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

Phase 1 Final Report

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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.

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Executive summary

The research conducted in Phase 1 of the *Predictions in Public* project focused on gaining an overview of current agency use and perceptions of the future use of public-facing predictive fire spread maps as well as current community comprehension and use of existing products. We sought to understand the role of current incident warning products to ensure that future predictive products can complement those existing products. Phase 1 has provided a strong foundation from which the project can move into Phase 2: the development and testing of predictive map concepts with communities across Australia.

Phase 1 has resulted in research reports for each Phase 1 study:

- Draft evidence-based principles drawn from a literature review.

- 44 interviews with agency staff.

- 94 community interviews in the ACT, NSW, Tasmania, and Victoria.

- 3,007 community responses to a national survey.

Discussions between the research team and the project steering committee were used to present the project findings and discuss their implications for current and future practice. These discussions resulted in agreement across the project team (i.e., the research team and the project steering committee regarding the following:

- National agreement on definitions of current incident warning maps and future predictive products.

- The selection of evidence-based principles of map design, risk communication, map dissemination and community education and engagement that will be further developed and tested in phases 2 and 3 of the *Predictions in Public* project.

The selection of potential practical outputs to be developed in Phase 3 based on Phase 1 results. It has also resulted in a potential practical output:

- The Predictions in Public Current Practice Atlas.

End-user statement

Don MacCorquodale, Project Officer, Fire Management Information Architecture, Bushfires NT, Department of Environment, Parks and Water Security, Northern Territory Government

The *Predictions in Public* project has provided an opportunity for representatives from across the Australian emergency management sector to come together and discuss, reflect, and collaborate on a topic that is relevant to current and future agency practice. Being a part of the Project Steering Committee has given me the chance to hear counterparts explain their current practices and share their views on future improvements, including practical challenges with delivering what some community members would like. The Project Steering Committee meetings are a valuable opportunity to re-examine assumptions about how we do things now.

The research can inform both our current practice, e.g., by fine-tuning the words that accompany our public alerts, and future practice, e.g., by identifying layers of data that could enhance the public-facing NT Fire Incident Map. Also, by coming together to discuss the research findings and the future use of predictive products, agencies can share their experiences and knowledge to inform the research as well as assist in the development of outputs that can support nationally consistent approach and use of predictive products in the future. For example, the recent fires near Tennant Creek that closed the main highway between the Territory and Queensland highlighted the importance of consistent messaging to residents and travelers on both sides of the border.

1. Introduction

The *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. This topic was identified as a challenge that fire agencies are currently grappling with, due to a number of factors:

- Advancements in technology have increased our opportunities to create and access situational intelligence.

- Public expectations related to being able to access real-time data have increased.

- Recommendations from reviews, inquiries and royal commissions have continuously called for improvements in the timeliness and quality of warning products.

- The use of fire predictions has received increasing attention since the 2019/2020 fire season when "Red Maps" were released to the public in NSW and the ACT, which has given rise to questions about the value of producing fire spread predictions during future fire seasons across Australia.

- Previous research in Victoria has shown that while operational staff agree 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 (Begg et al., 2021).

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

The project has been divided into three phases:

- **Phase 1:** Understanding current agency practice and community comprehension and use of existing public-facing map-based products (i.e., incident warning maps and predictive fire spread maps).

- **Phase 2:** Developing and testing national public-facing predictive map concepts.

- **Phase 3:** Developing practical outputs for agency use.

See Appendix 1 for an overview of the research design for all project phases.

This document provides an overview of the research findings of Phase 1. It also outlines the collaborative process that was undertaken between the Research Team and the Project Steering Committee to identify the implications of the research for current practice and future research. It concludes with an overview of the next steps of the project. Specifically, how the project will use the results of Phase 1 to inform Phase 2 of the project.

2. Phase 1 Research Results

Research conducted during Phase 1 of the *Predictions in Public* project included the following work packages (WPs):

- A literature review of current empirical evidence related to map design, risk communication, map dissemination and community engagement and education (WP2).

- Interviews with emergency management staff across all jurisdictions (WP3)

- Community interviews in 4 locations (the ACT, NSW, Tasmania, and Victoria) (WP4)

- A national community survey (WP5)

The aims and results of each piece of research are summarised below.

Literature Review (WP2)

When the project team discussed the research aims and potential outputs at the beginning of the project, one practical output emerged. Agencies agreed that a list of evidence-based principles is something that could be used by the emergency management agencies to inform and support future decisions in relation to the design, production, and use of predictions in emergency public communication.

Based on this, a draft list of evidence-based principles for map design, risk communication, dissemination, and community education and engagement were developed. This list built on existing work developed by a working group of the AFAC Predictive Services Group that was set up to develop national principles for the future use of public-facing predictive fire spread maps in the aftermath of the 2019/2020 fire season.

The first draft of these principles was very broad due to the lack of research on predictive fire spread maps. Therefore, it drew from a wide range of disciplines. The list has been revised based on the findings of phase 1. We have taken the original list of 4 themes and 26 principles and updated this initial list to 6 principles, 23 sub-principles and 19 areas of further research based on the findings of the phase 2 research and discussions with steering committee members (see Appendix 2 for a list of all the principles). These principles were selected because they not only currently lack empirical evidence, but also represent key decisions related to the production and dissemination of predictions which are of high relevance for all Australian jurisdictions. The six principles are:

- **Principle 1: Maintaining clear triggers** for map production, dissemination, and updates.

- **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).

- **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.

These six principles will be used to structure the research conducted in Phase 2. The evidence collected as part of Phase 2 will be used to improve and update the evidence-based principles to provide guidance for the future use of predictive map products for communications with the public during emergencies.

A final list of evidence-based principles will be available on completion of the project.

Interviews with emergency management staff across all jurisdictions (WP3)

Interviews with 44 emergency sector representatives from across Australia were conducted to better understand the perceived benefits and risks of releasing predictive fire spread maps to the public.[1]

Key findings:

- Overall, no interview participants were opposed to releasing predictive fire spread maps to the public in the future.

- Participants saw the primary *benefits* as increased public risk awareness, reduced bushfire impacts, increased access to hazard information, and increased agency credibility.

- The primary *risks* were risks to the public from the misinterpretation or misuse of fire spread maps (FSMs) and risks to agencies from possible legal, reputational, or political consequences from publicly releasing or withholding predictive fire spread maps.

- Asked about the *barriers* to releasing predictive FSMs to the public in the future, participants noted the persistent presence of risk aversion within agencies, the current lack of appropriate resourcing and training support, the current lack of public education regarding predictive FSMs, and the current lack of agreed processes, platforms, and formats.

- There is broad consensus from emergency sector representatives that the *most appropriate use* of public-facing predictions would be best reserved for impactful fires during extreme or catastrophic fire weather conditions and should be produced and designed as a specific product distinct from the predictions currently generated for sector practitioners.

These findings have been used to inform follow-up questions for the project steering committee in Phase 2 that aim to collect additional information about agency contexts, assumptions, as well as current capacities, capabilities and resources that support or hinder the production, dissemination, and public release of predictive maps currently and potentially into the future. This additional information will not only assist in the development of the fire spread prediction map concepts that will be tested in Phase 2, but also provide additional context related to requirements for how best-practice predictive maps might be implemented in the future.

Community interviews (WP4)

Community interviews in four locations that recently experienced a bushfire event (in ACT, NSW, Tasmania, and Victoria) were conducted to better understand how community members comprehend and use existing map-based products during an emergency.[2]

Key findings:

- The reasons respondents provided for using maps during an emergency is to:

  - *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.

- The information that people reported requiring to be able to fulfil these expectations are:

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[1] Neale, T., Miller, G., Begg, C., Dootson, P., Kuligowski, E., Griffin, A, Dwyer, G. & Gardner, A. (2023) Role and value of predictive service products. *Natural Hazards Research Australia*. Available at: https://www.naturalhazards.com.au/resources/publications/report/role-and-value-predictive-service-products

[2] Kuligowski E., Perry, P., Pupedis, G., Griffin, A., Mondel-McCann, N., Begg, C., Dootson, P., Gardner, A., Neale, T., & Dwyer, G. (*forthcoming*). Predictions in public: using qualitative data to understand the design, communication and dissemination of predictive maps to the public. *Natural Hazards Research Australia*.

- ○ **_Directionality of the hazard:_** The current locations of the fire, including the fire front; wind speed and direction; the type of fire and its intensity levels; and the burnt areas and their spatial accuracy.

- ○ **_Routes:_** Traffic information and road closures.

- ○ **_Timing:_** The time of the last update and/or expiry time for the map and how often the maps would update.

- ○ **_Landmarks:_** Information to assist them with self-localisation (e.g., city/town names, names of landmarks, topographic information, parks, road names, etc.), evacuation options and safe refuge locations.

- 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 lead to decisions being postponed.

- When desired information is not provided to participants, people 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.

A national community survey (WP5)

A national survey of community members (n=3007) was conducted to better understand how community members comprehend and use existing map-based products during an emergency.[3] A realistic, hypothetical simple and a complex map were tested in each Australian jurisdiction (with New South Wales and the Australian Capital Territory combined for the purposes of the survey).

Key findings:

- Communities are grateful for and value existing products.

- Respondents mostly comprehended the purpose of the maps. However, confusion increased as the complexity of the maps increased (i.e., multiple polygons, large number of roads, and lack of road names, etc.)

- Desired improvements included:

  - ○ **_Legibility:_** making sure symbols and map labels are legible and understandable (e.g., including a legend)

  - ○ **_Routes:_** show clear routes out to help people navigate their evacuation.

  - ○ **_Landmarks:_** show on the map key landmarks to help people locate themselves and important features on the map, including evacuation centres.

  - ○ **_Directionality of hazard:_** arrows showing directionality of the bushfire spread.

  - ○ **_Timing:_** indicate when the map was developed and for how long it is valid; time estimates on how fast the fire is tracking

The results of the community studies were discussed with the project steering committee and a list of map design elements that could be tested in Phase 2 has started to take shape. This list will be further developed in Phase 2 through WP7 – Development of predictive map concepts. The selection of map design elements will inform the development of the fire spread prediction map concepts tested with community members in Phase 2.

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[3] Dootson, P. McKay, C., Begg, C., Kuligowski, E., Griffin, A., Gardner, A., Neale, T., & Dwyer, G. (_forthcoming_). Predictions in public: understanding the design, communication and dissemination of predictive maps to the public – national community survey, WP5. _Natural Hazards Research Australia_.

Summary

Emergency management agency staff, who were interviewed in Phase 1, agree that there is value in the future use of predictive fire spread maps during extreme bushfire weather conditions and when communities are at great risk. However, there are concerns about how to best integrate predictions with existing incident warning products and how to appropriately communicate risk and uncertainty.

Community members are seeking information about the hazard during an emergency that will assist them to understand their risk, assess what their response options are and identify potential routes to evacuate the area. If this information is not provided, they will seek it from other sources or infer it. This could lead to decisions being postponed or inappropriate decisions being made that may place community members in harm's way.

Phase 2 of the project will take the findings of Phase 1 and develop a set of predictive map concepts that will be tested with community members across Australia to identify the most appropriate design of predictive maps that best promotes understanding of the risk as well as appropriate protective actions.

3. Implications for current practice and future research

To identify the implications of the Phase 1 research findings for current practice and future research, 3 workshops with the project team were held. There was agreement within the project that to be able to discuss the implications for current practice and future research related to the development and testing of public-facing predictive fire spread maps, we need agreement on the purpose of each of the products across all jurisdictions. This section outlines the approach that was used to ensure national agreement on the current and future product descriptions, the implications of the research for both products, and the selection of evidence-based principles to be tested in Phase 2 of the project.

3.1. Our Approach to the Development of Current and Future Product Descriptions

Prior to the first workshop, suggested current and future product descriptions were developed by the research team. These suggestions were presented to the Steering Committee (SC) in an Excel spreadsheet. Each product description contained suggested statements to define the products as well as open questions based on previous project discussions and the results of the research.

Steering Committee members were provided with two opportunities to review the Excel spreadsheet. Feedback from the first round was summarised and updated definition statements were provided. The second round of feedback included the updated statements and open questions related to the research findings. The results of the second round of feedback were moved to an online whiteboard (Miro board). The Miro board was used to assist a group discussion between the Steering Committee members during a 2-hour workshop. The workshop aimed to achieve agreement across the Steering Committee on the product description statements, as well as determine actions to be taken to address the research findings. Because we were not able to complete our discussion of both products during the initial workshop, an additional 1-hour workshop was held to complete the discussion.

The outcomes of this process are presented in the following subsections.

3.2. Workshop 1: Research Implications for Current and Future Product

The following subsections presents the product description and actions related to current products (see section 3.2.1.) followed by the product description and actions related to future products (see section 3.2.2.).

3.2.1. Current Products: Incident Warning Maps

This subsection presents the product descriptions and actions for current products which use maps to communicate bushfire risk to communities during an emergency.

Product Description for Current Products

Definition: Incident-specific information that shows the general area of the incident and the communities that need to take protective actions, depending on the warning level, to stay safe. Warning product utilises text content, as well as AWS icons and warning areas/polygons.

Purpose: To show an incident on a map. This could include a warning area of a going/active fire and the location of a community that needs to take protective action to stay safe.

Trigger: Going/active fire and a community that needs to take protective action to stay safe.

Timeframe: Updated as situation changes in line with existing agency doctrine.

Expected Community Action: to take the recommended protective action where identified. Where there is no recommended action, be aware of a nearby incident. AWS calls to action can be found here: https://www.australianwarningsystem.com.au/

Dissemination Method: Current products can be distributed easily across multiple channels. Limited geographical scope means that all information can be clearly shown on small device screens.

As a result of this discussion the project Steering Committee provided information and examples related to how jurisdictions currently:

- determine warning levels.

- warning update times and use of timestamps.

- use and context for calls to action.

The additional information captured by these actions is valuable as a resource for jurisdictions as well as the PiP project as a reference to take into consideration when developing and testing future products in Phase 2 of the project.

Implications of Phase 1 research findings for current products

The following 10 research findings that were common across all jurisdictions from the national community survey were discussed with the project steering committee (see Table 1). Specifically, the implications of the research for current agency practice and future research were discussed and are presented as actions below.

Table 1: Implications of research findings on current practice

Research finding	Implication based on workshop discussions
1. *The national survey found that although the sample was largely compliant with the agency issued instructions related to expected community actions, there were still instances where respondents indicated their top five protective action intentions would be an action that could put the individual (or their property) at risk (e.g., waiting for a firefighter to tell them to evacuate, waiting for police to knock on the door, etc.).*	The project steering committee supports future research that focuses on addressing risky community actions during an emergency, either to be explored as a practical output (see Phase 3 of project), or research conducted separately to the *Predictions in Public* project.
2. *The national community survey and the community interviews found that respondents from all jurisdictions would like current products to show fire direction.*	*ACTION 1*: capture examples of how fire direction is communicated/inferred by features of current products across all jurisdictions (e.g., use of weather layers, text, etc.). This information can be presented as a resource for jurisdictions as well as the input to take into consideration when developing and testing future products in Phase 2 of the project. *ACTION 2:* Recommendation for further research to focus on the viability of using predictive polygons across all jurisdictions. Some jurisdictions (VIC, WA, SA, QLD and TAS already use multiple polygons that infer the potential directionality of the hazard). Phase 1 research found that community members are reading these types of maps as predictions of fire direction (i.e., the percentage of respondents who reported the purpose of the current products "to show the direction of travel of the bushfire over the coming hours/days" - QLD: simple map 25%, complex map 28%; NSW simple map 25%, complex (red) map 41%; VIC simple map 27%, complex 32%; TAS simple map 26%, complex map 31%; SA simple map 31%, complex map 48%; WA simple map 32%, complex map 31%; NT simple map 28%, complex map 19%).
3. *The national community survey and community interviews found that community members across all jurisdictions would like to be able to self-localise when using current products.*	*ACTION*: collect examples of how jurisdictions currently display self-localisation on current maps.

Research finding	Implication based on workshop discussions
4. *The national survey and community interviews found that community members would like to see key landmarks on current maps to help locate themselves on a map in relation to opportunities to evacuate (e.g., evacuation centres).*	**ACTION 1**: Collect more information and examples of base maps used for current products across all jurisdictions. **ACTION 2**: Collect examples of how landmarks are displayed on current products across all jurisdictions.

5. *The national survey and community interviews found that community members across all jurisdictions would like to be able to see clear routes out of impacted areas to help navigate their evacuation.*	**ACTION 1**: to collect more information and examples of how evacuation routes are presented on current maps. This information can be presented as a resource for jurisdictions as well as the PiP project as a reference to take into consideration when developing and testing future products in Phase 2 of the project.
	
	ACTION 2: Support to further investigate this topic in Phase 2 of the project. Topics of interest are:
	
	● To explore how to communicate this information without placing communities in danger.
	● Opportunities include:
	   ○ to explore the ability of agencies to update routes.
	   ○ communicate location of evacuation centres and road closures rather than suggesting a specific evacuation route.

6. *The national survey found that community members across all jurisdictions would like to be able to engage with current products interactively (i.e., zoom function).*	● **ACTION**: support for testing interactive maps in phase 2 of the project. Focus of testing on why community members are using the zoom function, what information are they obtaining from this function?
7. *The national community survey and community interviews found that community members across all jurisdictions would like to see increased prominence of hazard markers alongside place names, roadways, and other landmarks.*	This finding may be related to point 5 and the fact that respondents were unable to use the interactive feature of the maps. It is unclear if the size of hazard markers can be changed on existing base maps. **ACTION**: Steering Committee support for testing interactive maps in phase 2 of the PiP project. Focus on testing to focus on which landmarks need to be displayed as well as sizing and legibility.

Research finding	Implication based on workshop discussions
8. *The national survey found that community members across all jurisdictions would like to see improvements in the use of contrast and colours to clearly delineate multiple warning areas used in current maps.*	*ACTION*: collect more information and examples of how the AWS colours have been implemented in each jurisdiction. This may include a description of any issues related to accessibility and any research/data that provides evidence of those issues.
9. *The national community survey found that the more information that is displayed on the map (i.e., the more complex the map – larger number of roads, polygons, etc.), the more likely community members were to report confusion.*	*ACTION 1*: Collect existing agency research related to information density.

ACTION 2: Include this topic and options to overcome issues related to map comprehension in research conducted in Phase 2 of the project. |
| 10. *The national community survey found that community members would like to see the use of legends to help interpret the information presented on the current products.* | *ACTION:* Collect examples of how current products display map legends. |

Summary

The actions identified as part of the discussions between the project team and the project steering committee were used to create a survey for the steering committee to capture more detailed information. The responses to the survey have been captured and presented in a Current Practice Atlas. This document is a useful reference document for the project team to inform the development of the predictive map concepts tested with community members in phase 2 of the project.

The Current Practice Atlas is currently an internal document. Further discussions with the project steering committee will explore the potential practical use of the product. This product may be used by agencies internally or presented as a public resource. A decision will be made during Phase 3 of the project.

Summary

3.2.2. Future Products: Public-Facing Predictive Fire Spread Maps

This subsection presents the nationally agreed upon product definition for future products that use map-based fire spread predictions to communicate risk to communities during a bushfire.

Product description for Future Products

Definition: To communicate the risk of fire impacting on the community on a broader scale and over a longer timeline than incident-specific warnings.

Further discussion: define "fire impact" - suggestions: fire, embers, and smoke.

Purpose: Communicates the risk to communities during an identified timeframe and provides a recommended action.

Further discussion: when maps should be produced and updated (see "trigger" and "timeframe" discussions, below)

Trigger: Significant fire activity in the landscape and dangerous forecast conditions.

Further discussion: development of a list of conditions/considerations that would lead to a recommendation for these products to be produced. This discussion should reflect on the potential impact of an incident on communities. It should also consult current work related to the Seasonal Outlook product to ensure that these two products work together.

Timeframe: Maps to be updated/published as required.

Expected community action: Predictive mapping will help improve the community's situational awareness and promote appropriate use of warning products.

Product production governance (who is responsible for producing public-facing predictive maps?): "State Controller" requests product. They are developed in collaboration between FBANs/predictive services and PIO and shared with Incident Controller(s) but authorised by the "State Controller" before being released to the public. Communication and consideration should occur with neighbouring jurisdictions where there may be cross-border impacts prior to releasing the product.

Dissemination method: maps to be shown on desktop and mobile platforms as well as at community meetings/door knocking.

The product description for future prediction products will be used to inform the development of the fire spread prediction map concepts in Phase 2.

Implications of Phase 1 research findings for future products

The following 11 research findings are drawn from the interviews with agency staff (WP3), community interviews (WP4), and the community survey (WP5). The implications of the research for future research were discussed and are presented as actions below (see Table 2).

Table 2. Research implications for future predictive products

Research finding	Implications based on workshop discussions
1. *The community survey found that agency websites/social media and the Bureau's website/app are the most preferred dissemination source.*	*ACTION:* There was general consensus that this was not required and there is no further action on this point at this time.
2. *Participants in the agency interviews suggested to, 1) include a generic disclaimer conveying the most important analytical assumptions (e.g., that fire suppression is ineffective on the given incident); 2) include a textual indicator of overall probability (e.g., 50% or 50-70%) similar to that used by meteorologists for rainfall; and 3) include visual indicators of levels of temporal and spatial uncertainty associated with potential impacts (e.g., colour gradients).*	*ACTION:* There was agreement from the project steering committee that communicating uncertainty should be a topic of further research within the project.
3. *The national survey found that community members across all jurisdictions would like to see improvements in the use of contrast and colours to clearly delineate multiple warning areas used in current maps.*	*ACTION*: There is consensus from the Steering Committee (SC) that use of colour and contrast should be investigated in Phase 2.
4. *The agency interviews found that participants would like to see predictions that use a simple and clear visual hierarchy. The national community survey found that the more information that is displayed on the map (i.e., the more complex the map – larger number of roads, polygons, etc.), the more likely community members were to report confusion.*	*ACTION*: there was consensus from the SC that visual hierarchy and information density should be further investigated in Phase 2 of the PiP project but that this was not a priority.
5. *The national community survey found that community members would like to see the use of legends to help interpret the information presented on the current products.*	*ACTION*: there was consensus from the project steering committee that different ways of presenting legends should be tested in Phase 2.

Research finding	Implications based on workshop discussions
6. *The national survey found that community members across all jurisdictions would like to be able to engage with current products interactively (i.e., zoom function).*	*ACTION:* Based on the discussion related to current products, the project steering committee supports testing interactive maps and static maps in Phase 2 of the project. This research should focus on testing why community members are using the zoom function, and what information are they obtaining from this function.
7. *Sizing and legibility: increased prominence of hazard markers alongside place names, roadways & other landmarks (common feedback from the community survey and community interviews)*	*ACTION*: There is project steering committee support for testing interactive maps and static in Phase 2. Focus on testing to focus on sizing and legibility of icons, roads, place names and landmarks.
8. *Base maps and the difficulty to make changes to current products was discussed in relation to current products.*	*ACTION*: There was consensus from the project steering committee that a range of base maps should be further explored in Phase 2.
9. *The national survey and community interviews found that community members across all jurisdictions would like to be able to see clear routes out of impacted areas to help navigate their evacuation.*	*ACTION*: The project steering committee supports further investigation of evacuation routes in Phase 2.
10. *The national community survey and community interviews found that community members across all jurisdictions would like to be able to self-localise when using current products*	*ACTION*: support further investigation of different ways to display self-localisation be tested in Phase 2

Summary

The results of the discussion from workshop1 provided an initial list of map elements to consider for testing with community members in Phase 2 of the project.

Summary

3.3. Workshop 2: Updating the evidence-based principles

The project's work package 2 (WP2) developed the first draft of a set of evidence-based principles for predictive map design, risk communication, dissemination, education, and engagement.

The first iteration of the principles was based on discussions with the project's steering committee and a literature review. Since then, we have received a peer-review of the principles, conducted empirical research to better understand community comprehension and intended use of existing incident warning maps and discussed the implications of the research findings with the project steering committee. Based on this, we have updated the principles based on the results of Phase 1 of the project. Workshop 2 aimed to update the evidence-based principles based on Phase 1 research results and the discussions had in workshop 1.

The project team agreed on the selection of 6 principles that require further evidence to support and inform future decision making. The principles will provide a scope for the design of the empirical studies conducted in Phase 2. The remaining 12 principles will support the development of best practice map concepts that will be tested with Australian communities in Phase 2 of the project.

The workshop 2 activity aimed to further the discussion related to the expected research outcomes to inform the principles and attempt to identify the decisions that need to be taken by the project team to select map design elements to test with communities in Phase 2. The results of this discussion are presented in Table 3.

Table 3: Expected research outcomes for Principles 1-6

Principle	Phase 1 results	Evidence gap	Expected research outcome	Discussion and actions
Principle 1: Maintaining clear triggers for map production, dissemination and updates	General triggers for predictive map production are: *"significant fire activity in the landscape and dangerous forecast conditions"*. The project steering committee is supportive of future research to provide a list of conditions or considerations that could assist agencies to make decisions related to when to produce, disseminate and update predictive maps.	Better understanding of what conditions predictive products add most value to for the public (i.e., increase situational awareness and the likelihood of community members taking desired/recommended protective actions) to develop evidence-based guidance around when to produce, disseminate and update predictive maps. The Predictions in Public working definition of the purpose of predictive maps is: *"To communicate the risk to communities during an identified timeframe and provide a recommended action"*. The Predictions in Public working definition of "timeframe" is: "*maps should be updated and published as required*". However, there is still a lack of clarity regarding when maps should be released to the public and how long they should be valid/how often they should be updated. The working definition of "expected community action" is: "*Predictive*	An improved guidance for triggers for map production, dissemination, and updates.	There is a lack of consensus about whether and how to link the messaging related to protective actions in the incident warning maps to predictive maps. Broad agreement that predictive maps should complement calls to action in the incident warning maps. In other words, predictive maps should provide extra context and validate risk - i.e., why areas have been placed in an Advice, Watch and Act or Emergency Warning polygon/warning area. Suggested scenarios: - one scenario is a complex fire which has multiple threats in different areas, at different timeframes, different weather situations. - Campaign fires not a fast-moving fire.

Principle	Phase 1 results	Evidence gap	Expected research outcome	Discussion and actions
		mapping will help improve the community's situational awareness and promote appropriate use of warning products". Need for a definition of situational awareness and (potentially) the identification desired/recommended community protective actions to be taken in line with current warning products (see principle 4), depending on what those actions are and how long community members would need to enact them.		*ACTIONS: Develop scenarios for testing maps to ensure that maps are adding value to existing incident warning maps and encouraging community members to take appropriate protective actions relevant to the given scenario.*
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.**	The national survey found that community members would like to see key landmarks and hazard markers on current maps to help locate themselves on a map in relation to opportunities to evacuate (e.g., evacuation centres). **The project steering committee supports further investigation of this topic in Phase 2.**	Identification of the most appropriate landmarks and hazard markers to assist with self-localisation and to support map readers to take appropriate protective actions. Current research suggests roads; water features, such as rivers or lakes; open spaces such as parks; built up areas (urban footprints) and/or individual buildings [depending on the map scale]; political boundaries such as shire borders; bushfire-relevant land covers such as forested areas; and locations of relevant points of interest	Guidance about which information (i.e., landmarks, hazard markers) to use for interactive and static maps to increase a map readers' ability to self-localise and guidance for how these features should be depicted. Guidance related to the most appropriate audiences for interactive and static maps as well as considerations for communication of risk and	In relation to which landmarks should be included in predictive maps, scale is key as predictive maps are quickly out of date: Broad agreement that road closures should not be communicated through predictive maps except, perhaps in relation to major roads. Base maps and viewing platforms should be further explored due to large variance

Principle	Phase 1 results	Evidence gap	Expected research outcome	Discussion and actions
		(e.g., hospitals, emergency services, evacuation locations).[4]	uncertainty when using either static or interactive maps. Guidance related to how communication and engagement approaches might be used to support the appropriate use of predictive products. A decision related to the use of base maps.	between existing agency platforms. *ACTIONS:* *Develop scenarios.* *identify which landmarks and hazard markers are most appropriate for the given scenarios.* *identify which landmarks and hazard markers are appropriate for interactive and static maps.* *Select potential base maps that align with the evidence-based principles and discuss whether those maps can be used within existing product suites.*
Principle 3: Communicating risk and uncertainty (showing location, directionality and timeframe of the hazard)	The working definition of predictive products for the PiP project is: "To communicate the risk of fire impacting on the community on a broader scale and over a longer timeframe than	How to depict risk and uncertainty on a public-facing predictive map in a way that supports improvements to situational awareness and encourages appropriate protective action (including appropriate map scale, appropriate use of colour.	Guidance related to how to depict bushfire risk (i.e., impact or arrival?) and which information to include (i.e., fire footprints, fire, embers, smoke). (see principle 1 - timeliness and triggers for predictive map	*ACTIONS*: *Develop scenarios.* *identify different ways to communicate the risk that the scenarios present most likely and worst case over 24 hours*

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4 Cao, Y., Boruff, B. J., & McNeill, I. M. (2017). Towards personalised public warnings: harnessing technological advancements to promote better individual decision-making in the face of disasters. International journal of digital earth, 10(12), 1231-1252.

Principle	Phase 1 results	Evidence gap	Expected research outcome	Discussion and actions
	incident specific warnings". The Steering Committee would like to further refine the definition of impact and how it is depicted on the map. Bushfire impact could include fire, embers and smoke. Fire agency representatives interviewed as part of this project suggested to, 1) include a generic disclaimer conveying the most important analytical assumptions (e.g., that fire suppression is ineffective on the given incident); 2) include a textual indicator of overall probability (e.g., 50% or 50-70%) similar to that used by meteorologists for rainfall; and 3) include visual indicators of levels of temporal and spatial uncertainty associated with potential impacts (e.g., colour gradients). This is inline with current research. However, conclusions about how scientific uncertainties should be communicated are	How trade-offs between timeliness and accuracy affect the intended behaviours of the public.	production, dissemination and updates). Guidance related to how to display uncertainty (i.e., time until arrival/impact and directionality of the hazard). Guidance related to the use of disclaimers.	*time to arrival or impact through time steps (i.e., 4, 8, 12, 24 hours). Inclusion of embers, smoke, etc.* *How to take suppression, wind, typography, and fuel into account and present the uncertainties related to these factors?* *Experiment with the colour and borders of polygons. Does a hard board vs a soft border impact map comprehension?*

Principle	Phase 1 results	Evidence gap	Expected research outcome	Discussion and actions
	not yet clear[5]			
Principle 4: Ensuring predictive maps complement incident warning maps	The working definition of the expected action from community members is: "*Predictive mapping will help the community's situational awareness and promote appropriate use of warning products*".	The extent to which a community's situational awareness is improved as well as whether community members are more likely to take protective action if they receive a predictive map in addition to an incident map.	Guidance related to how to link the key messages of incident warning maps to predictive maps.	*ACTION: Develop scenarios.*
Principle 5: Ensuring that maps are accessible to a wide range of audiences	Acknowledging that one size does not fit all, there is support for future research to identify the most appropriate design, dissemination and communication methods to ensure that predictive maps are accessible to a wide range of audiences.	The most appropriate design and dissemination methods for key community groups (see principle 17). The most appropriate engagement and communication approaches required to ensure that key community members are able to appropriately use predictive products (see principles 18).	Recommendations for how agencies can tailor the predictive maps to meet the needs of specific key community groups.	*ACTION: Discussions with WP7 lead to identify appropriate vulnerable groups to be involved in this study.*

[5] Scolobig, A., Potter, S., Knox, T., Kaltenberger, R., Weyrich, P., Chasco, J., Golding, B., Hilderbrand, D., Fleischhut, N., Uprety, D., & Rana, B. (2022). Connecting warning with decision and action: A partnership of communicators and users. In: Golding, B. (Ed.), Towards the "perfect" weather warning, pp. 47-86, Cham, Switzerland: Springer Nature.

Principle	Phase 1 results	Evidence gap	Expected research outcome	Discussion and actions
Principle 6: Ensuring cross-border coordination	Research conducted as part of the *Predictions in Public project* has found cross-border coordination as a topic that requires further investigation to improve the ability of agencies to work collaboratively and consistently across jurisdictions.[6]	Understanding barriers and opportunities for cross-border use of predictive maps.	Recommendations related to how to best organise cross border coordination for production, dissemination, and updates to cross-border predictive products.	*ACTION:* *Further investigate research findings (i.e., WP4 and WP5) to establish whether the data supports the need for improvements in cross-border map production and dissemination. Discuss the implications of this research with the Steering Committee to provide recommendations and/guidance related to this principle.*

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[6] Neale, T., Miller, G., Begg, C., Dootson, P., Kuligowski, E., Griffin, A, Dwyer, G. & Gardner, A. (2023) Role and value of predictive service products. *Natural Hazards Research Australia*. Available at: https://www.naturalhazards.com.au/resources/publications/report/role-and-value-predictive-service-products

Summary

The workshop series conducted at the end of Phase 1 focused on the research team working with the project steering committee to discuss the implications of the research findings for future research. The discussion related to the research findings highlighted topics of interest for future research. The discussion related to updating the evidence-based principles will provide a starting point for the development of predictive map concepts that will be tested with members of the community in Phase 2 of the project (see WP7).

4. Next Steps

The research conducted in Phase 1 of the *Predictions in Public* project focused on gaining an overview of current agency and community use of current incident warning products. It also sought to understand the role of current incident warning products to ensure that any future predictive products can complement those existing products through interviews with agency staff and workshops with the project steering committee. We also conducted research to understand how community members currently use and/or intend to use these existing products.

As a result, we received an initial list of expected research outcomes and map elements to potentially test in Phase 2. The aim of Phase 2 is to further investigate the potential role of public-facing predictive fire spread maps by testing maps that include information that community members have expressed as being necessary to assist them in understanding their risk and informing their decisions related to the appropriate protective actions to take for their given situation.

The challenge for Phase 2 is to balance what is currently achievable from the perspective of the emergency management agencies and the types of design elements that result in community members understanding their risk and intending to take appropriate protective actions.

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.

5. Appendices

Appendix 1: Research Design for all project phases

Phase	WP	Data collection method	Time	Outcomes
1: Existing Agency Use and Public Knowledge about Predictive Service Products	1	Online workshop with AFAC 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	Nov 2022	Preliminary principles for predictive map design, dissemination, and communication.
	3	AFAC PSG and WG 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	Dec 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	Dec. 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 PiP 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 PSG and the AFAC WG.
	6c	Publications/Hazard Notes for Phase 1 WPs	March 2024	Publications based on the findings of WP2-WP5.
2: Standardised Design, Communication and Dissemination for Predictive Maps	7	Development of map concepts	Sept. 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	Sept. 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

Phase	WP	Data collection method	Time	Outcomes
				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	Dec. 2024	Insights on how different predictive map designs compare in terms of community comprehension and ease of use.
	11a	Workshops with the project steering committee	Dec. 2024	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	Dec. 2024	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)	June 2025	Testing the revised national predictive map design and dissemination standard.
	13	Interviews with specific community groups (e.g., CALD) via peak agencies	June 2025	Testing the revised national predictive map design and dissemination standard (with alternatives for specific user groups).
	14a	Workshops with the project steering committee.	June 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	June 2025	The combined results of the WPs completed in Phase 2 will be documented in reports and presentations for AFAC and NHRA.

Phase	WP	Data collection method	Time	Outcomes
	14c	Publications	Dec 2024	Hazard Note equivalent/ submitted peer-reviewed paper
3. Practical Outputs for bushfire Agencies	15	Utilisation Activity 1: Utilisation of the evidence-based principles	Dec. 2025	Activities may include updating national doctrine, and/of educational content, and/or co-design workshops. Activity will be decided based on discussions with the project's steering committee.
	16	Utilisation Activity 2: Continuous improvement	Dec. 2025	Activity may include a tool to evaluate changes beyond the life of the project. Training for AFAC members on monitoring and evaluation of public-facing predictive maps. Activity will be decided based on discussions with the project's steering committee.
	17	Report and presentation to AFAC and bushfire agencies	Dec 2025	The combined results of the WPs completed in Phase Three will be documented in reports and presentations for AFAC and NHRA.
	18a	End of project report for NHRA	Dec 2025	The whole of project final report for Phases 1-3.
	18b	Publication	Dec 2025	Hazard Note equivalent/ submitted peer-reviewed paper

Appendix 2: Summary list of the draft Evidence-Based Principles from WP1.

Table 1. Initial 26 evidence-based principles based on a review of existing literature.

No.	Evidence-based Principle:	Supporting statement:
		Map design (how the map looks)
1	Using of bushfire "footprints"	Bushfire "footprints" show the location and extent of where a bushfire has burnt or is burning at a specific time. Challenges related to timeliness and accuracy need to be overcome.
2	Ensuring that map readers can understand their location in relation to the risk	Hazard and risk maps need to consider the map reader's ability to locate themselves on the map relative to the hazard or risk.
3	Ensuring that maps are accessible to a wide range of audiences	Due to difficulties many people have when using maps, care most be taken when choosing colours and icons as well as the use of different languages. Comprehension is increased when using iconic, well-understood symbols that result in a reduced need to consult the map legend.
4	Using timestamps	Maps represent a situation at a specific point in time. It is critical to include information about when a map was produced.
5	Presenting time of bushfire arrival/impact	Predictive fire spread maps show time of arrival information. The challenge is to identify the most appropriate way to present the predicted time of arrival of a bushfire to the public.
6	Using contrast to create a visual hierarchy.	The base map should be muted so that important bushfire data sit at the top of the map, developing an effective visual hierarchy.
7	Using of map scale appropriate for map purpose	The choice of map scale should be based on the considerations of the purpose of the communication, extent of bushfire activity and, in the case of predictions, potential limitations in modelling accuracy.
8	Avoiding cluttering maps	Cluttered maps are difficult to read and are even sometimes illegible.
9	Inclusion of layers appropriate for map purpose	Decisions related to what themes to include on a map should be based on the purpose of the map.

10	Using a well-designed legend	Map legends explain the meaning of visual symbols used on the map. Well-designed legends are particularly important when the map will be read by a wide range of people with different knowledge and backgrounds.
11	Ensuring maps are timely	It takes time for the community to take protective actions during hazard events. Therefore, if communications are to be useful to the map reader, they must be timely enough that the desired or recommended action can be taken.
12	Ensuring consistency of map design across Australian jurisdictions	The occurrence of large-scale fires has placed increasing emphasis on the importance of providing communities with consistent warning products across all Australian jurisdictions.
	Risk Communication (map content)	
13	Including maps in warnings by default	Consistent with national doctrine, maps are proposed to be included with all text-based (long and short) warnings during natural hazard emergencies.
14	Avoiding technical language in maps	Consistent with national doctrine, simple language that avoids technical and operation terms, as well as simple icons should be used to communicate risk.
15	Ensuring uncertainty is communicated in maps	Warnings are issued on uncertain information, and the level of confidence should be reflected in the warning.
16	Indicating source of map	The source of the information is most influential to the effectiveness of emergency communication.
17	Ensuring consistent key messages across jurisdictions	Agencies should work together to ensure that communication about risks across borders are consistent.
18	19.Personalising risk	Maps should be designed in such a manner that their readers can personalise the risk where appropriate.
	Map Dissemination (how the map reaches community members)	
19	Ensuring maps do not delay warning dissemination	The time it takes to develop a map should not delay the dissemination of a warning to the public.
20	Ensuring map dissemination through integrated information system	It is important that maps are disseminated through an integrated information system that can operate as a single point of truth, ensuring version control across communication channels.
21	Maintaining clear triggers for map dissemination	The triggers for the dissemination of maps to the public will be dependent on the purpose of the maps. However, in all cases, agencies should maintain clear triggers for disseminating different types of maps.
22	Identifying the most appropriate channels for maps	Emergency management officers must disseminate communication through channels that are relevant and appropriate for specific communities and support those communities to interpret information in a way that guides them to make meaningful decisions about their safety and protective action.

24	Ensuring cross-border coordination regarding authorisation of map dissemination to the public	Research conducted as part of the *Predictions in Public* project (see WP3) has found cross-border coordination as a topic that requires further investigation to improve the ability of agencies to work collaboratively and consistently across jurisdictions.
	Community Education and Engagement	
25	Educating and collaborating with the public	Principle 10 of the Australian Warnings Principles states, "[w]arnings are one component within a systems-based approach to community safety. Community engagement, education and awareness programs better prepare communities to receive, understand and act upon warnings"[7]
26	Ensuring that education and engagement is an appropriate blend of transactional, transitional, and transformational approaches	Blending transactional, transitional, and transformational approaches to community education and engagement provides a recipe for successful warnings.

Table 2. Revised list of evidence-based principles and research questions for Phase 2 studies based on the findings of Phase 1 studies and discussions with the project steering committee.

No.	Evidence-based Principle:	Supporting statement:
	Principle 1: Ensure there are clear triggers for predictive map production, dissemination, and updates.	
1.1.	Maintaining clear triggers for map dissemination	Agencies should maintain clear triggers for disseminating different types of maps. Research Question: When (under what fire scenarios) are predictions most effective at improving community safety? Research Question: When should fire spread predictions be released/updated?
1.2.	Ensuring maps are timely	It takes time for the community to take protective actions during hazard events. Therefore, if communications are to be useful to the map reader, they must be timely enough that the desired or recommended action can be taken. Research Question: When are the predictions likely to be timely and accurate?
1.3.	Using timestamps	Maps represent a situation at a specific point in time. It is critical to include information about when a map was produced.

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[7] Australian Institute for Disaster Resilience (2021). Australian Disaster Resilience Handbook Collection: Public Information and Warnings. Retrieved from: https://knowledge.aidr.org.au/media/9104/aidr_handbookcollection_publicinfoandwarnings_2021.pdf

| 1.4. | Identifying the most appropriate channels for maps | Emergency management officers must disseminate communication through channels that are relevant and appropriate for specific communities and support those communities to interpret information in a way that guides them to make meaningful decisions about their safety and protective action.

Research Question: What needs to be considered regarding communication of risk when disseminating predictions in agency warning platforms, social media and at community meetings?

Research Questions: What needs to be considered when disseminating predictions as an interactive or static product? How do the public interpret and use both products (i.e., role of zoom function)? |
| --- | --- | --- |
| | **Principle 2:** Ensure that map readers can understand their location in relation to the hazard (self-localisation) and the information that is displayed on the map can support appropriate protective actions. | |
| 2.1. | Using of bushfire "footprints"/ Burnt area/ incident area | Bushfire "footprints"/burnt area/incident area show the location and extent of where a bushfire has burnt or is burning at a specific time. Challenges related to timeliness and accuracy need to be overcome.

Research question: How do the public comprehend bushfire footprints/burnt area/incident areas, and what can we learn about how to improve their use in prediction maps and communicate their meaning to the public? |
| 2.2. | Ensuring that map readers can understand their location in relation to the risk | Hazard and risk maps need to consider the map reader's ability to locate themselves on the map relative to the hazard or risk.

Research Question: What information helps map users to locate themselves in relation to the hazard/understand their risk? |
| 2.3. | Base map selection to use contrast to create a visual hierarchy. | The base map should be muted so that important bushfire data sit at the top of the map, developing an effective visual hierarchy.

Research Question: Do different base maps have an influence on public map comprehension? |
| 2.4. | Inclusion of layers appropriate for map purpose | Decisions related to what themes to include on a map should be based on the purpose of the map.

Research Question: What information helps the public take appropriate protective actions? |
| 2.5. | Using of map scale appropriate for map purpose | The choice of map scale should be based on the considerations of the purpose of the communication, extent of bushfire activity and, in the case of predictions, potential limitations in modelling accuracy.

Research Questions: What needs to be considered when disseminating predictions as an interactive or static product? How do the public interpret and use both products (i.e., role of zoom function)? |
| 2.6. | Avoiding cluttering maps. | Cluttered maps are difficult to read and are even sometimes illegible.

Research Question: What information helps the public take appropriate protective actions? |

2.7.	Using a well-designed legend	Map legends explain the meaning of visual symbols used on the map. Well-designed legends are particularly important when the map will be read by a wide range of people with different knowledge and backgrounds. Research Question: Does the public comprehend legends and how can we ensure that they are well designed?
	Principles 3: Ensure maps communicate risk and uncertainty.	
3.1.	Presenting time of bushfire arrival/impact	Predictive fire spread maps show time of arrival information. The challenge is to identify the most appropriate way to present the predicted time of arrival/impact of a bushfire to the public. Research Question: Is there a difference in risk comprehension and intended action when risk is communicated as time of arrival vs. time of impact?
3.2.	Avoiding technical language in maps	Consistent with national doctrine, simple language that avoids technical and operation terms, as well as simple icons should be used to communicate risk. Research Question: What language and icons are most appropriate for communicating risk and uncertainty inherent in the predictions to ensure public comprehension?
3.3.	Ensuring uncertainty is communicated in maps	Warnings are issued on uncertain information, and the level of confidence should be reflected in the warning. Research Question: What language is most appropriate for communicating risk and uncertainty inherent in the predictions to ensure public comprehension?
3.4.	Indicating source of map	The source of the information is most influential to the effectiveness of emergency communication.
3.5.	Personalising risk	Maps should be designed in such a manner that their readers can personalise the risk where appropriate. Research Question: Is risk personalisation possible through predictions or is it more appropriate for the calls to action included on incident warning maps? Research Question: To what extent does familiarity with the area, hazard literacy, and past bushfire experience impact perceptions of risk and uncertainty when viewing predictions?

		Principle 4: Ensure predictive maps complement incident warning maps.	
4.1.	Ensuring that predictive maps complement incident warning maps	Predictions will never be released without incident warning maps. The purpose of a prediction, as defined by the project steering committee, is to communicate the risk of fire impacting on the community on a broader scale and over a longer timeline than incident-specific warnings. Research Question: To what extent do predictive maps result in an improvement on current practice (i.e., community comprehension of risk and uncertainty as well as intention to take appropriate protective actions)? Research Question: Do predictive maps enhance community understanding of risk when they accompany an incident warning map?	
		Principle 5: Ensure that maps are accessible to a wide range of audiences.	
5.1.	Ensuring that maps are accessible to a wide range of audiences	Due to difficulties many people have when using maps, care most be taken when choosing colours and icons as well as the use of different languages. Comprehension is increased when using iconic, well-understood symbols that result in a reduced need to consult the map legend. Research Question: Is there a different in perceived risk and uncertainty when viewing predictive isochrones in different colours (i.e., AWS, red scale/greyscale), textures (i.e., dots/hash), and borders (solid/dashed)? Research Question: Which icons do the public most easily comprehend and why?	
5.2	Educating and working with the public prior to maps being released (before an emergency)	Principle 10 of the Australian Warnings Principles states, "[w]arnings are one component within a systems-based approach to community safety. Community engagement, education and awareness programs better prepare communities to receive, understand and act upon warnings"[8] Blending transactional, transitional, and transformational approaches to community education and engagement provides a recipe for successful warnings. Research Question: How might existing or new community engagement programs assist in raising public awareness of predictions as well as ensuring that they can be used by the public effectively during an emergency?	
		Principle 6: Ensure cross-border coordination regarding authorisation of map dissemination to the public.	
6.1.	Ensuring consistency of map design across Australian jurisdictions	The occurrence of large-scale fires has placed increasing emphasis on the importance of providing communities with consistent warning products across all Australian jurisdictions.	

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[8] Australian Institute for Disaster Resilience (2021). Australian Disaster Resilience Handbook Collection: Public Information and Warnings. Retrieved from: https://knowledge.aidr.org.au/media/9104/aidr_handbookcollection_publicinfoandwarnings_2021.pdf

6.2.	Ensuring consistent key messages across jurisdictions	Agencies should work together to ensure that communication about risks across borders are consistent.
6.3.	Ensuring cross-border coordination regarding authorisation of map dissemination to the public	Research conducted as part of the *Predictions in Public* project (see WP3) has found cross-border coordination as a topic that requires further investigation to improve the ability of agencies to work collaboratively and consistently across jurisdictions. Research Questions: What practical constraints need to be considered to enable a cross-border authorisation of the production and dissemination of predictions across borders? And, what can be done to overcome these constraints?