform the decision of how to use scenarios in the Phase 2 research studies. Although there was variation in the scenarios from jurisdiction to jurisdiction, reflecting differences in the physical and social environments across jurisdictions, some commonalities were found across jurisdictions.

[5] See Begg et al. (2024) *Predictions in public: Understanding the design, communication and dissemination of predictive maps to the public. Phase 1 Final Report*. Natural Hazards Research Australia, https://www.naturalhazards.com.au/resources/publications/report/predictions-public-phase-1-report

Five interesting scenarios were identified as part of this process:

- **Scenario 1:** Campaign fire [a bushfire of significant size and complexity that requires a high level of resourcing in its response], main road likely to be cut off within 24 hours. Impacted communities: residents, tourists, farmers/business owners - see Northern Territory (NT), WA, South Australia (SA), Tasmania (TAS), Queensland (QLD) and ACT. There was a suggestion to include a wind change in the campaign fire scenario - NSW and SA.
- **Scenario 2:** Fire developing in a mountainous/hard to access landscape within a national park, communities likely to be impacted within the next 24 hours. Impacted communities: residents, tourists and businesses - see NT, Victoria (VIC), SA, QLD. This scenario presents particular challenges for self-localisation (Principle 2) because of a lack of distinctive and commonly recognised landmarks in many park locations.
- **Scenario 3:** Fast-moving grass fire. Impacted communities: residents and business owners - see VIC. Concern: how fast is too fast for production and dissemination of fire spread prediction maps?
- **Scenario 4:** Multiple fires in the landscape creating confusion – NSW.
- **Scenario 5:** A fire that is not a concern to emergency management agencies but has the potential for public interest (smoke prediction - QLD) or interest to specific groups (conservation - NT). Interested parties: residents, tourists, businesses and park rangers - see TAS, QLD, ACT, NSW and NT. Concern: fire is out before prediction is relevant - NSW and ACT. SA - prediction requires 4+ hours for level 3 fire.

Workshop 2: Fire spread prediction map concept development

Workshop 2 presented the five scenarios developed from workshop 1 and sought feedback from the Steering Committee regarding which scenarios to focus on. The research team also presented initial ideas about a number of map design concepts that we could test using PowerPoint slides. There was agreement from the project Steering Committee to focus on scenario 1. Focusing on one scenario in the first instance would allow the research to test a greater variety of design elements for the fire spread prediction maps in a first step (see Work Packages 8-10) and then to refine and further test the most promising design(s) to ensure that it is transferable across different scenarios and intended audiences (see Work Packages 12 and 13).

Regarding the design elements that we might test through our fire spread prediction map concepts, the approach of presenting the options using PowerPoint slides resulted in less feedback from the Steering Committee. This was perhaps also a result of map concepts being presented in the abstract – that is, not in the depiction of a specific fire in a specific scenario – meaning it was difficult to think about whether the concept might be effective. The research team decided to move the discussion back to the Miro board for workshop 3.

Workshop 3: Development of fire spread prediction map concepts (cont.)

During the wrap-up sessions between the research team and the project Steering Committee at the end of Phase 1, the evidence-based principles (Work Package 2) were discussed. It was decided that the three initial studies conducted in Phase 2 would focus specifically on principles 1-4. Principle 5 will be addressed by research conducted later in Phase 2 and principle 6 will be developed through discussions of all the research findings at the end of Phase 2.

Based on the discussion during the Phase 1 wrap-up sessions,[6] the research team developed a set of research questions for principles 1-3 (questions related to principle 4 were integrated across the questions for principles 1-3). These questions aimed to gain additional information from members of the project steering committee to inform the development of the fire spread prediction map concepts (see Table 1 for an overview of the research questions that correspond to each principle).

Prior to workshop 3, the research team worked with the WA steering committee members and their colleagues to further develop an initial scenario by placing a campaign fire in a specific location and describing how that fire would evolve in that location. WA nominated themselves to host the scenario and assist the research team to further develop the scenario.

The initial scenario was:

> *It is a hot, windy summer's day and a bushfire has started in Banyowla Regional Park in Kelmscott. The Incident Controller has requested an Emergency Warning for parts of Roleystone. The bushfire is heading in a south easterly direction however a wind change will move the fire in a south westerly direction towards Kelmscott. The fire will impact Turner Road and potentially Albany Highway within 24 hours, cutting off a major metropolitan thoroughfare and freight route into Perth. If the fire continues in this direction it will start impacting people in residential Kelmscott. There are people hiking in Banyowla Regional Park, tourists at orchards and various tourist locations, and farmers/residents in the townsite/rural areas.*

In workshop 3, the research team presented this initial scenario and the principles with their corresponding draft research questions on the Miro board to get feedback about which of the questions would provide information about the map designs that was seen to be most useful for the jurisdictions. Not all jurisdictions responded to every draft research question. However, all members of the project steering committee were provided with multiple opportunities to provide responses to the questions posed on the Miro board. In addition to workshop 3, one-on-one out of session meetings were set up with jurisdictions that were not able to be at the workshop or where input was missing. The input from the steering committee related to the principles and research questions, as well as discussion summaries and action statements are presented in the following section.

Table 1 presents an overview of the results of the workshop 3 discussion related to Principles 1, 2, and 3 (with questions related to the relationship between current incident warning products and future prediction products - Principle 4 - integrated into questions related to Principles 1-3). The actions identified as part of this workshop helped to revise and refine the WA scenario as well as produce a first set of draft maps that explored several design elements that could be tested in the Phase 2 studies. These draft maps were presented and discussed in workshop 4.

[6] See Begg et al. (2024) *Predictions in public: Understanding the design, communication and dissemination of predictive maps to the public. Phase 1 Final Report*. Natural Hazards Research Australia, https://www.naturalhazards.com.au/resources/publications/report/predictions-public-phase-1-report

TABLE 1. QUESTIONS FOR THE STEERING COMMITTEE, A SUMMARY OF DISCUSSIONS AND ACTIONS

Principle	Question	Summary of Discussion	Action
Principle 1: Maintaining clear triggers for map production, dissemination and updates	**1. *What protective actions are required from each target audience (i.e., residents, tourists, and farmers) for scenario 1?***	The responses to this question suggest that selecting specific locations for each of the target audience groups (i.e., residents, farmers and tourists) may better enable the team to create appropriate protective action statements that can be tested through the research conducted with community members in Phase 2.	The research team will work with the WA stakeholders to further develop the scenarios.
	2. *How can protective actions for prediction maps be linked to warnings and advice/incident warning maps?*	No comments.	To be further investigated.
	3. *How can the update times of the prediction maps complement incident warning update times?*	***Map production and initial release:*** Beginning of the day to be investigated as an appropriate time to release a predictive map. Things to consider are: Lead time required to take appropriate protective actions (current suggestions are early morning/night before) How long the fire has been going/likely to continue based on current conditions ***Map updates:*** Consensus that the timeframe for updates doesn't need to be set. Could be updated alongside Watch and Act incident warnings if changes are required (i.e., change in situation/weather). Predictions should accompany an incident warning as a way of providing additional information/context for the warning. Important to consider how current agency doctrine and policies related to incident warnings might impact upon prediction products. Important to consider the current capabilities of FBANs/incident management teams to update predictive products. Concerns about how updates might impact community decision making (i.e., could more updates/expectation of updates lead to inappropriate actions being taken by communities?) Important to include a timestamp and expressing time to impact as "impact at X:00" rather than "impact in 2 hours".	Use the reflections presented here to update the predictive product description in the Current Practice Atlas. Consider whether/how concerns/suggestions raised here can be tested in Phase 2 research (i.e., could more updates/expectation of updates lead to inappropriate actions being taken by communities? And, expressing time until arrival/impact as specific times rather than "arrival/impact in 2 hours").
	4. *How often could prediction maps reasonably be updated by agency staff in each jurisdiction?*	NSW noted that the prediction maps that included multiple fires took a day prior to release to produce. Predictions for one fire are seen to be easier and would take approx. 2 hours. One jurisdiction expressed that concerns are less about capability to update predictive maps and more about delays caused by the current authorisation environment. Currently lack of clarity about who would be producing the public-facing product (i.e., IC, Mapping, FBANs, PIOs).[7] One jurisdiction commented that releasing predictive maps at the beginning of the day to provide extra context for incident warning maps (i.e., to inform people before they are in the Emergency	Potential for further investigation of current agency capabilities and capacities to produce, release and update public-facing predictive maps in Phase 3.

[7] IC (incident controller), FBANs (fire behaviour analysts), PIO (public information officers).

Principle	Question	Summary of Discussion	Action
		Warning area), is potentially an effective use of existing capabilities. This is because the capacity to update prediction maps may decrease as the fire progresses throughout the day.	
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	**Which base map should we test (Google, monochrome or satellite)?**	There was support from most jurisdictions for all the base map options.	Research in Phase 2 will test three base maps (i.e., Google, monochrome, and satellite).
	2. *What information should be included on the map to encourage particular protective actions from specific members of the public (i.e., tourists, residents, businesses, etc.)? Please rank the following based on importance (pink examples were highlighted in Phase 1 community research as important map features to promote self-localisation and inform protective actions):* ***a. terrain*** ***b. road names*** ***c. known and potential road closures*** ***d. places of last resort/neighbourhood safer places/evacuation/relief centres*** ***e. local landmarks/shops*** ***f. hazard markers/icons*** ***g. burnt area*** ***h. additional information?***	There were mixed views from jurisdictions but broad agreement on the need to include/test: • Known road closures (investigate existing systems in SA and TAS/blue road to highlight potential routes and red road for potential closures) • Road names (only relevant roads) • Evacuation centres (use existing icon used in WA) • Burnt area (potentially active fire) There was less consensus around: • Terrain (potentially useful depending on location/scenario. Could use hill shading.) • Hazard icons (could be used to inform people of hazardous areas to avoid - i.e., factories). • Local landmarks Additional information could include: • Wind (fire direction) • Operational staging areas/air ops - to inform people to stay away from these areas.	Further discussions within the research team regarding which information to include in all map concepts and which information to test.
	3. *How should we test the aforementioned elements? Consider links to current incident map designs.*	Concerns were raised regarding potential confusion related to displaying known and potential road closures. Only one jurisdiction suggested that including neighbourhood safer places (NSPs) would be relevant. One suggestion to include key locations where relevant. Interest in testing burnt area to understand what people are doing with that information.	Potentially investigate the concern related to the potential for people to misunderstand potential road closure information. Is a fire spread prediction map the best place for actual and potential road closures? Further discussions about whether to include NSPs in scenario 1. Further discussions about whether to include key locations in scenario 1 and if so, how. Potentially use research to gain a better understanding of why and how people are using the information provided by the burnt area.
	4. Is it possible to include this information	Only one jurisdiction responded to this question.	Further investigate how to work with existing base maps at

Principle	Question	Summary of Discussion	Action
	on current agency base maps?		the end of Phase 2.
Principle 3: Communicating risk and uncertainty (showing location, directionality and timeframe of the hazard)	***1. How should risk and uncertainty be communicated to encourage particular protective actions from specific members of the public (i.e., tourists, residents, etc.)? Consider findings from research conducted in Phase 1.***	*Most likely vs. worst case scenarios*: General support for testing the worst-case scenario (except for SA due to concern related to community trust). Existing models do not include suppression, therefore, "most likely" scenarios based on typical suppression activities will be difficult to create. Ensembles may be able to present probabilities/likelihoods, using a colour gradient to communicate severity or likelihood, beyond most likely/worst case. There is potentially an option to include a time slider to communicate directionality and impact over time. Ensembles are based on changing inputs (e.g., wind, temperature, etc.) rather than actual weather data. It will be challenging to communicate percentage likelihood. Need for simple language. *Timeframes*: General support for the use of isochrones but not hourly, rather 3, 6, 12 hours.	Further investigation of how to present risk and uncertainty, including the opportunity to use ensemble predictions.
	2. What additional information should be included to communicate the risks related to this scenario? (i.e., directionality of hazard, smoke, embers, burnt area/location of fire front at time of publication, etc.)	While one jurisdiction expressed that being able to show smoke would be useful in some scenarios, other jurisdictions acknowledged that it is difficult to currently predict and show smoke as well as embers. Two jurisdictions expressed interest in testing an unexpected wind change.	Exclude smoke and embers from the first round of studies and focus on fire. Investigate the opportunity to include an earlier wind change. Is it possible to include this in an ensemble prediction? How can this be communicated to the public?
	3. What colour polygons/isochrones should be used/tested? Consider links to current incident warning maps and the findings from research conducted in Phase 1.	There was a lack of consensus from jurisdictions regarding what colours to use for the polygons/isochrones displayed on the draft prediction map concepts. While some jurisdictions were in favour of using the AWS colours (red, orange, yellow) because they are familiar, others suggested the colours should be different for the same reason and that use of the AWS colours has the potential to cause confusion between products. Other options discussed were slightly different colours to the AWS (i.e., dark maroon from the ignition point to yellow, greyscale, and shades of red).	Further investigate colour options and test a variety of them in the first round of Phase 2 studies.
	4. What type of borders should the polygons/isochrones have? Consider links to current incident warning maps and the findings from research conducted in phase 1.	There is interest from the steering committee in testing both hard polygon borders and soft/fuzzy borders. One suggestion was to investigate whether the circles used in cyclone predictions are applicable to bushfires.	Further investigate polygon borders by testing a range of options, including hard and soft borders in the first round of Phase 2 studies. Further investigate the applicability of the approach to cyclone predictions for transferability to bushfire predictions.

The research team also met with the WA stakeholder team outside of the regular fortnightly Steering Committee meetings to discuss the WA scenario. Based on the discussions from workshop 3 and further discussions with the WA stakeholder team, it was decided that we needed to revise and refine the scenario so that it modelled a larger fire. The rationale for this was that, based on prior research and discussions, such prediction maps would only likely be used for fires that have been burning for a long enough period for fire agencies to be confident that the fire is likely to continue to burn over the next 24 hours (see Work Package 3). Also, because the models do not include suppression, it was argued that fire spread prediction maps are more appropriate and potentially useful when the weather conditions are such that there is high confidence that suppression activities will be unsuccessful. This also supports a decision to test a worst-case scenario in the Phase 2 studies.

As a result, the WA stakeholder team worked to develop a new scenario:

> *A bushfire has been burning near Jarrahdale State Forest, south of Brookton Highway, in Ashendon for four days. Today is a hot, windy summer's day and the fire activity is expected to increase. The Incident Controller has called Public Information to issue an Emergency Warning for parts of Karragullen. The bushfire is heading in a northerly direction however a wind change will move the fire in a northwesterly direction towards Roleystone. The fire may impact Brookton Highway within 24 hours, cutting off a major thoroughfare and route out of the Perth Hills. If the fire continues in this direction it will start impacting people in residential Roleystone. There are tourists visiting Araluen Botanic Park, people hiking in local bush tracks and farmers/residents in the townsite/rural areas.*

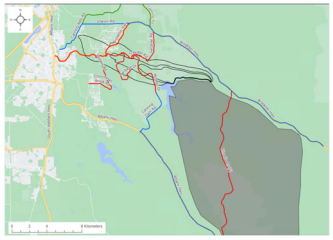
The WA stakeholder team subsequently provided the research team with a modelled prediction that described how this fire was predicted to evolve over time, consisting of hourly isochrones to assist with the development of the prediction map concepts. The research team took the responses of the steering committee presented above and developed a first set of prediction map concepts. These map concepts were presented in workshop 4.

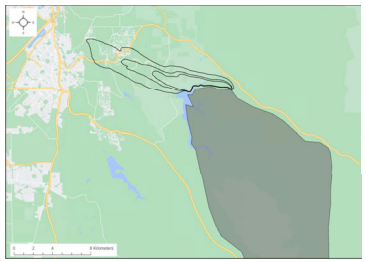
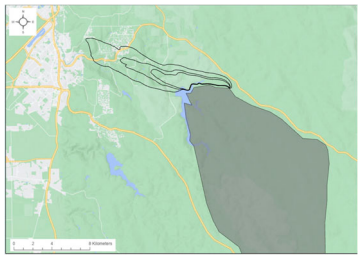
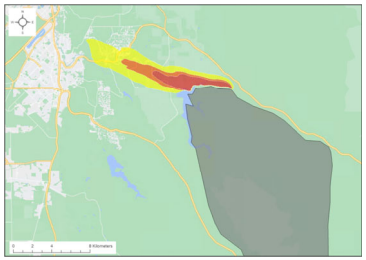
Workshop 4: Draft prediction map concepts

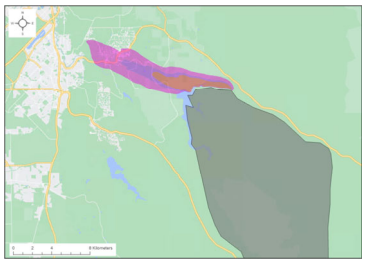
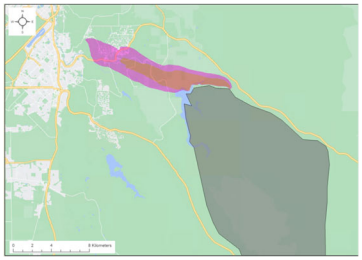
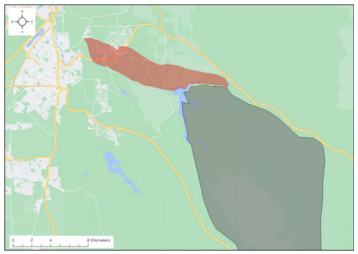
The presentation and discussion of the draft prediction map concepts was structured along Principles 2 and 3.[8] The discussions related to each principle and the draft map concepts are provided in this section.

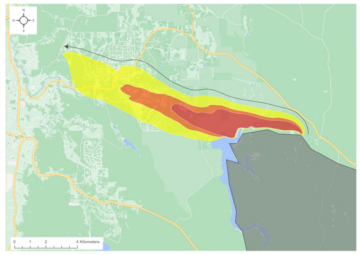
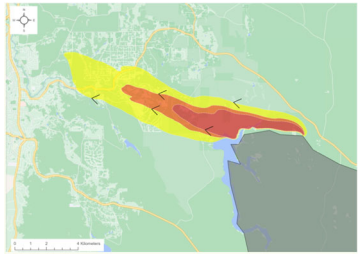
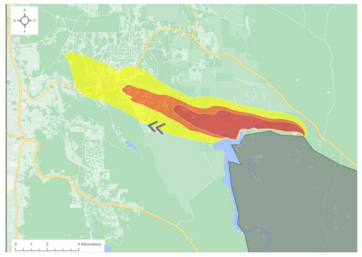
[8] **Principle 2:** Ensuring that map readers can understand their location in relation to the risk (self-localisation) and the information that is displayed on the map can support appropriate protective actions; **Principles 3:** Communicating risk and uncertainty (showing location, directionality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

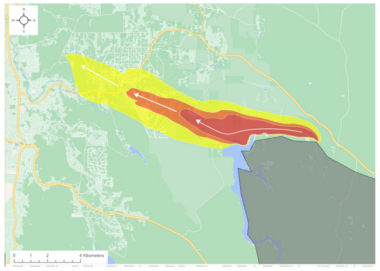
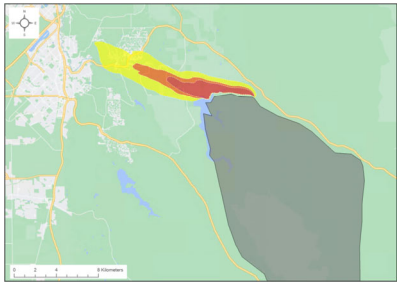
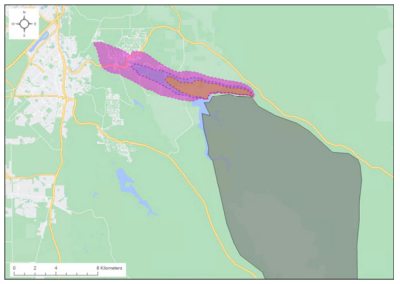
TABLE 2. SUMMARY OF DISCUSSIONS RELATED TO THE DRAFT FIRE SPREAD PREDICTION MAP CONCEPTS.

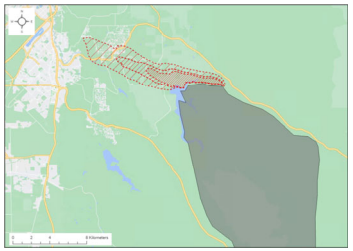
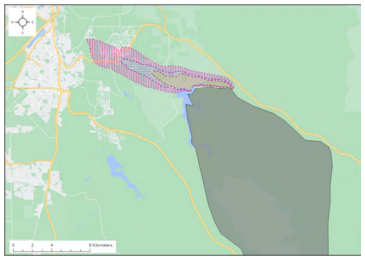
Principle	Map element	Map example	Discussion/Action
Principle 2: Ensuring that map readers can understand their location in relation to the risk (self-localisation) and the information that is displayed on the map can support appropriate protective actions	**Road names** (community research in Phase 1 found that community members would like to see clear road names on maps to assist self-localisation and protective action decision making)	 Large roads and roads of potential egress labelled.	Support for forced labelling of important roads.
	Actual and potential road closures (community research in Phase 1 found that community members would like to have information related to road closures to assist their decisions related to evacuation - other examples include existing symbols used by SA Police and a suggestion to depict recommended routes from QLD),	 All Potentially Closed and Closed Roads Shown in Red  Recommended Routes Shown in Blue  South Australian Police Road Closure Symbols	Concerns whether potential road closure information is appropriate for prediction maps. Concerns that this information will make the map too busy. Suggestion to include this information in text format as is current practice in some jurisdictions for incident warning maps. One preference is to present only roads that are closed at the time that the map is issued rather than all roads that will potentially be closed over the duration of the prediction period.

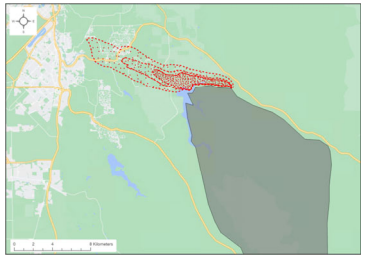
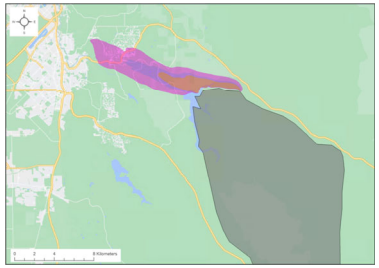
Principle	Map element	Map example	Discussion/Action
	Terrain (was mentioned by some members of the community in Phase 1 research as informing their understanding of the risk associated with their location. This information could assist with understanding risk.)	 No shaded relief  With shaded relief	Considered as potentially important for specific scenarios
Principle 3: Communicating risk and uncertainty (showing location, directionality and timeframe of the hazard)	**Most likely vs. worst case over 12/24hrs** (rationale used during 2019/2020 bushfire season in ACT and NSW)		The discussion related to the worst case vs. most likely scenario is fraught because it assumes that there is certainty in current predictions. While it was argued that there is some level of certainty in the location of the fire, there is less certainty related to time of arrival/impact. There is a hesitancy to use these terms (“worst case” or “most likely”) with community members.

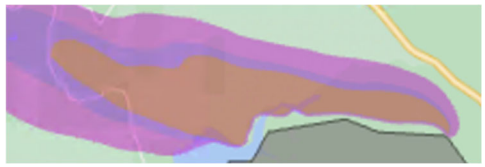
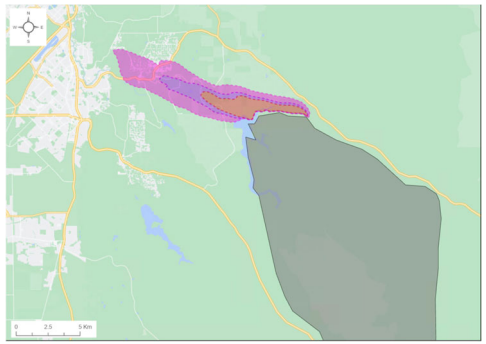
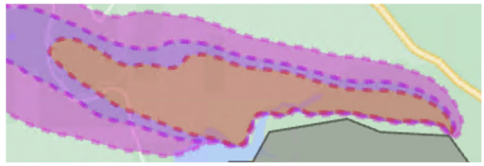
Principle	Map element	Map example	Discussion/Action
	Granularity of prediction information (community research in Phase 1 found that time-related information was important to community members to assist their decision-making)	 6, 12, 24 hours  12, 24 hours  24 hours	There was a suggestion to communicate predicted time to arrival/impact as a specific clock hour rather than “in # hours”. Suggestion to test whether 6, 12, 24-hour prediction creates apathy and/or a 24-hour prediction creates undue fear or uncertainty that inhibits appropriate protective action panic. Suggestion to include specific times in incident warning maps and not predictions. Concerns about current ability to produce reliable, granular time-related information.

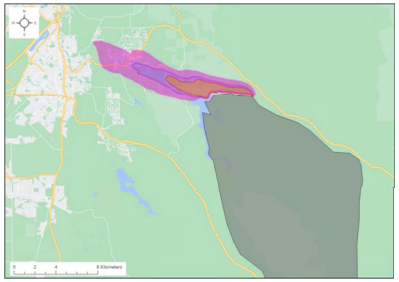
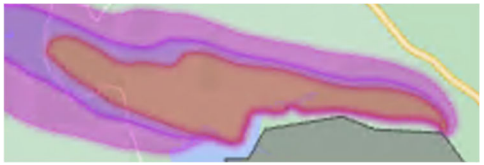
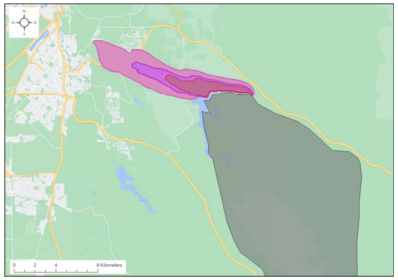
Principle	Map element	Map example	Discussion/Action
	Directionality of the hazard (community research in Phase 1 found that community members would like to see directionality of the hazard on maps to assist their decision-making)	 1  2  3	States and territories present were supportive of option 4. The interest in testing a wind change was reiterated in relation to the topic of directionality. Interest in whether adding arrows to polygons would create confusion if wind direction is also displayed.

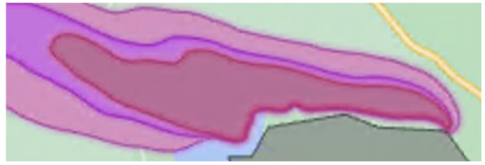
Principle	Map element	Map example	Discussion/Action
		 4	
	Colours (need to select a colour palette that best supports community understanding of risk; need to be sure colours are visually distinguishable even when semi-transparent)	 AWS colours  Non-AWS colours	As in the previous workshop, concerns were expressed regarding the use of AWS colours and the potential for these colours to cause confusion. There is support for greyscale and texture. Acknowledgement that there is a need for community communication/education to support prediction map products.

Principle	Map element	Map example	Discussion/Action
		 Greyscale	
	Textures (can help with legibility of other map features, can communicate uncertainty / fuzziness, especially for predictions that are farther into the future (e.g., 24 hours out)).	 Red line texture density  Line orientation and colour	The responses to the texture options were mixed, from not being convinced that it was necessary, to providing support for the red line texture. There was a concern that using the black hatched option would conflict with one state or territories' use of the AWS, which uses a black hatched area to represent an incident area. There was one suggestion to use a black line texture for burnt areas rather than solid grey.

Principle	Map element	Map example	Discussion/Action
		 Red dot texture density  Texturing the burnt area to make it distinct from grey prediction polygons	
	Borders (need to select a design for the borders of the prediction polygons that best supports community understanding of risk and uncertainty)	 No border	Some support for no border as well as dashed border options.

Principle	Map element	Map example	Discussion/Action
		 Enlargement to show the no border symbol example more clearly  Dashed border  Enlargement to show the dashed border symbol example more clearly	

Principle	Map element	Map example	Discussion/Action
		 Fuzzy border  Enlargement to show the fuzzy border symbol example more clearly  Solid border	

Principle	Map element	Map example	Discussion/Action
		 Enlargement to show the solid border symbol example more clearly	

Collaboration outcomes

The workshops provided an opportunity for the development of a research design that was complex but highly collaborative. The motivation for this approach to the study design for Phase 2 studies was an attempt to create research outputs that are both scientifically robust as well as practically relevant and usable.

The research team worked with the project steering committee to select principles for prediction map design, dissemination and communication that should be tested in the empirical studies because they require more evidence to support design decision-making. We worked together to develop the scenario for the fire spread prediction map concepts and to select the map elements to test in our studies that are best suited to obtain evidence to support and inform future agency decision-making.

As a result, the initial empirical studies conducted in Phase 2 (Work Packages 8-10) will collect evidence to address research questions which aim to improve the evidence base for Principles 1-4. Based on the results of the workshops presented above, the research team has developed a list of draft research questions to address in the initial empirical studies. The research questions are presented in Table 3.

TABLE 3: PRINCIPLES AND ASSOCIATED DRAFT RESEARCH QUESTIONS

Principle	Draft Research Questions	Draft Research Design
Principle 1: **Maintaining clear triggers for map production, dissemination and updates**	Which scenarios are most appropriate for issuing fire spread prediction maps? • When are they most effective at improving community safety? • When are they most likely to be timely and accurate? When should fire spread prediction maps be released/updated?	Phase 2 studies will test: • The refined map concepts (based on the findings of WPs 8-10) will be tested in a wider range of scenarios, which will provide some insight into which scenarios are most appropriate for issuing fire spread prediction maps.
Principle 2: **Ensure 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.**	What information helps map users to locate themselves in relation to the hazard? • How quickly can respondents locate themselves on the static or interactive fire spread prediction map? • How quickly can respondents comprehend their risk? What information helps map users take appropriate actions? • How quickly can respondents make a decision about what actions to take to protect themselves?	We will include the following design elements in all map concepts: • Relevant road names • Burnt area • Terrain • Evacuation centre location • Legend Phase 2 studies will test: • Three base map designs • including recommended routes
Principle 3: **Communicate risk and uncertainty (show location, directionality and timeframe of the hazard.)**	Which design concept best communicates risk and uncertainty in a way that supports all target audiences (i.e., residents, businesses and tourists) to intend to take appropriate protective actions? How accurately do respondents comprehend the risk presented in the scenario? Does trust in the predictions vary across different fire spread predictions symbol types? How often do respondents intend to take appropriate protective actions based on the information provided on the fire spread prediction map? How do respondents vary in their propensity to take appropriate action decisions depending on the target audience [residents, businesses (e.g., farmers), tourists]?	Phase 2 studies will test: • Prediction isochrones at different intervals of time and potentially an ensemble prediction. • Different colours for the isochrones/polygons (i.e., AWS colours, greyscale and red lightness gradients) • Different textures for the isochrones/polygons (i.e., opaque, red lines, red dots) • Different isochrone/polygon borders (i.e., hard border and dashed (soft) border) • Communicating time to arrival/impact • Warning text • Showing directionality of the hazard
Principle 4: **Ensure fire spread prediction maps complement incident warning maps.**	Do fire spread prediction maps result in an improvement on current practice? What considerations need to be taken into account to ensure that prediction maps complement incident warning maps? • What information do respondents glean from fire spread prediction maps and how does this compare to the information they glean from warning maps? • To what extent does the context provided by the fire spread prediction maps help respondents to better understand the advice provided in incident warning maps?	Phase 2 studies will test: • Incident warning maps for the same scenario as the WA prediction maps as a control. • Incident warning maps together with the WA prediction map in a scenario that develops over time.

The following section presents the fire spread prediction map concepts that will be used to address these overarching research questions.

Fire spread prediction map concepts

The project aims to find an approach to research that takes the contexts and interests of the project Steering Committee into account as well as ensuring robust and high-quality research methods are employed, improving the evidence base in this domain. The intention behind this approach is for the research to result in both robust and quality research as well as outputs that meet the practical needs of the project steering committee.

Discussions with members of the project steering committee resulted in a larger number of map design elements that the team would like to test than is possible to test in one study, or even a set of three studies. This created a challenge for the research team in developing study designs and determining what to include and exclude from the studies to gain the most value from the studies.

This section presents the draft study designs (map concepts) that the research team have developed to address the above challenge and inform the (future) refinement of the design of the fire spread prediction map concepts. The prediction map concepts presented in this report document the initial designs of the map concepts. As described in the project plan, this project has taken an iterative approach to the design of fire spread prediction maps, following a best practice user-centred design methodology that began with a needs analysis and understanding the context of use of prediction maps (Phase 1 of the project). This was followed by design prototyping that was informed by the findings of this Phase 1 research and further engagement with the steering committee members. The initial three studies of Phase 2 will provide evidence about what is comprehended by map users and how this comprehended information informs their intentions to take protective actions. These findings will be used, along with additional information provided by the project steering committee, to continue to refine the design of the map prototypes; these refined designs will be tested in the final two studies of Phase 2 of the project (Work Packages 11 and 12, see Appendix A).

Study design

National survey

The large sample size of the national survey allows us to test a wide range of concepts that explore different visual symbols for depicting *when* a fire is anticipated to impact a location; ways of visually indicating that the mapped fire is a prediction and it therefore has some uncertainty which increases with time (Principle 3); whether including additional map features helps people understand their location with respect to the risk (i.e., self-localisation)(Principle 2); and whether including additional map features helps people to intend to take appropriate protection actions (Principles 2 and 3).

In addition, the initial overarching aim of the national survey was to collect data to inform and support the release of future fire spread prediction maps to the community via social media.

To maximise the advantages of the survey methodology, we will test several design variants related to three different aspects of map design in this study:

- **five** different map symbol sets for showing the predicted fire locations at 6, 12 and 24 hours after the scenario start (T_0); (Principle 3)
- **two** different borders for the fire locations (certain: solid borders; uncertain: dashed borders); (Principle 3)

- two different levels of information for helping map readers to self-localise their risk and to support protective action decision making (force-labelled roads only, force-labelled roads plus recommended evacuation routes). (Principle 2).

Varying these three aspects produces a total of twenty maps that will be tested for their communication efficacy and supporting appropriate protective action decision making.

These map concepts will also be tested against a control map – the warning map that would be issued for the fire in this scenario.

The results of the national survey will inform the further development of both the study design and prediction map concepts examined in the focus groups and eye-tracking studies. As a result, the two following studies present several decisions that are yet to be resolved. The research team's current thinking about the details of the focus groups and eye-tracking study are presented below.

Focus groups

The focus group methodology allows us to get qualitative insights into what is capturing the attention of respondents and rich detail about what they understand about the fire spread prediction maps. It also affords the opportunity to capture evidence that can support and inform the dissemination of prediction maps at a community meeting. The focus groups will be conducted in three locations. Those locations are WA, SA and QLD. The selection of these locations was based on the following criteria:

- Locations that were not included in the community interviews conducted in Work Package 4 will be prioritised.
- Self-nominations from jurisdictions that have the capacity to support the focus groups through selection of study locations, local contacts, venue selection, and study promotion.

WA self-nominated and conducting a focus group in this jurisdiction offers the opportunity to test the prediction map concepts with participants who are potentially familiar with the scenario location. Queensland and South Australia were selected because they were not involved in Work Package 4.

Decisions to be resolved for the focus groups:

- How to best use the focus groups to obtain evidence to support and inform the dissemination of prediction maps during a future community meeting.

Eye tracking studies

The eye tracking methodology presents several opportunities that the other methodologies used in this Phase of the research do not afford. With this method, it is possible to see what people are looking at within the maps, for how long, and to pair this information with logs of what they are doing with the maps and what they are thinking about while looking at the maps. These affordances are of particular benefit for understanding how people use interactive fire spread prediction maps, for example, their zooming and panning behaviour and how they interact with the interface for drawing and un-drawing specific map layers. For this reason, we have chosen to use the eye tracking methodology to explore interactive maps and any challenges or benefits that format of mapping produces for respondents.

The eye tracking method will be used to test three specific aspects of the fire spread prediction maps, with one small study focused on each of the aspects:

1. How the incident maps complement the fire spread prediction maps and what added benefit fire spread prediction maps provide. (Principles 1 and 4)

In this study, we will allow the scenario to play out over time, with respondents examining a series of maps as the scenario evolves. One group will see a series of incident warning maps as they would be issued over time in the scenario. A second group will see the same incident warning maps, but also a fire spread prediction map that gives added context to the warning maps.

2. How respondent behaviour and understanding of the risk information differ between static and interactive versions of the fire spread prediction map. (Principles 2 and 3)

In this study one group will see a static version of the fire spread prediction map while the other group will see an interactive version. The information content of the two maps will be the same with the exception of the participant's location being shown explicitly in the interactive version with the "blue dot" that is commonly used in navigation applications like Google or Apple Maps. The interactive map will offer the ability to pan, zoom, change base maps, and turn layers on and off.

3. How respondents understand numerical estimates of likelihood (i.e., probabilities) associated with fire spread prediction maps and whether presenting information as a numerical estimate of likelihood makes participants more likely to take appropriate protective actions as compared to simple depiction of the area predicted to be impacted, as tested in Studies 1 and 2 of the eye tracking research. (Principle 3)

We would like to use the final eye tracking study to explore how respondents understand a map design that differs greatly from the other map concepts developed in this work package. At the time of writing, fire agencies are not producing public-facing maps based on ensemble predictions. These predictions are time-consuming to produce and are currently too labour intensive to consider in operational contexts. Furthermore, not all jurisdictions are currently able to produce them. However, with planned future upgrades to fire simulators, this information may be easier to produce in operationally relevant time frames.

The benefit of ensemble predictions is that they provide likelihoods (probabilities) that can be associated with a prediction, an explicit quantification of the uncertainty of the prediction. Some research evidence suggests that numerical measures of uncertainty might be more easily comprehensible for respondents than less precise categories like 'low' or 'high', which may be interpreted very differently by different respondents. This study therefore aims to explore what participants understand from a visualisation of fire spread prediction uncertainties.

We have chosen to use the eye tracking study to explore this as these uncertainties are also spatiotemporally variable (i.e., they can be quantified for each hour of the fire spread prediction). It is not possible to depict information of this complexity clearly in a single map, so an interactive map where respondents can manipulate a time slider is needed, and the eye tracking methodology is one where we can capture participant behaviour with an interactive map.

Decisions to be resolved for the eye tracking studies:

- Working with jurisdictions to develop an ensemble prediction as an option to test in a map concept for the eye tracking study.

Map concepts

The map concepts have been created to be able to test several designs to identify which of the potential designs is most effective in supporting one or more of the design principles and to understand the benefits and disadvantages of different symbol sets.

National survey

Some map design decisions were informed by the findings of earlier work packages (e.g., Work Packages 2-5). For example, interview respondents in Work Package 4 described how they were using **burnt area depictions** to understand the movement of the fire and to understand something about their distance from the active fire front. Respondents in Work Package 4 and Work Package 5 expressed a need for **important roads to be clearly labelled** and a desire to have the **location of evacuation centres** or places of last resort depicted on the maps. Several respondents also described how they used **terrain** to understand where and how quickly the fire would move, affecting their risk. For this reason, these features are included on all maps.

The literature review, Work Package 2, identified that best practice map design would be to use a muted **base map** that allows the hazard information to be depicted clearly. However, in practice, no jurisdiction uses this type of base map. Another base map option draws on satellite imagery, which presents challenges for clearly showing other information but benefits for self-localising risk. Some jurisdictions offer a satellite image base map capability in their interactive map, but none uses it by default -- it must be actively chosen by the user. Several jurisdictions use a Google Maps-sourced base map. The impacts of different base map styles on respondent comprehension of the map will be examined in one of the other studies, in order to make it possible to test a wider range of symbol sets for showing the fire spread predictions in the national survey. Therefore, in this study, we have decided to use a **Google Maps style base map**.

Other design decisions were made based upon the constraints of the survey methodology. For example, testing interactive maps in a survey is technically challenging and we don't have the ability to record which interactions people are having with the map. For this reason, **the designs tested in this study are static, meaning that respondents cannot zoom in or pan within the map**. Static maps are used by agencies in the context of social media posts with accompanying maps, so this study is expected to provide some insights into respondent comprehension of the maps when delivered in that dissemination mode.

Based on the feedback of the steering committee in workshops 3 & 4 (described previously), we winnowed multiple candidate designs for each of the design features (symbolisation of the fire prediction polygons, border style for the fire prediction polygons, and inclusion of additional features to support self-localisation of risk) to a number that would be tractable for testing within the resources allocated to the survey.

Fire prediction polygon fill symbolisation

The first two designs use a **semi-transparent colour lightness gradient** with the most certain predictions (those temporally closest in time) are darkest. The two chosen colours for the colour lightness gradient are colours shown to be semantically associated with fire (**red** and **grey**) in the Work Package 4 interview responses.

The third design implements **semi-transparent AWS colours**. The steering committee expressed that they believed this might be confusing for map readers. The rationale for testing it anyway is to develop evidence that this is in fact the case. This evidence can then be used to counter a suggestion from a decision maker who wants those colours implemented in a map.

The fourth and fifth designs use **texture gradients**. Textured fills have the advantage that they enable some underlying base map features to be more visible. The first texture gradient, an **increasing intensity of dots**, is semantically suggestive of embers. The second, an **increasingly dense diagonal hash pattern**, is semantically

suggestive of “don’t enter” (see the ISO Standard 7010 General Prohibition sign). The colour **red** was chosen because of its links to fire and because some jurisdictions use a black (another high contrast colour) diagonal hash for incident area polygons.

The varying intensities of all the symbol sets imply both the certainty of the prediction and the direction of travel of the fire, with the least intense symbol used in the fire prediction that is the least certain and furthest from the burned area edge.

Fire prediction border symbolisation

Current incident warning maps use a solid line border. **Solid line** borders are suggestive of crisp edges and certain spatial locations. **Dashed lines** suggest uncertain or porous boundaries. Fuzzy borders were also considered but they are more challenging to implement technically, especially in cases where the borders of polygons are close together (as in the case of the scenario being used here where the fire’s spread in one direction is limited by a reservoir).

Inclusion of additional map features to support self-localisation

An additional map feature not already included on all maps that Work Package 4 and Work Package 5 respondents noted as important for understanding their level or risk was road closure status. Therefore, the team decided it would be fruitful to devote study effort to examining the effect of depicting road closure status. Of the three candidate symbol sets for depicting road closure status (all closed or potentially closed roads shown with one symbol, use of the South Australian Police’s road closure status symbology, or **depicting only recommended routes**), the steering committee showed the most interest in testing the recommended routes. They are depicted in a high-contrast blue, which is a colour not used in the other symbols and that is clearly visible against the base map. These recommended routes are also force-labelled so that their names are clearly visible.

The full set of twenty maps that combine these symbol options is shown in Figure 1. The incident warning map (the control map), which was produced by the DFES Public Information Team in WA, is shown among the series of incident warning maps depicted in Figure 2.

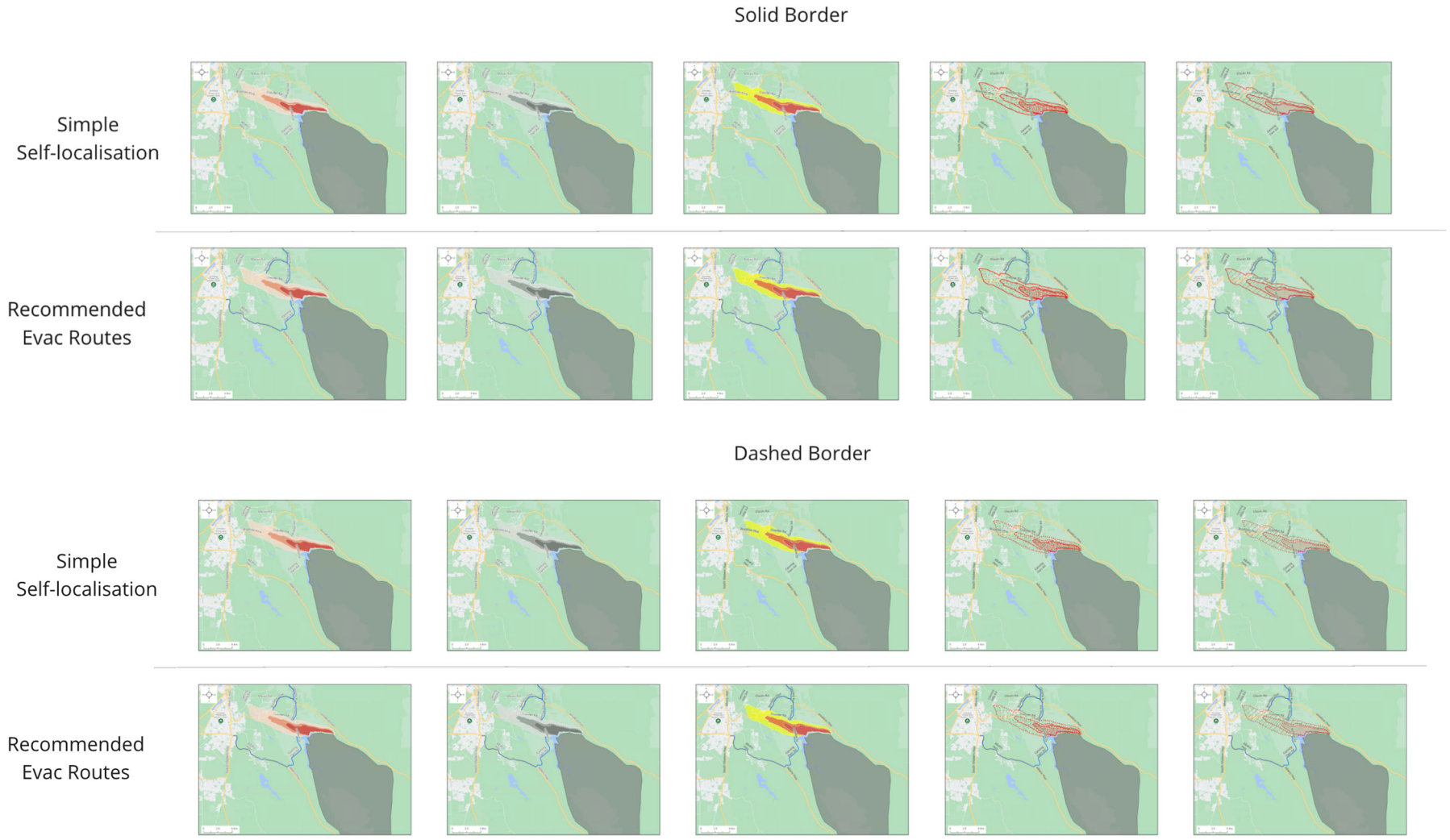


FIGURE 1. TWENTY DESIGN VARIANTS THAT WILL BE TESTED IN THE NATIONAL SURVEY (WORK PACKAGE 9). THE MAPS WILL BE EMBEDDED WITHIN A SOCIAL MEDIA POST FRAMING (X [FORMERLY TWITTER] OR FACEBOOK) TO SIMULATE DELIVERY OF THE MAP VIA THAT COMMUNICATION PLATFORM.

Focus groups

The specific symbols used in the focus group maps to depict the fire spread predictions and accompanying self-localisation features will be informed by the findings of the national survey (i.e., the most efficacious option(s) will be implemented). See Figure 1 for the maps from which the focus group map will be chosen.

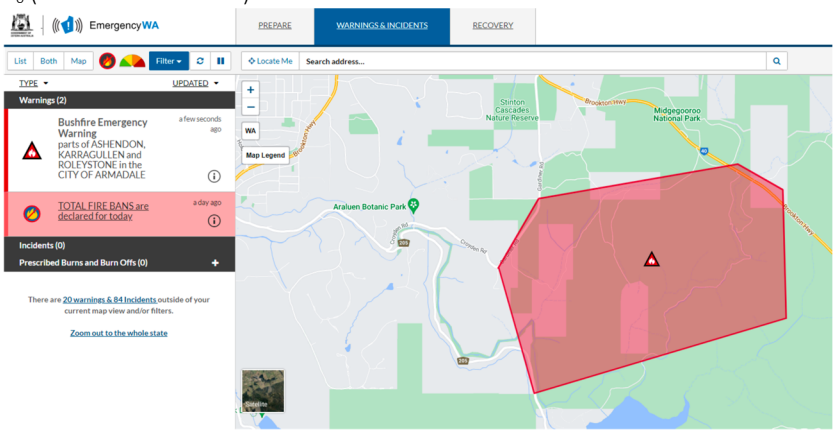
Eye tracking

The specific symbols used to depict the fire spread predictions and accompanying self-localisation features will be informed by the findings of the national survey (i.e., the most efficacious option(s) will be implemented) for study in the interactive maps. See Figure 1 for the maps from which the focus group map will be chosen.

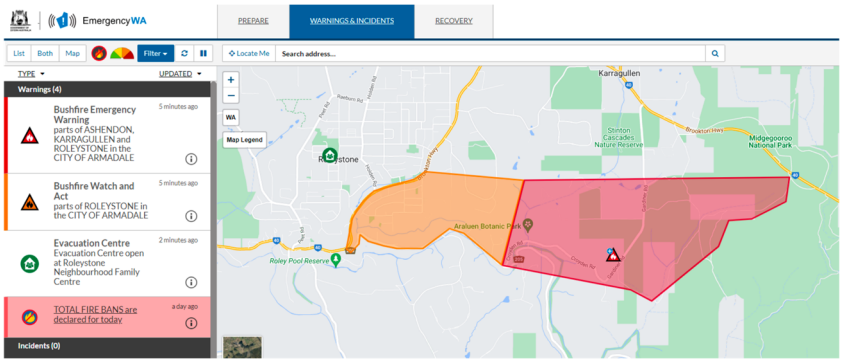
Eye-tracking study 1 maps

One group in Study 1 will see only a **series of incident warning maps** related to the unfolding scenario provided by DFES in WA (Figure 2). The second group will see these same **warning maps** and an **interactive fire spread prediction map** chosen based on the national survey's findings (Work Package 9).

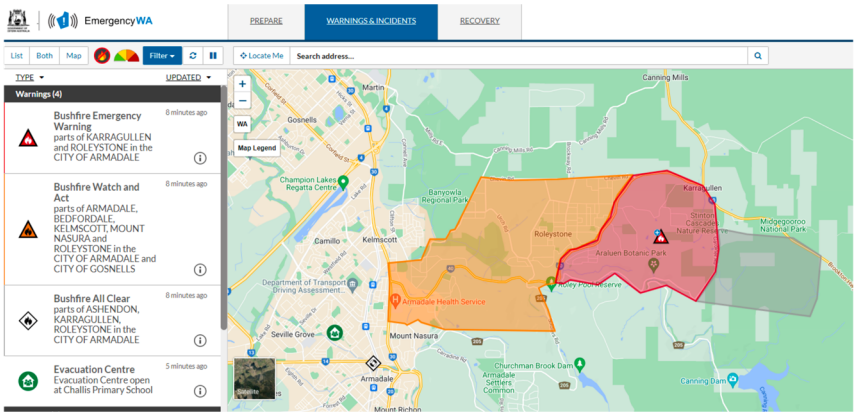
T_0 (start of the scenario)



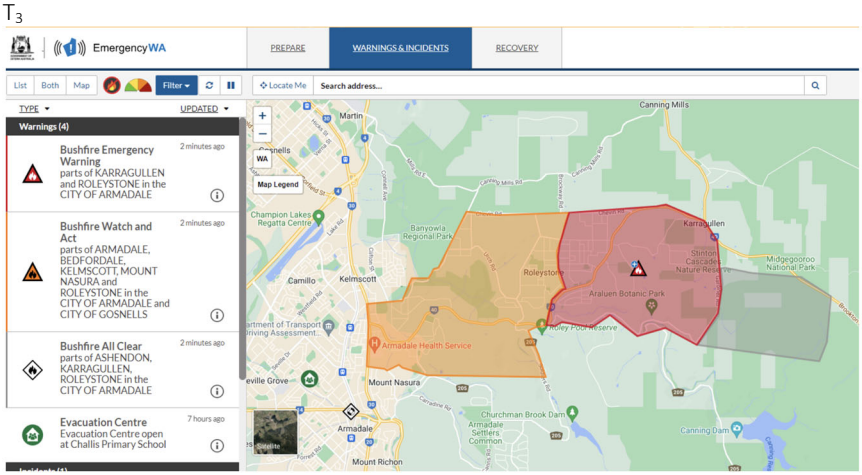
T_1



T_2



T_3



T_4 (end of the scenario)

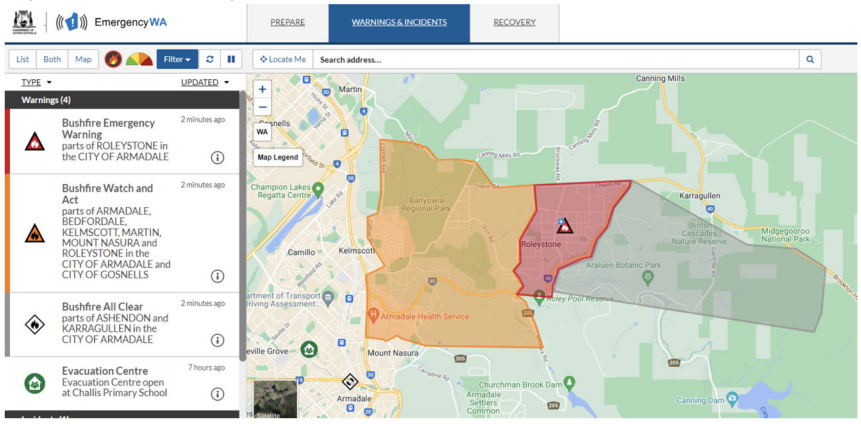


FIGURE 2. SERIES OF FIVE INCIDENT WARNING MAPS PROVIDED BY THE TEAM LEADER OF PUBLIC INFORMATION AT DFES (WA) THAT MATCH THE SIMULATED BUSHFIRE USED IN THE SCENARIO. THESE INCIDENT WARNING MAPS ARE EXEMPLARS OF WHAT WOULD BE ISSUED IN CURRENT PRACTICE AND WILL BE SEEN BY BOTH GROUP 1 AND GROUP 2 IN STUDY 1.

Eye-tracking study 2 maps

One group in study 1 will see a **static version** of the **fire spread prediction map** identified to perform most effectively in the national survey's findings (Work Package 9). See figure 1 for the designs from which this static map will be selected.

The second group will see **an interactive version of the same map** that is embedded within an interface that is similar in appearance to the Emergency WA platform that is currently used in Western Australia to publish incident warnings.

See a mock-up of how this will appear in Figure 3. The interactive map will allow respondents to pan, zoom, and change the base map between the Google-style base map and a satellite image-style base map (both are currently existing options in the Emergency WA platform). The map will depict the respondent's location explicitly using a blue dot. The respondent will be located at a specific location described to them in the scenario.

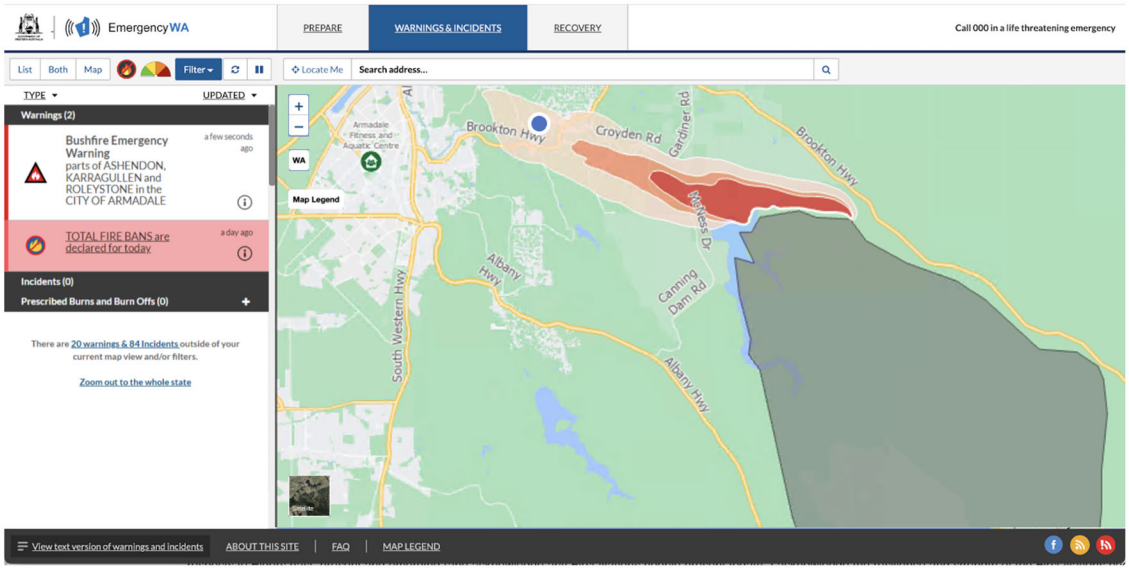


FIGURE 3. MOCKUP OF THE BUSHFIRE SPREAD PREDICTION MAP WITH INTERACTIVE FEATURES (PANNING, ZOOMING, BASE MAP SELECTION) EMBEDDED IN AN INTERFACE THAT LOOKS LIKE THE EMERGENCY WA PLATFORM.

Eye-tracking study 3 maps

As in Studies 1 and 2, the isochrone-based fire spread prediction map used in Study 3 will be determined in the future based on the findings of the national survey (Work Package 9).

At the time of writing this report, the WA FBAN team was preparing ensemble predictions for the developed scenario from which to build a prototype design for the visualisation that includes numerical probabilities.

Open questions

The following questions need to be discussed among the research team and/or the WA stakeholder team to refine the map concepts as they will be used in the Work Package 8-10 studies.

- Ensemble predictions - the research team is working with the WA stakeholder team to develop map concepts based on ensemble predictions. The research team is currently awaiting the ensemble inputs from the WA stakeholder team to finalise these concepts.
- Development of warning text to accompany map concepts (both the isochrones and the ensemble).
- How to deal with the different target groups in the WA scenario (i.e., residents, farmers and tourists).
- Where to locate study respondents in the map/scenario.
- Which incident warning map to test in the national survey.
- Which social media platform to use for framing Work Package 9 maps.
- Whether base maps will be tested in the focus group study.
- Whether or not to produce local maps for the focus groups (i.e., maps for each state in which the focus groups will be undertaken).

Next Steps

The fire spread prediction map draft concepts will be presented to the project steering committee and the AFAC Predictive Services Group and AFAC Warnings Group for endorsement.

This research will provide evidence that intends to provide clearer recommendations for how current incident warning platforms can be improved as well as provide evidence-based guidance to emergency management agencies to encourage and inform a nationally consistent approach to the future use of public-facing predictive fire spread maps during an emergency.

Appendices

Appendix A: Research design overview, Phases 1 & 2

Phase 1: Existing agency use and public knowledge about predictive service products (completed)

Work Package	Data collection method	Estimated Time	Outcomes
1	Online workshop with project Steering Committee	February 2022	Clear problem definition and scope for the project based on end user feedback
2	Review of existing research on best practice for map design and use/ interpretation by the community	November 2022	Preliminary principles for predictive map design, dissemination, and communication.
3	AFAC Predictive Services Group and Warnings Group interviews	July 2022	Defining intentions and expectations of designers and disseminators of predictive maps in terms of expected public response to the maps.
4	Community interviews	June 2023	Insights about community awareness of predictive maps and how the public is using both predictive maps and other existing maps (e.g., from VicEmergency or Fires Near Me) during events.
5	Community surveys	December 2022	Insights about community awareness of predictive maps and how the public is using both predictive maps and other existing maps (e.g., from VicEmergency or Fires Near Me) during events.
6a	Series of 3 workshops with the project Steering Committee	December 2022-June 2023	Discussions of the implications of Phase 1 research for current practice and the research conducted as part of Phase 2 of the *Predictions in Public* project.
6b	Presentation and reporting to AFAC and bushfire agencies	June 2023	The combined results of the WPs completed in Phase 1 will be documented in reports and presentations for AFAC and NHRA. The principles selected to focus the research conducted in Phase 2 of the project were endorsed by the AFAC Predictive Services Group and the AFAC Warnings Group.
6c	Publications/Hazard Notes for Phase 1 WPs	March 2024	Publications based on the findings of WP2-WP5.

Phase 2: Standardised design, communication and dissemination for predictive maps

Work Package	Data collection method	Estimated Time	Outcomes
7	Development of map concepts	September 2023	Consolidation of insights from Phase 1 to develop map concepts for testing across Phase 2. Maps will be developed with and endorsed by the project steering committee.
8	Community focus groups; 3 locations	September 2024	Insights into community perceptions, comprehension, and intended actions and the effect of different methods of dissemination (e.g., community meeting) based on the presentation of a range of map types and bushfire scenarios.
9	National survey	March 2024	Insights into community perceptions, comprehension and intended actions and the effect of different methods of dissemination (e.g., website v social platform) based on the presentation of a range of map designs. The findings of WP9 will be discussed with the project steering committee and a decision paper will provide an opportunity for all steering committee members to vote on the refined map designs to be tested with communities in WP8 and WP10.
10	Eye-tracking studies with members of the community	April 2025	Insights on how different predictive map designs compare in terms of community comprehension and ease of use.
11a	Workshops with the project Steering Committee	June 2025	Discussions of the findings from WP8 and WP10. The results of these discussions will be captured in the Phase 2 report, presented to the broader sector (see WP11b) and will define what is tested with communities in WP12.
11b	Presentation and reporting to AFAC and bushfire agencies	June 2025	The combined results of the WPs completed in Q3/4 2023 will be documented in reports and presentations for AFAC and NHRA. We present one final design option.
12	National community survey (online)	September 2025	Testing the revised national predictive map design and dissemination standard.
13	Interviews with specific community groups (e.g., CALD) via peak agencies	September 2025	Testing the revised national predictive map design and dissemination standard (with alternatives for specific user groups).
14a	Workshops with the project Steering Committee.	November 2025	Discussions about the research findings and implications. The results of these discussions will be presented in the report produced for WP14b.
14b	Report and presentation to AFAC and bushfire agencies	November 2025	The combined results of the WPs completed in Phase 2 will be documented in reports and presentations for AFAC and NHRA.
14c	Publications	November 2025	Hazard Note equivalent/ submitted peer-reviewed paper