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FINAL PROJECT REPORT
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TOWARDS PROTECTIVE ACTION: EFFECTIVE RISK AND WARNING COMMUNICATION DURING NATURAL HAZARDS

Final project report

Vivienne Tippett, Dominique Greer, Amisha Mehta, Paula Dootson, Lisa Bradley, Sophie Miller & Scott Murray
Queensland University of Technology & Bushfire and Natural Hazards CRC

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Cover: Flooded house in Victoria.

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The QUT research team would like to thank the Bushfire and Natural Hazards Cooperative Research Centre (CRC) for their sustained support of this research program. QUT researchers gratefully acknowledge the engagement and partnership with our industry partners over the life of this research program. These relationships have enabled the rapid implementation of research products.

We recognise the thousands of Australians who have participated in surveys, interviews and focus groups over the last four years. This opportunity to test our work with the community has provided invaluable insights into how warnings are interpreted and how they trigger protective action.

The outstanding work of our research assistants is also acknowledged and greatly appreciated.

EXECUTIVE SUMMARY

CONTEXT FOR THE RESEARCH

The focus of this research project was informed by the findings of earlier CRC research that investigated how to encourage community compliance with natural hazard warning messages by optimising the design of the warnings. Over a four-year period between 2017 and 2021, the risk and warning communication research program combined end-user engagement with interdisciplinary expertise in communication, consumer psychology, marketing, and emergency management to take a multi-method and multi-hazard approach to addressing two core research aims:

- to develop evidence-based strategies that motivate appropriate protective action and support informed decision-making during the response and recovery phases across multiple natural hazards
- to work with end-users to share research findings and support their integration into practice.

At the commencement of this research, participants reported that warning messages were sometimes confusing due to the use of technical and/or operational language, which had little meaning for the community; contained limited instructions for how community members should respond to a potential hazard; sometimes conflicted with messages of other agencies or with what the community observed was occurring in their community; were sometimes completely unfamiliar; and failed to attract the attention of community members who needed the message the most.

With the aim of developing evidence-based strategies that motivate appropriate protective action and support informed decision-making during natural hazards, this report captures key activities, outcomes, and impact of work conducted across the three research packages:

- Research Package 1: *Encouraging protective action and enhancing trust with multi-agency risk and warning communication strategies* investigated how community members respond to risk and warning communication from multiple agencies and supported optimal communication strategy to enhance trust and encourage protective action across multiple channels including video and emergency alerts. This research culminated in the identification and categorisation of signal words (e.g., warning, emergency) and phrases (e.g., evacuate now, prepare to leave) that are inputs of co-designed emergency alerts and provide the evidence base to support the calls-to-action statements included in the new Australian Warnings System.
- Research Package 2: *Overcoming ambiguity: conflict between emergency warning messages and socio-environmental cues* explored how community members interpret socio-environmental cues that conflict with warning messages and how emergency services agencies can overcome this conflict to encourage protective action. An extension research project explored the use of visual media content used by

emergency services agencies educating the community, signalling risk of an event and/or encouraging protective actions.

- Research Package 3: *Optimising emergency warning messages to encourage readiness to act* investigated the extent to which current warning messages encourage readiness to act and whether adding colours or icons encourages further readiness to act.

PROJECT STRATEGY FOR RESEARCH AND COLLABORATION

This research utilised a mixed-method approach to examine how individuals interpret and act on forecasts and warnings issued by national response agencies. Qualitative methods such as focus groups and interviews were used where depth of understanding specific issues were needed, ensuring participants could provide individual and thorough responses. Quantitative, large-scale online surveys were used to determine population-level responses to various stimuli from representative samples of the Australian population. These surveys included the application of experiments testing improvements to message comprehension and triggers for behavioural intention (Table 1).

Research Package 1: *Encouraging protective action and enhancing trust with multi-agency risk and warning communication strategies*	Research Package 2: *Overcoming ambiguity: conflict between emergency warning messages and socio-environmental cues*	Research Package 3: *Optimising emergency warning messages to encourage readiness to act*
Chief investigators Amisha Mehta and Lisa Bradley	*Chief investigator Paula Dootson*	*Chief investigator Dominique Greer*
Six national focus groups (32 participants) Four national surveys (N = 1732; 1721; 620; 3138)	Two national surveys (N=2649; 1563) Two comparative sample surveys (N=1294; 1621) Interviews (N=11)	Two national surveys (N=1595; 2482)

TABLE 1. SUMMARY OF DATA COLLECTION BY RESEARCH PACKAGE.

SNAPSHOT OF KEY FINDINGS

As the project comprised several studies, it generated a substantial number of findings and insights. These have been summarised in a series of CRC *Hazard Notes* and end-user presentations (see further below).

Encouraging protective action and enhancing trust with multi-agency risk and warning communication strategies (RP1)

Across all studies (i.e., national focus group and surveys), trust in emergency services agencies and the Bureau of Meteorology was found to be high and

these agencies were among the most preferred sources of information in emergency situations. To explore the ways in which trust operated during flood and fire emergencies, national surveys were conducted. Findings demonstrated that trust was positively related to intended protective actions. Findings further showed that trust increased when the two message types tested (i.e., official warning and video warning) were both presented. Critically, participating in the survey itself increased participants' knowledge and reported intentions to create a formal plan or have a conversation about hazard responses.

However, focus group responses revealed that inconsistencies with content and headings in warnings and forecasts were of concern. This was particularly evident in messages with the intent of having community members 'Evacuate Now' but that also provided information about what to do if community members were not evacuating. This was seen as inconsistent by participants, leading to less certainty as to what was expected, and therefore what they intended to do. This research also examined the threat rating for signal words (e.g., warning, prepare, advice) and phrases (e.g., evacuate now, act now) to guide their use within short-form emergency alerts. For example, for bushfires, highest threat was signalled by the phrases 'evacuate now', 'act now', 'prepare to evacuate', 'shelter indoors now', and 'emergency warning'. For floods, similar categorisations were seen but the phrase 'shelter indoors now' was not tested within this hazard.

Finally, this research examined barriers for taking protective action. The most common barriers were pets and worry about others stealing from property. The strongest motivators for taking action were to keep family safe and to avoid being stuck in an area experiencing hazard.

Overall, this work provides an important evidence base on which agencies can optimise the trust of the community in their agencies and warning information across multiple media including videos and emergency alerts. This trust can then be leveraged to maximise appropriate protective action being taken by community members.

Overcoming ambiguity: conflict between emergency warning messages and socio-environmental cues (RP2)

A nationally representative sample found conflicting cues (versus consistent cues) can affect information processing of risk, risk perceptions, and intentions to take protective action. Both fire and flood contexts were tested for the *"prepare to evacuate"* and *"evacuate now"* levels of warnings and the results were observable regardless of hazard type. Factors such as age, language spoken at home, country of birth, or experience with a hazard were not significantly associated with changes in risk perception in the presence of conflicting environmental cues. The work was replicated on a United States (U.S.) sample as research from the U.S. is commonly used as evidence for warning design and practice in Australia. The results differed across both Australian and U.S. samples. The results suggest the value of testing warnings and public information on local samples.

Interviews with emergency services agencies across Australia were undertaken to explore the types of conflicting cues evident in practice and strategies

agencies currently use, and could use, to manage the existence and spread of these conflicting cues. Results show that conflicting cues do exist in practice, particularly conflict between the instruction being issued by the lead response agency and environmental or social (i.e., media, unofficial organisation, and peers) cues. Participants of these interviews also identified an additional source of conflict: when the lead agency itself issued conflicting instructions to a community or when the warning language conflicted with the specific instruction. While it is acknowledged that a lot of these factors are outside of agency control, there are available strategies to mitigate the creation and extent of conflicting cues in natural hazard emergencies. These strategies fall into one of two categories. The first category encompasses proactive strategies, such as provision of public information and warnings training for media, volunteers, staff and stakeholders, together with formal partnerships with stakeholders to coordinate messaging, generating content to meet real-time media and community needs to inform protective action decision making, and cross jurisdictional deployments. The second category encompasses reactive strategies, such as dedicated monitoring online (e.g., social media platforms) and offline (e.g. town halls, radio) roles during events, embedding the agency in community groups, using technological solutions for warning design, and verifying visuals.

The interviews also revealed that despite hype in the popular press about deep fakes and their legitimate ability to sow discord and inflame tensions (especially for politicians who have been a prime target of synthetic media), within the emergency services domain, problematic visuals are more likely to result from cases of altered, absent, or inaccurate context delivered through captions or through simple Photoshop edits, than they are through sophisticated and synthetic videos. Four specific types of problematic visuals evident in Australian natural hazard emergencies include use of stock images, misattributed visuals (from old events or alternate locations), visuals amplifying non-compliant actions and to some extent, sensationalised visuals.

Despite the breadth of manual and machine-learning tools available, most strategies currently employed by agencies are low-tech, which places a resourcing burden on the agency during an event. Strategies currently used to combat visual conflicting cues include monitoring channels (in-person and online) and reacting to a problematic visual being circulated across any channel like television or social media, having formal arrangements with news outlets to manage circulation of problematic visuals and make corrections where necessary, accessing and using publicly available and free tools to verify visuals, and proactively producing and disseminating visual media for an event.

Based on the finding that proactively producing and disseminating visual media for an event reduced opportunities for conflicting cues that cause anxiety and confusion in the community on how to respond, an additional piece of research was conducted. Specifically, the research examined which types of visuals are more effective than others. Visual media were collected from end-users to test the efficacy of visual content created and shared by emergency services agencies in improving knowledge about a hazard, triggering risk perceptions, and encouraging protective action intentions. Preliminary findings suggest:

- infographics are useful in conveying large amounts of information about a hazard
- actual demonstrations of how a hazard works were effective at conveying key messages
- personalised and highly consequential facts were more likely to be retained after viewing the media
- shorter, focused messages (provided via multiple media) performed better at improving knowledge than longer, multi-fact videos
- B-roll videos (especially those that show hazard intensity and consequences) did not see a reduction in coping appraisal; and did raise risk perceptions. Both encourage protective action.

The work is replicated on visual media used in the U.S. due to their greater use of augmented reality and virtual reality in comparison to Australian agencies. Findings are forthcoming.

Optimising emergency warning messages to encourage readiness to act (RP3)

In a series of experiments conducted via national surveys of community members, this work demonstrated that current warning messages, optimised to match existing evidence of good practice, work well to encourage community members' readiness to act. Current warning messages provided by eight response agencies [CFS (SA), DFES (WA), MFB (VIC), MFS (SA), NSW SES, TAS SES, VIC SES and QFES (QLD)] were reviewed to develop composite mock warning messages that formed the basis of this testing. The surveys demonstrated that when messages include clear calls to action, warning messages provoke moderate and appropriate threat appraisal.

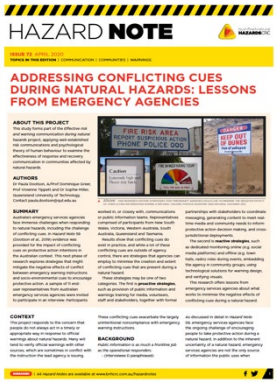
Participants examined the instructions contained within each message to establish a coping appraisal and determined that their ability to execute each instruction was high, the protective effectiveness of the instruction was high, and the cost to action of the instruction was appropriately low. These results demonstrate that the changes response agencies have implemented since the 2014 National Review of Warnings and Information have had the desired effect: warnings are clear and likely to provoke appropriate protective action by the community.

Although readiness to engage in protective action appears high for existing messages, messages calling for evacuations can be marginally improved by adding colour (specifically red) to draw the reader's attention and assist quick comprehension and action. Adding a red header to an evacuation message increases the perceived probability that the recipient will be exposed to the hazard but also increases their perception of their own ability to cope with the event. While this improvement is small from a statistical standpoint, the effect small changes can have at a population level are likely impactful, especially when minor message improvements may save lives, properties and reduce harm.

AREAS OF RESEARCH UTILISATION

The research program has provided an evidence base to enable industry utilisation and impact. Four primary areas of research utilisation include:

- *National doctrine*: the research described here has provided an evidence base for many of the subsequent reforms to warning and emergency communications that have been undertaken across the Australian emergency services sector since 2014. In 2018, the release of the Australian Institute of Disaster Resilience's *Public Information and Warnings Handbook* and *Guideline 1: Warning Message Construction: Choosing Your Words*, which we co-authored, provided the emergency services sector with sound, evidence-based advice about the construction and distribution of warning messages. However, this practice will continue to evolve with new technologies and practical insights. As the severity and complexity of natural hazard events increases and communities experience concurrent events of different hazard types, the challenges associated with communicating effectively increases. The team is engaged with making ongoing contributions to both doctrinal artefacts.
- *Consulting with agencies:* to support translation of research into practice, the QUT research team was engaged to support (a) the co-design of bushfire warnings by the Queensland Fire and Emergency Services, (b) the co-design and testing of flood warnings by New South Wales State Emergency Services, and (c) run workshops to support bushfires and grassfires and flood guidance content.
- *National risk communication professional development*: in 2017, together with Professor Brooke Liu (University of Maryland), Associate Professor Amisha Mehta delivered a risk communication professional development series in Brisbane, Sydney, and Melbourne. Workshops brought together operational and communication practitioners in the emergency management sector.
- *Practitioner materials*: throughout the project a series of *Hazard Notes* and supporting industry workshops have been prepared to summarise key research insights in an accessible format for practitioners.


HAZARD NOTE

ADDRESSING CONFLICTING CUES DURING NATURAL HAZARDS: LESSONS FROM EMERGENCY AGENCIES


HAZARD NOTE

CONFLICTING CUES WITH EMERGENCY WARNINGS IMPACTS PROTECTIVE ACTION


HAZARD NOTE

COMMUNICATING FOR MAXIMUM COMPREHENSION

FIGURE 1. *HAZARD NOTES* FROM THE PROJECT.

In addition to this utilisation, the project team has worked actively with end-users and a range of additional stakeholders to co-produce project outputs, including conference presentations (e.g., World Congress on Disaster and Emergency Medicine 2019; ANZDMC 2017-2020; AFAC 2017-2020) and co-authored peer-reviewed articles (e.g., Dootson et al., 2021; Mehta et al., 2020). Utilisation is an ongoing process that will continue beyond the formal end of the research program.

END-USER PROJECT IMPACT STATEMENT

Amanda Leck, *Australian Institute for Disaster Resilience, VIC*

The AFAC Warnings Group has collaborated with the CRC Communications and Warnings research project over many years, with researchers being active contributors.

The Australian Warning System was endorsed by Australian Governments in March, to provide a consistent warning system across multiple hazards for Australian communities. There are a number of elements to the new warning system including warning levels, call to action messages, icons and colours.

The call to action messages have been co-developed with researchers, and these have been informed by the extensive research program into signal words and phrases that encourage the community to take positive protective action during an emergency to protect life and minimise hard.

Further research investigating the extent to which current warning message encourage readiness to act has also been used to inform the Australian Warning System, and has informed the adoption of a standard set of icons and colours by hazard management agencies nationally, to communicate increasing risk in a visual format.

Fire and emergency services agencies have also utilised the research that explores how community members interpret socio-environmental cues that conflict with warning messages and how emergency services agencies can overcome this conflict to encourage protective action.

Warnings can save lives and protect people from harm. By collaborating with researchers, fire and emergency services are ensuring that the warnings they issue are informed by research and evidence.

INTRODUCTION

The release of the National Review of Warnings and Information (Emergency Management Victoria, 2014) triggered the need for a range of evidence-based practice about constructing better natural hazard emergency warning messages. This report showcases a three-year program of end-user driven interdisciplinary research that derived evidence-based insights into risk and warning communication during the response phase of natural hazard emergencies. The research examines existing and modified communication to community members who may be affected by natural hazards. The work outlined in this report builds on our previous CRC project on effective communication in natural hazards.

The first CRC project (2014-2017) focused on the pre-decisional processes of community members and business owners, particularly their exposure to, attention to, and comprehension of warning messages in the response and early recovery phase of multiple hazards. The current project (2017-2020) builds on that knowledge and focuses on how the inputs into the pre-decisional process—environmental cues, social cues, information sources, channel access and preference, warning messages and receiver characteristics—inform protective action during the response phases of natural hazards.

There are two core research aims:

- to develop evidence-based strategies that motivate appropriate protective action and support informed decision-making in the community during the response and early recovery phases across multiple natural hazards.
- to work with end-users to share research findings and support research integration into practice.

These aims have been achieved through three tailored research packages:

- Research Package 1: *Encouraging protective action and enhancing trust with multi-agency risk and warning communication strategies* (led by Associate Professor Amisha Mehta and Professor Lisa Bradley)
- Research Package 2: *Overcoming ambiguity: conflict between emergency warning messages and socio-environmental cues* (led by Dr Paula Dootson)
- Research Package 3: *Optimising emergency warning messages to encourage readiness to act* (led by Associate Professor Dominique Greer)

This project employs a multi-method, multi-hazard research design to:

- develop an evidence-base for the content of risk and warning messaging across multiple channels and sources (e.g., media channels and agencies) to enhance trust in agencies and encourage positive community responses to events (e.g., evacuating and information sharing)

- construct evidence-based warning messages that overcome ambiguity caused by conflict between warning messages and socio-environmental cues (e.g., blue-sky flooding)
- optimise warning messages to improve community members' readiness to act in accordance with emergency instructions
- translate research findings into practical tools tailored to the existing and emergent needs of end-users.

Our research findings have been shared with end-users through the AFAC Warnings Group, invited presentations and consultancies, private meetings, conferences, and workshops, and translated into practice via audits, public information, visual content (e.g., infographics), emergency alert templates, national doctrine, and to support the Australian Warnings System.

BACKGROUND

Natural hazard emergencies provoke considerable uncertainty and anxiety in at-risk communities. Devising and delivering natural hazard information and warnings that prompt community members to take protective action is an important goal for emergency management agencies. In Australia, and around the world, people are frequently observed not complying with instructions issued by agencies (e.g., Dash & Morrow, 2000; Haynes et al., 2017; Whittaker et al., 2020). People who fail to comply with these instructions significantly impede the emergency response because they (a) divert resources to compliance enforcement, (b) risk the lives of emergency service workers who may later be required to assist them, and (c) confuse the core safety message or instruction. Why do individuals behave in unanticipated ways when faced with natural hazards? Why, for example, do people drive through flooded causeways or attempt to stay and defend indefensible properties in the face of bushfire? Why do people ignore official emergency instructions and rely instead on their friends' local knowledge or the opinions of family members? Human behaviour is complex, and it is well established that during times of high stress, decisions can often be illogical and unpredictable. Consequently, emergency services agencies devote significant resources to designing and delivering risk and warning communications that persuade Australians to respond to natural hazards with specific and immediate behaviours. These warnings, which vary from simple messages (e.g., not driving through floodwater) to complex messages (e.g., how to safely evacuate from a hazard-affected area), are designed to protect community health, welfare, and safety.

Researchers have invested a significant amount of time in understanding why warning messages generate such a response from the community (e.g., Sorenson, 2000; Lindell & Perry, 2004; 2012; Whittaker et al., 2020). This project uses several motivation theories and frameworks to explore key factors that may impede compliance with instructional messages, including protective motivation theory, the risk information seeking and processing model, and protective action and decision-making model.

Protection Motivation Theory (PMT; Prentice-Dunn & Rogers, 1986; Rogers, 1983) is an educational and motivational model originally conceived to better understand health promotion behaviours in the face of fear appeals. It has since been widely adapted to understand self-protection intentions and behaviours across a range of contexts, including natural hazards (Floyd et al., 2000; Maddux & Rogers, 1983; Milne et al., 2000). PMT proposes that individuals engage in protective behaviour in accordance with (a) the perceived severity of the threat, (b) the perceived probability the threat will occur (i.e., their vulnerability), (c) the perceived efficacy of the protective behaviour, and (d) their perceived self-efficacy to engage in the behaviour (Rogers, 1975). Thus, protection motivation stems from both a threat appraisal and a coping appraisal.

Protection motivation initiates, directs and sustains behavioural responses to a threat (Prentice-Dunn & Rogers, 1986). Protection motivation can either inhibit behaviours (e.g., reducing milling behaviour) or act as an explicit behaviour (e.g., commencing protective behaviours). Factors that activate the adaptive response process include when (a) a severe threat is perceived, (b) perceived

vulnerability is felt, (c) one believes an adaptive response can avoid the threat, (d) one feels confident to perform the adaptive response, (e) only small rewards are associated with the maladaptive response behaviour, and (f) the perceived costs associated with the adaptive response are small (Prentice-Dunn & Rogers, 1986).

Grothmann and Reusswig's (2006) Precautionary Adaptation Model (see Figure 2) is based on the Protective Motivation Theory. It was developed to understand why protective action is enacted by some and not others from a socio-psychological perspective. The non-protective (or maladaptive) responses outlined in the Precautionary Adaptation Model include fatalism, denial of threat and wishful thinking. These three maladaptive responses aim to protect individuals from the negative emotional consequences of a difficult situation such as a natural hazard (Grothmann & Reusswig, 2006).

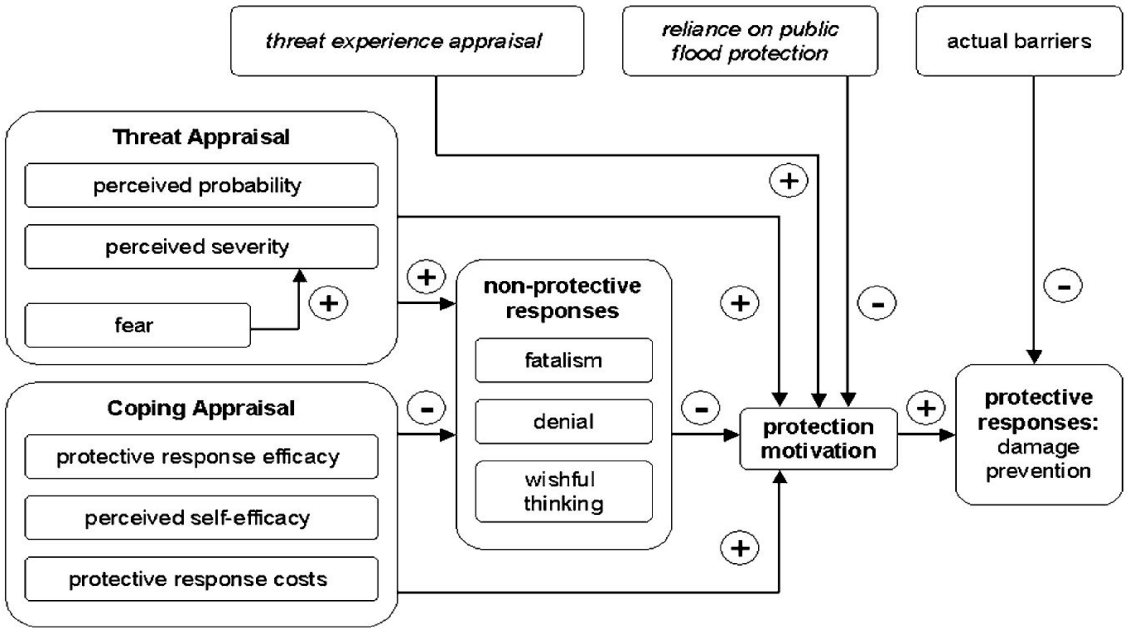


FIGURE 2: PRECAUTIONARY ADAPTION MODEL BASED ON PROTECTION MOTIVATION THEORY. SOURCE: REPRODUCED FROM GROTHMANN & REUSSWIG (2006).

The Risk Information Seeking and Processing (RISP) Model (see Figure 3) was developed to examine factors that influence the ways individuals seek and process information including hazard characteristics, emotions, and information-seeking motivations such as information insufficiency and informational subjective norms (social pressure to be informed), information-gathering capabilities, and communication channels (Griffin et al., 1999). A recent meta-analysis suggested the importance of risk communication that increases perceived relevance of risk (Yang et al., 2014).

The model purports that three factors directly influence information seeking and processing. Those factors are information sufficiency, relevant channel beliefs and capacity. In their sufficiency principle, Eagly and Chaiken (1993) explain that individuals will exert the effort needed to obtain a sufficient amount of confidence that they have achieved their goals; and that any perceived gap between an individual's current understanding pertaining to a hazard and the level of understanding required (to meet sufficiency), is linked to information seeking (ter Huurne et al., 2009). Relevant channel beliefs are the individual's

beliefs about the information channels that supply the risk information. Information gathering capacity is a specific type of self-efficacy (Griffin et al., 2008) and captures one's capacity to both process and assess risk information (Yang, 2012).

The RISP model also identifies indirect factors that affect an individual's information seeking or processing behaviour: individual characteristics, perceived hazard characteristics (i.e., perceived risk), affective responses, and informational subjective norms. Individual characteristics are static and dynamic aspects of the individual and can include demographics, hazard knowledge, previous experience, social status and other factors. An individual's hazard characteristics (or perceived risk) refers to how individuals respond affectively to risk (Griffin et al., 1999) and can be represented by judgements of the likelihood and/or severity of an event occurring (Yang, 2012). Subjective norms are individuals' perceptions that the people who are important to them, such as family members and friends, would require them to be knowledgeable about hazards in their local area (Yang, 2012). Affective responses, a consequence of perceived risk, are either positive or negative regarding the hazard.

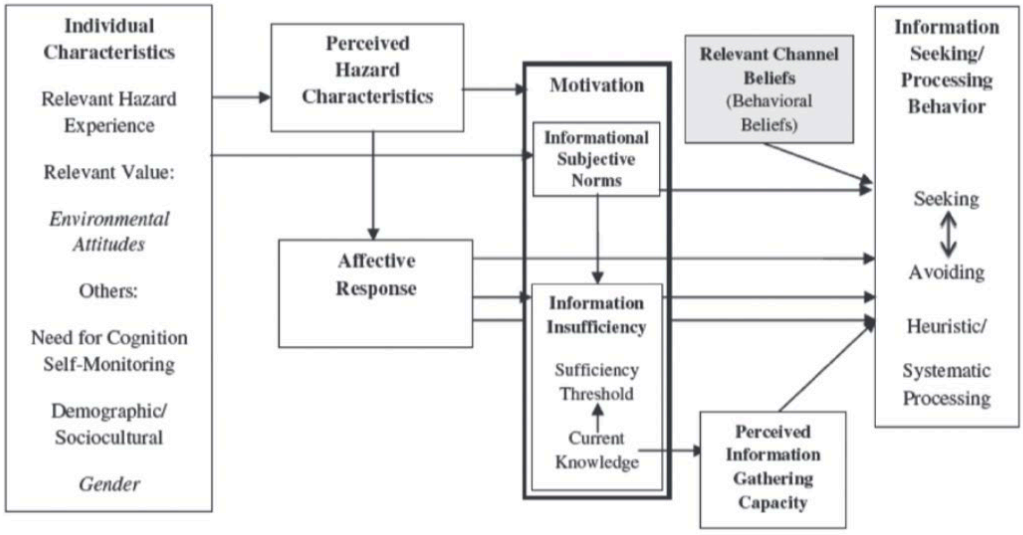


FIGURE 3. RISK INFORMATION SEEKING AND PROCESSING (RISP) MODEL. SOURCE: GRIFFIN ET AL, 2012, AS PRESENTED IN YANG 2014.

A complementary model to RISP is the Protective Action Decision Model (PADM; see Figure 4) that also considers information processing, yet subsequently considers how that can impact the decision to take protective action. In this context, protective actions are behaviours in which people engage during hazard events, including preparing for evacuation (e.g., their family and/or their property), requesting emergency assistance, and telling others to evacuate.

The PADM model asserts that the process of decision-making begins with the receipt of any type of environmental cue, social cue or warning. Environmental cues are those presented to individuals from the hazard itself, such as seeing or smelling smoke from bushfires or hearing heavy rains that lead to flooding (Lindell & Perry, 2004; 2012). Social cues initiate from other people and their behaviour, including seeing neighbours preparing to evacuate (Huang et al. 2016). According to Lindell and Perry (2004, p. 69-70), "behavioural observations can reinforce the advisability of complying with protective action recommendations, inform observers of protective actions previously unknown to them, or remind them about relevant protective information that was communicated to them

previously". Warnings can consist of an alert or warning message received through a variety of channels, including mobile phones or social media.

These cues can initiate a series of decision-making steps after which an individual decides to take protective actions or not. First, the individual engages in pre-decisional processes, including receiving the cue (or series of cues), paying attention to them and comprehending the meaning of the cue(s). In the case where the cue received is a warning message, message comprehension is vital, since an individual is more likely retain the message if they clearly understand its claims (Smith et al., 2008). Therefore, eliminating message ambiguity is likely to result in increased message comprehension (Peracchio & Meyers-Levy, 1994; Smith et al., 2008).

Following the pre-decisional processes, the individual determines the credibility of the threat and its personal relevance, described by Mileti and Sorensen (1990) as believing and personalizing the threat (or risk). An individual is more likely to perform protective actions if they perceive the threat and risk as more certain, severe, and immediate (Perry et al. 1981).

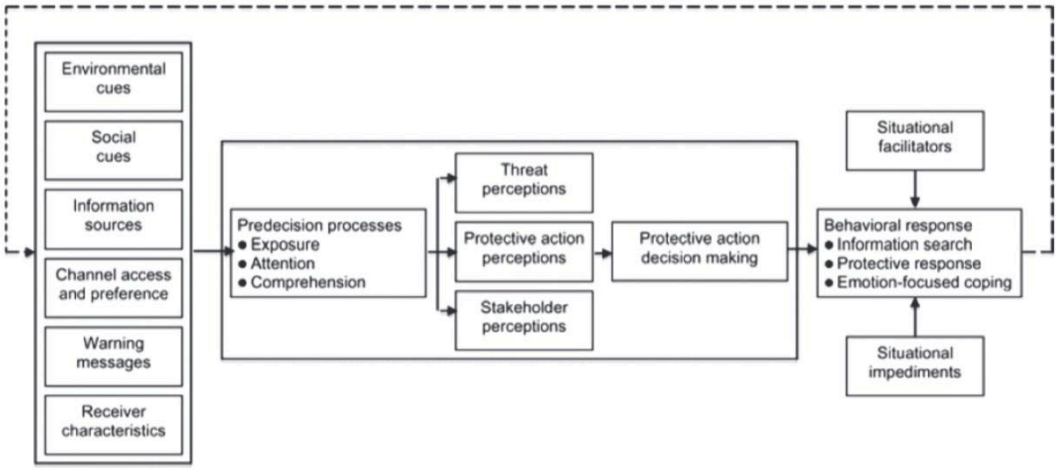


FIGURE 4: PROTECTIVE ACTION DECISION MAKING (PADM) MODEL (LINDELL & PERRY, 2004; 2012).

Finally, the individual engages in decision-making, which includes developing a list of possible protective actions from which to choose and comparing these options with others to establish the best method of protection. The individual actively or passively engages in information-seeking actions in cases where they are uncertain about the situation. The greater the situation's ambiguity, the more likely that individuals will search for information to guide their actions (Mileti & Beck 1975; Mileti &O'Brien 1992).

All these models discussed here, and the research presented in this report, focus on behavioural intentions, which could be seen as a limitation to actual behaviour. However, this evidence-base has led to changes in warnings and public information that end-users report as having been useful during a natural hazard event.

As major natural disasters have a significant economic impact on society, even small changes in protective behaviours can be valuable (Lindell & Perry, 2012). Informed emergency messaging can subsequently reduce the costs associated with disasters, which are largely attributed to the public response to the disaster (Burns & Slovic, 2012) and could potentially save lives. This research complements

the increasing industry interest in addressing key limitations of the warnings framework as outlined in the National Review of Warnings and Information (EMV, 2014) and developing a National Multi-Hazard Warning System that can promote clear understanding of warnings and appropriate protective action across Australian jurisdictions (Metrix, 2019).

RESEARCH APPROACH

This section will review the primary project activities for the period from July 2017 to June 2020.

RESEARCH PACKAGE 1: *ENCOURAGING PROTECTIVE ACTION AND ENHANCING TRUST WITH MULTI-AGENCY RISK AND WARNING COMMUNICATION STRATEGIES*

This research package responds to CRC end-user needs to understand the following:

- How do community members respond to risk and warning communication from multiple agencies during natural hazards?
- What is the optimal communication strategy (timing, content, agency) to enhance community trust in agencies and encourage protective action?

Study 1

Focus

Community member responses to risk and warning communication from multiple agencies using multiple strategies

Aim

To examine how community members evaluated a sequence of escalating weather forecasts, warnings and emergency alerts and the subsequent protective actions they would take.

Method

Six focus groups with a total of 32 participants were conducted in three States, Queensland, Western Australia, and Victoria. Four focus groups had a Bushfire context and two focus groups had riverine flooding as the scenario. Focus group members were from the general population in each area and responded to different stimuli. Messages included: a BoM weather forecast, written warning and video warning from the relevant emergency service, and a SMS Emergency Alert.

Findings

Overall, there was a very high level of trust in all the agencies even though there were some recognition or attribution issues (e.g., some participants did not actually know or could not distinguish between agencies). The Bureau of Meteorology (BoM) forecast videos provided a strong primer to each event. Information provided by BoM that led participants to trust the message included the scientific approach taken to communicate the message, the visual and verbal communication of the weather patterns, the amount of and region-specific information, and the professional style of the presentation.

The agency warning messages that followed increased participants' understanding of the likely event and were felt to contain useful information. However, there was also some confusion when there appeared to be conflicting or unclear advice or instructions. For example, where a message started with "Evacuate Now" but subsequently provided information about what to do if community members were not evacuating.

The agency videos tested were seen to give useful information about what actions to take and to frame content that enhanced the personalisation of a message. However, participants were more likely to report a personal connection with the message and pay attention to the action being requested if the spokesperson was in uniform. Emergency alerts encouraged some participants to act immediately but for others, intended action and timing for action was unclear. Participants indicated that for all message types (i.e., forecast video, written warning, video warning, and emergency alert), they would be likely to engage in some process of information verification via another channel (e.g., personal networks, television, and social media). This process of verification would occur before the requested action would commence, suggesting a trust but verify model for participants.

Study 2

Focus

Hazard warning communication strategy

Ai

Determine the optimal communication strategy (timing, content, agency) to enhance community trust in agencies and encourage protective action.

Method

Two national online surveys were conducted examining both riverine flooding and bushfire. There were 1,732 participants for flood with Victoria State Emergency Services (VICSES) as the focal organisation and 1,721 participants for bushfire with Queensland Fire and Emergency Services (QFES) as the focal organisation. The surveys provided a scenario with warning messages and measured participant responses in terms of perceptions of trust, trustworthiness, risk perceptions, knowledge, knowledge sufficiency, and responsibility.

Findings

Irrespective of the hazard and agency, participants responded with mostly appropriate intentions. The most likely intended actions were preparing property and family for the event and to evacuate, follow instructions, and share information with others. Participants also thought these were the most effective actions. Participants were most likely to undertake the actions they thought were effective. Doing nothing was the least likely activity and considered least effective. Results also showed that there is the opportunity for agencies to enhance participant knowledge about hazards.

Trust in the agencies and the information provided was high. Intended actions were related to trust level, with increases in trust linked to higher likelihood to undertake protective actions. Trust increased as each subsequent message was received.

The impact of having insurance was one of the strongest individual characteristic effects. Having insurance meant people were more likely to intend to prepare and start to evacuate, more likely to follow instructions, and less likely to do nothing. Age was also related to actions, with participants more likely to engage in many of the actions as age increased. In addition, having pets meant participants were more likely to engage in some protective actions.

Participants in both scenarios (flood and bushfire) perceived more individual responsibility (and lower agency responsibility) after viewing the video which emphasised responsibility. Emphasising care had a complex effect with some participants perceiving less personal responsibility when care was emphasised in the video. By stressing that the agency cared about the community, participants perceived the agency had more responsibility and so should be avoided in the response phase

Participating in the survey influenced participants' self-reported knowledge and knowledge sufficiency perceptions, possibly indicating a more measured evaluation of their knowledge or some knowledge development. Further, at the completion of the survey, over half of the participants indicated they would create a formal plan or have conversations in their household about how they would respond to these natural hazards in the future.

Study 3

Focus

Warning messages from two different agencies

Aim

To explore how risk communication relates to perceptions of trust and trustworthiness and intended protective actions following a weather warning video and emergency services written message.

Method

A Victorian state based online survey of 620 participants was conducted. Participants received a BoM severe weather update video and a VICSES Prepare to Evacuate written message for a riverine flooding scenario (the same context as in Study 2). Prior experience with flooding, knowledge and knowledge sufficiency, confidence to respond, risk perception, responsibility, preferred source of information, trust, barriers and motivations to respond, and intended protective actions were among the variables measured. All participants received both the BoM video and VIC SES written message, but half of the participants received the video first followed by the written message and half the participants received the stimuli in the other order.

Findings

It was found that agencies experience high levels of trust with the BoM being the agency most sought for information, and VICSES being the most trusted agency. Findings showed that intended protective actions were reported to be higher when there was higher trust in the agency, higher trust in the information, and the message was perceived to be more effective and to be more reliable. These findings replicate those found in the survey conducted for Study 2.

Including the BoM video seemed to have the most useful effects when the video was presented first followed by the written VICSES message. Seeing both the video and a written message (in either order) consistently led to higher likelihood of appropriate intended actions than seeing only one form of the message. As well, it was found that keeping family safe, not being stuck, and avoiding potential danger or damage were the main motivators for evacuating. Having pets and being concerned about people stealing from property were the main barriers to evacuation.

Study 4

Focus

How to structure emergency alerts by examining signal words and phrases

Aim

To examine how community members (a) evaluated the level of risk signalled by key words and phrases and (b) assessed emergency alerts formatted by length (i.e., short versus long) and content order (i.e., action-led versus hazard-led content) for both bushfire and flood events.

Method

A national survey of 3,138 participants was conducted online. Signal words and phrases that represented hazards and emergency warning levels and short-form and long-form versions of emergency alerts were presented. Participants provided their reactions to the various words, phrases, and emergency alerts.

Findings

Long-form messages can provide significant benefits most particularly at the earlier stages of an event (i.e., bushfire monitor conditions and flood prepare to evacuate) and to improve message comprehension across all conditions. However, the differential impact of long-form messages reduces at higher risk levels where short-form messages perform similarly.

The differences between action-led versus hazard-led content order were considered. Action-led messages produced higher comprehension and supportive protective action intentions compared to hazard-led messages. For example, in a bushfire shelter indoors now emergency alert, the action-led message resulted in lower likelihood to wait for further instructions compared to the hazard-led alert.

The calls-to-action signal words and phrases tested in this survey (e.g., evacuate now, act now) signal higher risk within each category than the emergency warning levels (i.e., advice, watch and act, and emergency warning).

This research was designed to support national conversations about emergency alerts, including their length and provide insights on signal words and their role within a larger context of warnings. Research findings are being applied to support the design of emergency alerts during natural hazard emergencies. In particular, findings related to signal words and phrases were used as an independent evidence base to support the Australian Warnings System. Learnings from this research are valuable across multiple hazards to help community members understand and react appropriately to risk and urgency communicated via emergency alerts.

RESEARCH PACKAGE 2: *OVERCOMING AMBIGUITY – CONFLICT BETWEEN EMERGENCY WARNING MESSAGES AND SOCIO-ENVIRONMENTAL CUES*

This research package responds to CRC end-user needs to understand the following:

- How do community members interpret socio-environmental cues that conflict with warning messages?
- How can emergency services agencies overcome this conflict to encourage protective action?

Studies 1 and 2

Focus

Socio-environmental cues in conflict with warning messages from agencies and community.

Aim

Establish an evidence-base for how consistent and conflicting cues impact community risk perceptions and intentions to engage in protective action.

Method

Survey research of Australians (N = 2649; Study 1) was conducted to examine the extent to which consistent and conflicting cues can impact perceptions about an event and their protective action intentions (see Figure 5). The survey was replicated on a US sample (N = 1294; Study 2) to compare findings.

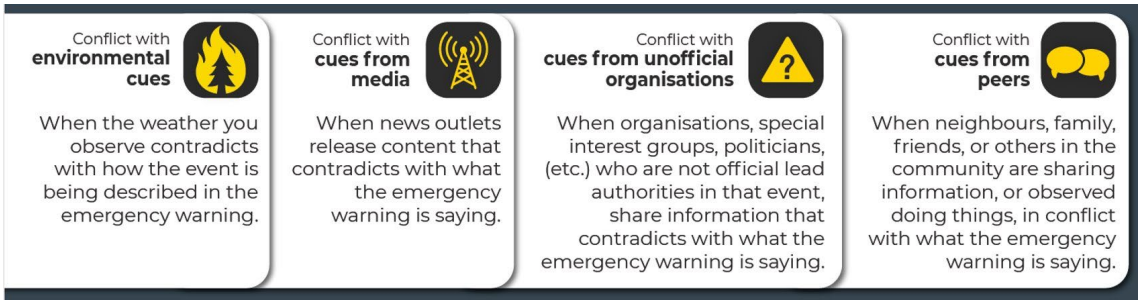


FIGURE 5: SOCIO-ENVIRONMENTAL CUES EXAMINED IN THE REESARCH AS CONFLICTING WITH WARNING MESSAGES FROM AGENCIES.

Findings

Results show that conflicting cues do exist and can affect information processing of risk perceptions, and therefore prevent appropriate protective action. The significant results were evenly spread across hazards, suggesting the problem is not unique to one hazard. Of all the individual differences tested, gender was the only statistically significant covariate influencing the findings such that the impact of consistent and conflicting cues was more likely to be significant with female respondents. The results did not change when investigating different ages, language spoken at home, country of birth, or experience with a hazard. The results did vary when splitting the data into male/female. The US data revealed similar patterns, however, at a hazard and warning level of inspection, the specific perceptions and behaviours being triggered differed across both samples. Also, age was the only covariate influencing protective action (but only in the flood conditions) such that the older participants were more likely to intend to engage in protective action.

Study 3

Focus

Conflicting cues; agency management

Aim

To explore how agencies manage conflicting cues to encourage the community to take protective action.

Method

Interviews conducted with emergency services agencies (N = 11) across Australia to explore the types of conflicting cues evident in practice and what strategies agencies can use to manage the existence and spread of these cues.

Findings

Managing conflicting cues: These strategies may be one of two categories. The first is proactive strategies, such as provision of public information and warnings training for media, volunteers, staff and stakeholders, together with formal partnerships with stakeholders to coordinate messaging, generating content to meet real-time media and community needs to inform protective action decision making, and cross jurisdictional deployments. The second is reactive strategies, such as dedicated monitoring online (e.g., social media platforms) and offline (e.g., town halls, radio) roles during events, embedding the agency in community groups, using technological solutions for warning design, and verifying visuals (see Figure 6).

FIGURE 6: VISUALS SHARED DURING NATURAL HAZARD EMERGENCIES THAT ARE IN CONFLICT WITH THE EMERGENCY INSTRUCTIONS. THE LEFT IMAGE CONFLICTS WITH INSTRUCTION TO 'STAY INDOORS' AND THE RIGHT IMAGE CONFLICTS WITH THE INSTRUCTION 'DO NOT PLAY IN FLOODWATER'. LEFT IMAGE BY TODAY SHOW AUSTRALIA (SOURCE: TODAY SHOW AUSTRALIA, 2018). RIGHT IMAGE BY NINE NEWS (SOURCE: GARCIA, 2020).

Managing problematic visual media in natural hazard emergencies: Despite hype in the popular press about deep fakes and their legitimate ability to sow discord and inflame tensions—especially for politicians who have been a prime target of synthetic media—within the emergency services domain, problematic visuals are more likely to result from cases of altered, absent, or inaccurate context delivered through captions or through simple Photoshop edits than they are through sophisticated and synthetic videos (see Figure 7). Four specific types of problematic visuals evident in Australian natural hazard emergencies including use of stock images, misattributed visuals (from old events or alternate locations), visuals amplifying non-compliant actions and to some extent, and sensationalised visuals.

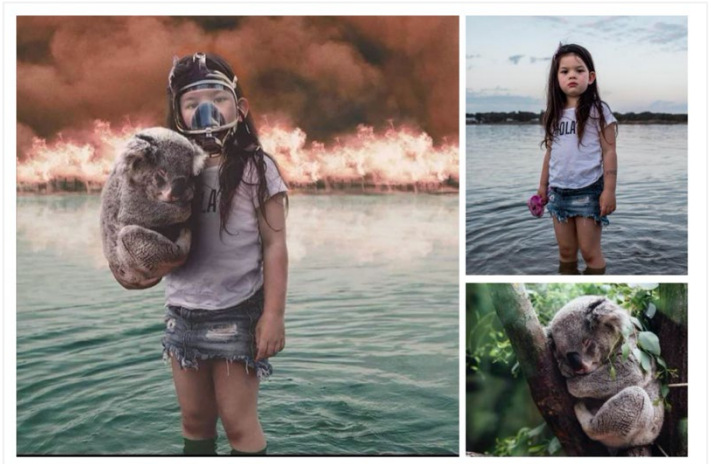


Figure 3. The photo on the left, which was shared widely on social media during the 2019-20 Australian bushfire crisis, is a composite of at least three other images that have been digitally combined in Photoshop, including photos on the right. Source: AFP Australia, 2020.

FIGURE 7: IMAGE TAKEN FROM DOOTSON ET AL., 2021 ON MANAGING PROBLEMATIC VISUALS DURING NATURAL HAZARD EMERGENCIES.

Problematic visuals were more of an issue for some agencies than others. And despite the breadth of manual and machine-learning tools available, most strategies agencies employ are low-tech, which places a resourcing burden on the agency during an event (see Figure 8). Strategies included monitoring channels (in-person and online) and reacting to a problematic visual being circulated across any channel like television or social media, having formal arrangements with news outlets to manage circulation of problematic visuals and make corrections where necessary reactively or proactively, accessing and using publicly available and free tools to verify visuals, and proactively producing and disseminating visual media for an event.

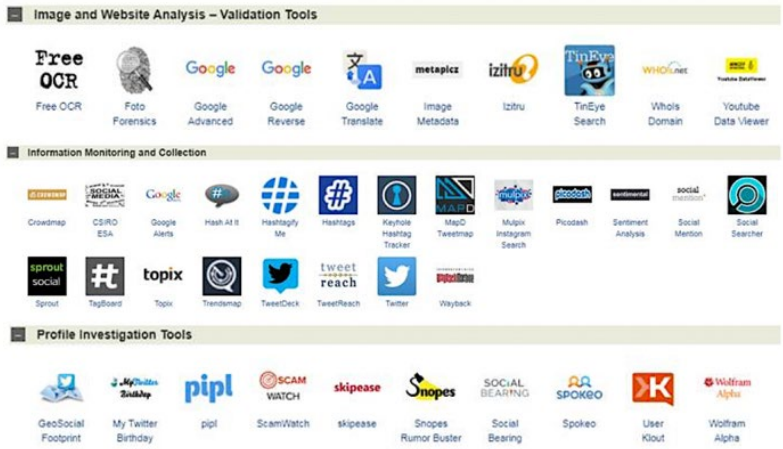


FIGURE 8: SOME OF THE TOOLS USED FOR VISUAL VERIFICATION. SUPPLIED BY AN INTERVIEWEE.

Studies 4 and 5

Focus

Visual media during natural hazard emergencies; community; agencies

Aim

To understand what type of visual media agencies should be using during a natural hazard to improve knowledge about the hazard, signal risk, and encourage the community to take protective action.

Method

The survey research (N=1563; Study 4) tested the efficacy of visual content created and shared by emergency services agencies in achieving education, risk perceptions, and protective action intentions (see Figure 9). This was replicated on a US sample (N=1621; Study 5) to compare findings, given the investment into content creation by agencies such as FEMA and The Weather Channel, and to ascertain best practice.

Findings

Infographics were useful in conveying large amounts of information about a hazard. Actual demonstrations were effective at conveying key messages. Personalised and highly consequential facts were more likely to be retained. Shorter, focused messages (provided via multiple media) performed better at improving knowledge than longer, multi-fact videos. B-roll videos (especially those that show hazard intensity and consequences) did not see a reduction in coping appraisal; did raise risk perceptions; both are good to encourage protective action, supporting Protective Motivation Theory. This research will provide suggestions to agencies in how to invest their limited resourcing into content creation for meeting the informational needs of media and the community during a natural hazard emergency. Data analysis is ongoing.

FIGURE 9: VISUAL MEDIA EXAMPLE STIMULI FROM THE PROJECT.

RESEARCH PACKAGE 3: *OPTIMISING EMERGENCY WARNING MESSAGES TO ENCOURAGE READINESS TO ACT*

This research package responds to CRC end-user needs to understand the following:

- To what extent do current warning messages encourage community members' readiness to act on emergency instructions?
- Can warning messages be further optimised with colours and/or icons to encourage higher levels of readiness to act on emergency instructions?

Study 1

Focus

Official warning messages; readiness to act; community; colour

Aim

Establish an evidence-base for how current warning messages (optimised to match best practice) encourage readiness to act on emergency instructions.

Method

Following a review of current warning messages provided by CFS (SA), DFES (WA), MFB (VIC), MFS (SA), NSW SES, TAS SES, VIC SES and QFES (QLD) to develop mock warning messages for testing, an online survey of Australians (N = 1595) was conducted to examine the extent to which current warning messages encouraged readiness to act and how colour is interpreted in relation to risk.

Findings

Overall, the research results show that current warning messages encourage readiness to act. Current warning messages are highly comprehensible and effective, with only marginal differences between bushfire and flood messages.

The warning messages provoke a moderate and appropriate threat appraisal (which comprises the perceived probability and perceived severity of the risk, as well as any fear it generates), again with only marginal differences between bushfire and flood messages. When participants examined the instructions contained within each message to establish a coping appraisal, they determined that their ability to execute each instruction (i.e., perceived self-efficacy) was high, the protective effectiveness of the instruction (i.e., protective response efficacy) was high, and the cost to action the instruction (i.e., protective response cost) was appropriately low.

While protection motivation is the most desirable outcome of a warning message, we also investigated the potential for three maladaptive coping responses. After controlling for the effects of the other variables, response cost has the strongest association with all three maladaptive coping responses. Thus, reducing perceived response costs may reduce potential maladaptive responses to warning messages. In sum, the results show that the instructions contained in current warning messages do encourage readiness to act in the face of a bushfire or flood hazard, and that lowering response costs will prevent maladaptive responses.

When asked to indicate the perceived riskiness of a colour that could be added to a warning message, participant's ratings of risk escalated systematically from cool colours (i.e., green, blue) to warm colours (i.e., yellow, orange, red with black hatch, red with white hatch, red).

Study 2

Focus

Official warning messages; readiness to act; community; icons; colour

Aim

Investigate whether adding colour and/or icons to current warning messages (optimised to match best practice) further encourages readiness to act on emergency instructions.

Method

Given that the written elements of warning messages are well optimised to encourage readiness to act, an online survey of Australians (N = 2482) was conducted to examine whether warning messages can be further optimised by adding coloured headers and/or hazard icons to encourage higher levels of readiness to act on emergency instructions (see Figure 10). Participants were exposed to one of 16 emergency warnings about either a bushfire or a riverine flood and were then asked a series of questions relating to their demographic characteristics, message comprehension and effectiveness, threat appraisal, coping appraisal, protection motivation and maladaptive coping behaviour.

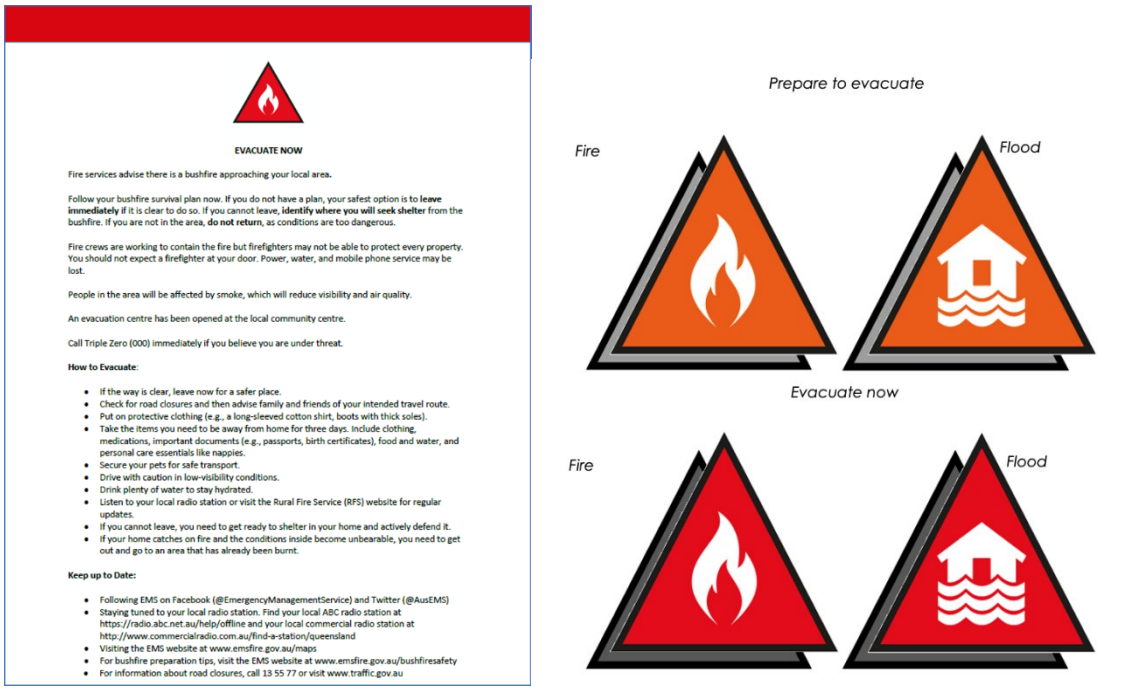


FIGURE 10. EXAMPLE COLOUR AND ICON STIMULI FROM THE PROJECT.

Findings

Overall, the research results show that adding colours and/or icons to the *Evacuate Now (Bushfire)* message creates improvements, albeit small ones, in message comprehension, effectiveness, perceived probability and perceived self-efficacy. While these improvements are small from a statistical standpoint, the effect small changes can have at a population level are likely impactful, especially when message improvements can save lives, properties and reduce harm. The other three messages [*Prepare to Evacuate (Bushfire), Prepare to Evacuate (Flood)* and *Evacuate Now (Flood)*] showed no improvement or loss in message comprehension, effectiveness, threat appraisal, or coping appraisal as a result of adding colours and/or icons.

First, the results show that a red header serves as a significant cue to assist community members to perceive, interpret and respond to warning messages appropriately. The red header increases the perceived probability that the recipient will be exposed to the hazard but also increases their perception of their own ability to cope with the event. Interestingly, adding orange headers to the *Prepare to Evacuate (Flood or Fire)* messages does not result in any significant change in message comprehension, effectiveness, threat appraisal, or coping appraisal, despite orange being the next highest hazard risk rating received. This may be because colours are often studied in isolation from supporting text, which did not occur in this research as it is unlikely in practice that these warning elements would appear separately.

Second, the results show that the communicative role of icons in warning messages is less clear. Although icons can be used to clarify, illustrate and supplement written information, they did not appear to create any significant change in message comprehension, effectiveness, threat appraisal, or coping appraisal (with one exception). In the *Evacuate Now (Bushfire)* message, risk probability was perceived differently when colour and icons were combined.

When this message was presented in greyscale, the addition of an icon reduced the perceived probability that the recipient would be affected by the event. This result suggests that deeper investigation is needed into the role that icons play in signalling risk probability if they are not presented in colour.

Finally, these research findings highlight an interesting future research opportunity to investigate the impact of colour and/or icons on less well optimised messages. Although colour and/or icons appear to have little impact on optimal warning messages, they might be more useful to aid interpretation of less well worded warning messages if they reduce uncertainty.

KEY MILESTONES

This section highlights the key milestone for July 2017 to June 2020.

The first suite of milestones (2018) focused on the 'prove' phase of each of the three research packages, where evidence was sought for the phenomenon being explored.

- Findings of RP1.1: *Encouraging protective action and enhancing trust with multi-agency risk and warning communication strategies* (focus groups)
- Findings of RP2.1: *Exploring conflict between socio-environmental cues and emergency warning messages*
- Findings of RP3.1: *Optimising emergency warning messages to encourage readiness to act*

The second wave of milestones (2019) focused on the 'assess' phases of each of the three research packages, where evidence for possible solutions or interventions were sought for the phenomenon being explored.

- Findings of RP1.2: *Encouraging protective action and enhancing trust with multi-agency risk and warning communication strategies*
- Findings RP2.2: *Addressing conflict between socio-environmental cues and emergency warning messages*
- Findings of RP3.2: *Optimising emergency warning messages to encourage readiness to act*

The third (and ongoing) wave of milestones (2020-present) is focused on the utilisation of the research, starting with the publication of scholarly academic journal articles (e.g., Dootson et al., 2021; Mehta et al., 2020). Utilisation also occurred through additional commercial research and consulting projects with end-users including QFES, NSW SES, and ACT ESA.

Each year (2017-2020), we participated with a presentation or poster in the ANZDMC Conference and the AFAC Conference to disseminate insights derived from new research. Additional conferences where the work was presented during the project included the World Congress on Disaster and Emergency Medicine (2018) and the International Crisis and Risk Communication Conference presentation (2017-9).

Additional milestones were examined as opportunities arose, which included:

- evaluating national doctrine on warnings and public information with AFAC and AIDR
- evaluating visual media use in natural hazard events to ascertain which types of media are useful to agencies to disseminate if they aim to improve knowledge about a hazard, trigger risk perceptions, or encourage protective action. This was an outcome of Research Package Two findings, driven by end-user interest in their own use of visual media
- providing evidence around how particular signal words and phrases in Emergency Alerts are perceived and evaluated in terms of risk and urgency.

UTILISATION AND IMPACT

SUMMARY

This project provides an evidence base for warning message design and community responses. The translation of these findings into utilisation and impacts is an ongoing process that will continue beyond the formal end of the research.

CONTRIBUTION TO THE AUSTRALIAN WARNING SYSTEM

Output description

Associate Professor Amisha Mehta was engaged by AFAC to contribute to a sub-committee to co-design with national warning practitioners the calls-to-action statements that form part of the Australian Warnings System. Using RP1's Study 4, Amisha contributed independent evidence behind this important, but previously missing, component of the Australian Warning System. Call-to-action statements clearly signal the behaviours required of communities across severity intervals (e.g., prepare to leave vs. leave now). Doing so overcomes the educational burden and misinterpretation issues seen with operational levels (e.g., watch and act; see RP1, Study 1).

Extent of use

- The calls-to-action statements are available via the AIDR Knowledge Hub (the 'Knowledge Hub'), which is a national, open-source platform that supports and informs policy, planning, decision making and contemporary good practice in disaster resilience: https://knowledge.aidr.org.au/resources/australian-warning-system/.

Utilisation impact

- The calls-to-action statements are presented across warning levels and are designed to "give the community clearer advice about what to do" (AIDR, 2021). They can be adapted for use by hazard type and by each State or Territory.

Utilisation and impact evidence

Evidence to support their use is in progress as States and Territories adapt systems to support the Australian Warning System.

DOCTRINE FOR EMERGENCY COMMUNICATION

Output description

Associate Professor Dominique Greer and Dr Paula Dootson were commissioned to provide the academic evidence to support the creation of, and changes to, two critical pieces of doctrine for emergency communication for the Australian Institute for Disaster Resilience (AIDR). These two doctrinal documents included:

- Handbook 16: Public Information and Warnings Handbook
- Guideline 1: Warning Message Construction: Choosing your words.

AIDR develops, maintains, and shares knowledge and learning to support a disaster resilient Australia. Building on extensive knowledge and experience from within Australia and internationally, AIDR works with government, communities, NGOs, not-for-profits, research organisations, education partners and the private sector to enhance disaster resilience through innovative thought leadership, professional development, and knowledge sharing. AIDR is supported by its partners, the Australian Government Department of Home Affairs, AFAC and the Australian Red Cross.

Both Associate Professor Dominique Greer and Dr Paula Dootson attended all contracted meetings and provided research support directly to Deb Martindale, who was the author of AIDR Handbook 16. In addition, Dominique and Paula held several teleconferences with the client to ensure their needs were met. Dominique and Paula received positive verbal feedback on their contributions.

Dominique, Paula, and Amisha are presently engaged to integrate findings into these doctrinal materials.

Extent of use

- The AIDR Knowledge Hub (the 'Knowledge Hub') is a national, open-source platform that supports and informs policy, planning, decision making and contemporary good practice in disaster resilience. The Knowledge Hub highlights current and emerging themes in the resilience sector, linking national guidelines with research and fostering collaboration among leading agencies and organisations. The Knowledge Hub also houses information on historical Australian disasters.

Utilisation potential

- The *Public Information and Warnings Handbook* is designed to support organisations and individuals with specific responsibilities for developing and disseminating public information and warnings in an emergency. It will benefit Australian leaders and practitioners in emergency management, meteorological services, policing and security, health agencies, and other hazard management organisations. Broadcasters and other organisations committed to sharing warnings effectively will also find the handbook useful. Individuals and community groups, regulators, auditors general, the legal fraternity, international practitioners in disaster resilience and emergency management, and those working in communication and behavioural science may also value the information and research presented.
- The *Guideline 1: Warning Message Construction: Choosing your words* is a companion document to the Public Information and Warnings Handbook (AIDR 2018). It provides guidance on key considerations for writing effective warning messages, a proposed structure for a warning message, specific language to use when constructing messages, and suggestions for constructing warning messages for non-English speaking audiences.

The words and principles identified in this guideline have been developed from related literature and from the preferences of community members. It is not, and cannot be, a totally prescriptive template for writing a warning message. Rather, it offers specific advice on effective words to use in constructing a warning message.

Utilisation impact

- Doctrine endorsed and shared on Australian Institute for Disaster Resilience Knowledge Hub. The Handbook Collection:
    - provides an authoritative, trusted and freely available source of knowledge about disaster resilience principles in Australia
    - aligns national disaster resilience strategy and policy with practice, by guiding and supporting jurisdictions, agencies and other organisations and individuals in their implementation and adoption
    - highlights and promotes the adoption of good practice in building disaster resilience in Australia
    - builds inter-operability between jurisdictions, agencies, the private sector, local businesses, and community groups by promoting use of a common language and coordinated, nationally agreed principles.
- Sets ten national warning principles to guide the development and use of warnings in Australia, replacing the 2008/09 principles in Australia's Emergency Warning Arrangements. The Commissioners and Chief Officers Strategic Committee endorsed these new principles on 1 May 2018.
- Offers nationally agreed and applicable definitions of warnings and public information in the Australian emergency and disaster context.
- Translated into a training tool with facilitator notes as a means of assisting agency representatives to conduct internal briefings or training sessions. The content reviews the principles in the handbook and includes activities to reflect on how these may be applied to a specific jurisdiction or context. Link: https://knowledge.aidr.org.au/resources/public-information-and-warnings-handbook/#links.
- The ACT Emergency Services Agency commissioned Associate Professor Dominique Greer and Dr Paula Dootson to facilitate a workshop designed to review and revise the public messaging templates for bush/grass fires issued by ACT ESA.

Utilisation and impact evidence

- Murphy, Joe, Rutland, Kaylee, Dyson, Joanne, Leck, Amanda, Rundle, Sascha, Greer, Dominique, Dootson, Paula, et al. (2018) *Public information and warnings (Australian Disaster Resilience Handbook Collection, Handbook 16).* Australian Disaster Resilience Handbook Collection. Australian Institute for Disaster Resilience, Australia.

- Murphy, Joe, Dyson, Joanne, Leck, Amanda, Rundle, Sascha, Maguire, Shoni, Greer, Dominique, Dootson, Paula, et al. (2018) *Warning message construction: Choosing your words: Key considerations for writing effective warning messages (Australian Disaster Resilience Handbook Collection, Guideline 1).* Australian Disaster Resilience Handbook Collection. Australian Institute for Disaster Resilience, Australia.
- AIDR. (2018). Public Information and Warnings Handbook Training Slidedeck. https://knowledge.aidr.org.au/resources/public-information-and-warnings-handbook/#links
- Deb Martindale, whose background includes executive and advisory roles in emergency management and public safety, posted on LinkedIn a COVID-19 communication evaluation tool that used Australia's Warning Principles from the Australian Disaster Resilience handbook, *Warning Message Construction: Choosing your words*. This handbook was reviewed to reflect contemporary research and practice by Associate Professor Dominique Greer and Dr Paula Dootson in 2018. On the LinkedIn platform, 14 April 2020, Deb Martindale has 935 followers.

EXAMINING CONFLICTING AND CONSISTENT CUES

Output description

Research findings for Research Package 2, led by Dr Paula Dootson, were disseminated as a *Hazard Note* (Issue 59), titled "*Conflicting cues with emergency warnings impacts protective action*". The *Hazard Note* was disseminated through the Bushfire and Natural Hazards Cooperative Research Centre's (CRC) mailing list and posted on their website.

Extent of use

- The CRC can reach all of Australia and New Zealand's fire and emergency service agencies; leading partner experts across universities, Geoscience Australia and the Bureau of Meteorology; and international research organisations. Under the direction of the CRC, researchers and emergency agency end-users collaborate to ensure research pursuits are informed by partner operations.
- Dr Paula Dootson presented '*Overcoming Ambiguity: Conflict between Emergency Warning Messages and Socio-environmental Cues*' to the AFAC National Warnings Group, which comprises representatives from emergency services agencies across Australia, plus the Australian Institute for Disaster Resilience and the ABC.

Utilisation potential

- Mr Andrew Richards from the State Emergency Services, New South Wales, provided the following statement in support of the research: "*These findings have the potential to be readily applied by agencies in these key situations where comprehension, trust and validation plays an important*

role for the community in understanding and believing public information and warning messages and acting upon them in a timely manner".

Utilisation impact

- Emergency Media and Public Affairs (EMPA) Australia 2019 **Award for Excellence in Emergency Communication**, Research Category: *Highly Commended* for Conflicting Cues in Emergency Warnings.
    - The research provides clear evidence of conflicting cues in practice, collates first-hand interview responses from Australian emergency services representatives, and explores the types of strategies that might help mitigate the negative effects of conflicting cues. This research provides evidence that public information and warnings is as much a frontline job as the operational responders and offers strategies for emergency services agencies to help minimize the negative social, physical and economic consequences of conflicting cues that impact community decision making during a natural hazard. For more information visit: https://www.empa.org.au/awards/2019-empa-australia-award-winners and https://www.bnhcrc.com.au/news/2019/community-engagement-research-picks-prizes
- The magazine **Asia Pacific Fire** published an article based on *Hazard Note* 59. Asia Pacific Fire is the only quarterly journal for the Asia Pacific Fire protection, fire service and emergency management communities. Asia Pacific Fire is dedicated to keeping readers up to date with current research, new and innovative equipment, techniques, and training methods. Asia Pacific Fire also covers regional news stories and current issues. The articles are written and read by leaders in the fire and disaster management world, looking at the issues around protection, prevention, mitigation, response, and recovery.
- Another industry magazine, **Fire Australia**, published an article based on RP2.1's *Hazard Note*. *Fire Australia* is the joint publication of the Bushfire CRC, the Australasian Fire and Emergency Services Authorities Council (AFAC) and the Fire Protection Association Australia (FPAA). The magazine brings the latest news, developments, research knowledge and technical information to the fire protection industry, emergency services and fire research organisations. *Fire Australia* is produced quarterly and distributed throughout Australia and New Zealand.
- The research was shared on the **United Nation's PreventionWeb Knowledge Platform for Disaster Risk Reduction**. PreventionWeb is a collaborative knowledge sharing platform on disaster risk reduction (DRR), managed by the UN Office for Disaster Risk Reduction (UNDRR). The Prevention Web is the global knowledge sharing platform on disaster risk reduction, managed by the UN Office for Disaster Risk Reduction (UNISDR). Their knowledge base is updated daily and features over 55,000 entries, including news, publications, events, training, and job vacancies. The UN's Prevention Web audience includes specialists working at local, country,

and regional levels, as well as non-specialists – teachers and students, citizens and journalists. The site receives an average of 100,000 visits per month. For more information visit: https://www.preventionweb.net/news/view/67598

- *Hazard Note* was included in a summary of 'emerging and useful' information for WA DFES as they develop their **strategic plan for improving public information** c/o Deb Martindale.

Utilisation and impact evidence

- Dootson, P., Greer, D., Tippett, V., & Miller, S. (2019). Conflicting cues with emergency warnings impacts protective action. *Hazard Note 59*, Bushfire and Natural Hazards Cooperative Research Centre (CRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/59
- Dootson, P., Greer, D., Miller, S., & Tippett, V. (2019). Overcoming Ambiguity: Conflict Between Emergency Warning Messages and Socio-Environmental Cues. *Prehospital and Disaster Medicine*, *34*(s1), S21.
- Dootson, P., Greer, D., Miller, S. A., & Tippett, V. (2019). Impacts of *conflicting cues in emergency warning*. Fire Australia, Issue 3. Retrieved from https://www.bnhcrc.com.au/resources/fireaustralia-edition/5874
- Dootson, P., Greer, D., Miller, S. A., & Tippett, V. (2019). *Conflicting cues with emergency warnings impacts protective action*. Asia Pacific Fire, Issue 70. Retrieved from https://apfmag.mdmpublishing.com/asia-pacific-fire-magazine-issue-70-july-2019/
- UNDDR. (2019). Australia: Impacts of conflicting cues in emergency warnings. United Nation's PreventionWeb Knowledge Platform for Disaster Risk Reduction. Please visit: https://www.preventionweb.net/news/view/67598.

MANAGING CONFLICTING CUES

Output description

Research findings for Research Package 2, led by Dr Paula Dootson, were disseminated as a *Hazard Note* (Issue 72), titled "*Addressing conflicting cues during natural hazards: lessons from emergency agencies*". The *Hazard Note* was disseminated through the Bushfire and Natural Hazards Cooperative Research Centre's (CRC) mailing list and posted on their website.

Extent of use

- The CRC can reach all of Australia and New Zealand's fire and emergency service agencies; leading partner experts across universities, Geoscience Australia and the Bureau of Meteorology; and international research organisations. Under the direction of the CRC, researchers and emergency agency end-users collaborate to ensure research pursuits are informed by partner operations.

- It was disseminated in the CRC Hazard News. Hazard News is a website and e-newsletter that publishes articles monthly for an audience of end-users, partners, participants, and the general community. Link: https://www.bnhcrc.com.au/resources/hazardnewsedition/6840
- Dr Paula Dootson presented results to AFAC National Warnings Group in February 2020, which comprises representatives from emergency services agencies across Australia, plus the Australian Institute for Disaster Resilience and the ABC.

Utilisation potential

- "This project had the edge in terms of value to EMPA members. There was a real connection between the research and what could be applied in the response phase of an emergency event." Judging panel at the Emergency Media and Public Affairs (EMPA) conference.
- "The shared lessons presented in this research have the potential to be readily applied by agencies in these key situations where comprehension, trust and validation plays an important role for the community in understanding and believing public information and warning messages and acting upon them in a timely manner." – Marc Unsworth, Lead Officer, Operational Communication Capability, Emergency Management Victoria.

Utilisation impact

- Dr Paula Dootson, Associate Professor Dominique Greer, Dr Sophie Miller and Professor Vivienne Tippett won Emergency Media and Public Affairs (EMPA) Australia 2020 Award for Excellence in Emergency Communication, Research Category, for *Addressing Conflicting Cues During Natural Hazards: Lessons from emergency agencies.* See for more information: https://www.bnhcrc.com.au/news/2020/excellence-crc-research-nationally-recognised and https://youtu.be/UV2asBUcXLs and https://empa.org.au/empaaust/awards/2020-empa-awards-winners/
- Dr Paula Dootson was invited to present this work to the NSW SES Community Capability Team, the Media and Communications Team and the lead for their Warnings Project and also engaged with their questions. The impact of the presentation was evident in the following audience feedback: *"Very interesting … very informative"* (Attendee A), *"Thank you, I agree very interesting"* (Attendee B), *"Thanks Paula and David – great session – so appreciated"* (Attendee C), *"Thanks Paula, very interesting presentation …"* (Attendee D).

Utilisation and impact evidence

- Dootson, P., Thomson, T., Angus, D., Miller, S., Hurcombe, E., & Smith, A. (2021). Managing problematic visuals in natural hazard emergencies. *International Journal of Disaster Risk Reduction.*
- *Thomson, T. J., Angus, D., Dootson, P., Hurcombe, E., & Smith, A. (2020). Visual Mis/disinformation in Journalism and Public Communications:*

Current Verification Practices, Challenges, and Future Opportunities. Journalism Practice, 1-25.

- Dootson, P., Greer, D., Miller, S., & Tippett, V. (2020). Addressing conflicting cues during natural hazards: Lessons from emergency agencies. *Hazard Note 72,* Bushfire and Natural Hazards Cooperative Research Centre (CRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/72
- Dootson, P. (2020). Addressing conflicting cues during natural hazards: Lessons from emergency agencies. Presentation to NSW SES.
- Dootson, P., Thomson, T.J., Angus, D., Burgess, J., Hurcombe, E., Smith, A. (2020). Communicating with visuals in a natural hazard: Verifying their authenticity and provenance. In AFAC20 conference, 25-28 August 2020, Adelaide, Australia. The conference was cancelled due to COVID-19.

READINESS TO ACT AND WARNING OPTIMISATION

Output description

Research findings for the CRC1.0 Focus Group Research and CRC2.0 Research Package 3, led by Associate Professor Dominique Greer, are disseminated as *Hazard Notes*. The three *Hazard Notes* are:

- ***Hazard Note 79*:** Greer, D., Dootson, P., Mehta, A., & Tippett, V. (2020). Emergency warning messages: How do community members comprehend them? *Hazard Note 79,* Bushfire and Natural Hazards Cooperative Research Centre (CRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/79
- ***Hazard Note 80*:** Greer, D., Dootson, P., Miller, S., & Tippett, V. (2020). Emergency warning messages: Encouraging readiness to act. *Hazard Note 80,* Bushfire and Natural Hazards Cooperative Research Centre (CRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/80
- ***Hazard Note 81*:** Greer, D., Dootson, P., Miller, S., & Tippett, V. (2020). Emergency warning messages: Do colours and icons improve community readiness to act? *Hazard Note 81,* Bushfire and Natural Hazards Cooperative Research Centre (CRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/81

Each *Hazard Note* is disseminated through the Bushfire and Natural Hazards Cooperative Research Centre's (CRC) mailing list and posted on their website.

Extent of use

- The CRC can reach all of Australia and New Zealand's fire and emergency service agencies; leading partner experts across universities, Geoscience Australia and the Bureau of Meteorology; and international research organisations. Under the direction of the CRC, researchers and emergency agency end-users collaborate to ensure research pursuits are informed by partner operations.

- The *Hazard Notes* will be disseminated in the CRC Hazard News. Hazard News is a website and e-newsletter that publishes articles monthly for an audience of end-users, partners, participants, and the general community.
- Link: https://www.bnhcrc.com.au/resources/hazardnewsedition/6840

Utilisation potential

- The *Hazard Notes* may likely inform and underpin emergency services agencies operations.
- The *Hazard Notes* may result in industry magazine publications (e.g., Fire Australia, Asia Pacific Fire).
- Continued collaborations with emergency services agencies to improve warning messages.

Utilisation impact

- This research was shared on the **United Nation's PreventionWeb Knowledge Platform for Disaster Risk Reduction**. PreventionWeb is a collaborative knowledge sharing platform on disaster risk reduction (DRR), managed by the UN Office for Disaster Risk Reduction (UNDRR). The Prevention Web is the global knowledge sharing platform on disaster risk reduction, managed by the UN Office for Disaster Risk Reduction (UNISDR). Their knowledge base is updated daily and features over 55,000 entries, including news, publications, events, training and job vacancies. The UN's Prevention Web audience includes specialists working at local, country and regional levels, as well as non-specialists – teachers and students, citizens and journalists. The site receives an average of 100,000 visits per month. For more information visit: https://www.preventionweb.net/publications/view/73727 https://www.preventionweb.net/publications/view/73728 https://www.preventionweb.net/publications/view/73730
- *Hazard Note 81* was discussed at a **World Meteorological Organisation** meeting and subsequently disseminated to the **UK Met Office** and **New Zealand MetService**. This *Hazard Note* was also tabled at a meeting of the HI Weather Communication Taskforce, New Zealand.
- Themes from this research informed A/Professor Dominique Greer's contribution to the **Institute of Future Environment's Grand Challenge Future Forum** *Clearing the Air: Making Sense of Australia's Bushfire Crisis*.

Utilisation and impact evidence

- ***Hazard Note 79*:** Greer, D., Dootson, P., Mehta, A., & Tippett, V. (2020). Emergency warning messages: How do community members comprehend them? *Hazard Note 79,* Bushfire and Natural Hazards Cooperative Research Centre (CRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/79
- **CRC1.0 Focus Group Research: *Hazard Note* (Issue 79):**

- **Anthony Clark,** (Director Corporate Communications), *New South Wales Rural Fire Service*
- *"This research is a really important piece of the puzzle. It is a game-changer for us as we had been sending out information and warnings in a format that met the needs of the emergency services. This research tips the process on its head and puts the community first and foremost. Emergency services are forming warning messages with the community in mind, so we can get the best possible response from the community in a time of disaster."*

- ***Hazard Note 80*:** Greer, D., Dootson, P., Miller, S., & Tippett, V. (2020). Emergency warning messages: Encouraging readiness to act. *Hazard Note 80,* Bushfire and Natural Hazards Cooperative Research Centre (CRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/80
- **Research Project 3.1 – *Hazard Note* (Issue 80):**

Jacob Riley (Senior Advisor, Public Information and Warnings), Victoria State Emergency Service, VIC

"VICSES and QUT have been collaborating on a range of risk communication research projects to ensure Victorians continue to receive high quality information and warnings during emergencies.

This project has examined the effectiveness of current warning messages and the extent to which individuals perceive risk and take action. The innovative research led by Associate Professor Dominique Greer, in conjunction with the VICSES Communications and Community Resilience Directorate, has reaffirmed that VICSES warnings are highly effective when they contain clear instructions.

The research findings will support VICSES to further refine its robust warnings doctrine and templates to ensure people can continue to make informed decisions, take action to protect their lives and property and avoid engaging in fatalism during emergencies.

VICSES looks forward to continuing to work alongside QUT to ensure it can continue to deliver on its vision of 'safer communities – together'."

- ***Hazard Note 81*:** Greer, D., Dootson, P., Miller, S., & Tippett, V. (2020). Emergency warning messages: Do colours and icons improve community readiness to act? *Hazard Note 81,* Bushfire and Natural Hazards Cooperative Research Centre (CRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/81
- **Research Project 3.2 - *Hazard Note* (Issue 81):**

Hayley Gillespie (Executive Manager, Media), Queensland Fire and Emergency Services

"As QFES implements evidence-based emergency warning message design, it is important to understand how community members perceive and respond to updated warning messages. This research by Greer, Dootson, Miller and Tippett provides several findings that affirm our current practice and provide some direction for the future. Firstly, it is useful to know that warning messages similar to ours are perceived to be highly comprehensible and effective. We will continue

to include instructions to the community that they perceive to be easily undertaken, protective, and low in cost (i.e., time, money and effort). Secondly, it is valuable to understand the impact of warning colours and icons on how community members interpret warning messages. Looking ahead to the next bushfire season, QFES will draw on this research and use colour more prominently to enforce warning levels and severity. Our messages will continue to be reviewed in light of these findings to continue encouraging protective action in the community."

INDUSTRY AND GOVERNMENT ENGAGEMENT

Output description

During 2017 to 2020, the project team has been extensively involved in with end-user, industry, and government agencies at both state and national levels. This engagement has provided opportunities for members of the team to engage with influence in state and national decision and 'think tank' forums. The team has also provided subject matter expertise to several state forums. Since 2016, Associate Professor Amisha Mehta has been one of two academic advisers to the Inspector General Emergency Management's Advisory Panel. In this role, she has supported strategic planning and governance of emergency management in Queensland. For example, she has co-designed standards and provided detailed implementation support on tools for agencies to assess and comply with public engagement and warnings accountabilities in Queensland.

In May 2018, Professor Tippett was invited to address the Shine Dome forum held at the Australian Academy of Science, and joined CRC CEO Dr Richard Thornton and Dr Jason Sharples, to provide members with an overview of the significance of the bushfire and natural hazard research effort in Australia.

On 15 January 2020, Minister Karen Andrews, then Minister for Industry, Science and Technology, hosted a national think tank on the current and future research activity directed to disaster events and strategies for ensuring that Australian communities and infrastructure were well protected. This meeting was attended by Richard Thornton (CEO CRC), Dr John Bates (Research Director, CRC) and Professor Vivienne Tippett, representing QUT and the CRC. This forum contributed to the decision in July 2020 of the Minister to announce jointly with the Minister for Disaster Management, to announce a commitment of $88.1 million dollars for the establishment of a new national disaster resilience research capacity building on the work of the CRC.

Professor Tippett represented QUT at the Minderoo Foundation Roundtable on Wildfire and Disaster Resilience in February 2020. This forum included business, academic and industry leaders from across the country and assisted the Foundation in the development and delivery of the Minderoo Foundation Wildfire and Disaster Resilience Program launched in September 2020.

PUBLICATION LIST

PEER-REVIEWED JOURNAL ARTICLES

1 Dootson, P., Thomson, T. J., Angus, D., Miller, S., Hurcombe, E., & Smith, A. (2021). Managing problematic visual media in natural hazard emergencies. *International Journal of Disaster Risk Reduction*, *59*, 102249.
2 Mehta, A. M., Murray, S., Hammill, C., Dootson, P., & Langdon, R. R. (2020). Checks and balances: A business-oriented lens on disaster management and warnings. *Disasters*.
3 Thomson, T. J., Angus, D., Dootson, P., Hurcombe, E., & Smith, A. (2020). Visual Mis/disinformation in Journalism and Public Communications: Current Verification Practices, Challenges, and Future Opportunities. *Journalism Practice*, 1-25.

CONFERENCE ABSTRACTS (PEER-REVIEWED)

4 Greer, D., Dootson, P., Miller, S. & Tippett, V. (2020). Current emergency warning messages encourage readiness to act. *Australian & New Zealand Disasters & Emergency Management Conference (ANZDMC)*, 1-2 October, Gold Coast, Australia.
5 Mehta, A., Bradley, L., Weeks, C., & Murray, S. (2020). What words signal to community members during disasters. *International Crisis and Risk Communication Conference*, 9-11 March 2020, Orlando, FL.
6 Mehta, A., Riley, J., Weeks, C., Bradley, L., & Murray, S. (2020). *Do words matter? Community responses to emergency alerts during natural hazards emergencies*. *AFAC20 Conference*, 25-28 August 2020, Adelaide, Australia. The conference was cancelled due to COVID-19.
7 Dootson, P., Thomson, T.J., Angus, D., Burgess, J., Hurcombe, E., Smith, A. (2020). Communicating with visuals in a natural hazard: Verifying their authenticity and provenance. AFAC20 Conference, 25-28 August 2020, Adelaide, Australia. The conference was cancelled due to COVID-19.
8 Tippett, V., Graham, T., Greer, D., Mehta, A., and Dootson, P. (2020). 'Liar, Liar, Pants on Fire!' Can we combat fake news and misinformation on social media in the face of bushfires? AFAC20 Conference, 25-28 August 2020, Adelaide, Australia. The conference was cancelled due to COVID-19.
9 Dootson, P., Greer, D., Miller, S., & Tippett, V. (2019). Overcoming Ambiguity: Conflict Between Emergency Warning Messages and Socio-Environmental Cues. *Prehospital and Disaster Medicine*, *34*(s1), S21.
10 Dootson, P., Greer, D., Miller, S., & Tippett, V. (2019). Overcoming ambiguity: Conflict between emergency warning messages and socio-environmental cues. *Australian & New Zealand Disasters & Emergency Management Conference (ANZDMC),* 12-13 June 2019, Gold Coast, Australia.
11 Dootson, P., Greer, D., Miller, S., & Tippett, V. (2019). Overcoming ambiguity: Conflict between emergency warning messages and socio-environmental cues. *World Congress on Disaster and Emergency Medicine [WADEM]*, 7-10 May 2019, Brisbane, Australia.
12 Bradley, L., Mehta., A., & Miller, S. (2019). Towards trust and protective actions: The role of risk communication and context during natural hazards. *Australian and New Zealand Academy of Management (ANZAM) conference*, 3-6 December 2019, Cairns, Australia.
13 Mehta, A., Bradley, L., & Miller, S. A. (2019). Mind the gap: The role of convergence and conflict in community perceptions versus agency intentions of warnings. *International Crisis and Risk Communication Conference*, 11-13 March 2019, Orlando, FL.
14 Mehta, A., Tippett, V., Greer, D., & McAndrew, R. (2018). Towards message effectiveness: The role of efficacy-based content and images in bushfire and flood emergency warnings. *International Risk and Crisis Communication conference,* 12-14 March 2018, Orlando Florida, USA.
15 Mehta, A., Tippett, V., Greer, D., & McAndrew, R. (2017). Evidence-based risk communication: An industry-academy research collaboration that enhanced dam messages. *AFAC17 conference*, 4-7 September 2017, Sydney, Australia.

HAZARD NOTES

16 Greer, D., Dootson, P., Mehta, A., & Tippett, V. (2020). Emergency warning messages: How do community members comprehend them? *Hazard Note 79,* Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/79.
17 Greer, D., Dootson, P., Miller, S., & Tippett, V. (2020). Emergency warning messages: Do colours and icons improve community readiness to act? *Hazard Note 81,* Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/81.
18 Greer, D., Dootson, P., Miller, S., & Tippett, V. (2020). Emergency warning messages: Encouraging readiness to act. *Hazard Note 80,* Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/80.
19 Dootson, P., Greer, D., Miller, S., & Tippett, V. (2020). Addressing conflicting cues during natural hazards: Lessons from emergency agencies. *Hazard Note 72,* Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/72.
20 Dootson, P., Greer, D., Miller, S., & Tippett, V. (2019). Conflicting cues with emergency warnings impacts

protective action. *Hazard Note 59,* Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/59.

21 Tippett, V., Greer, D., Mehta, A., & Dootson, P. (2018). *Communicating for maximum comprehension. Hazard Note 57,* Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC). Retrieved from https://www.bnhcrc.com.au/hazardnotes/57.

PRESENTATIONS (POSTERS)

22 Mehta, A., Walker, S., Tutticci, A., Greer, D., Dootson, P., Hammill, C., & Tippett, V. (2017). Evidence-based risk communication: An industry-academy research collaboration that enhanced dam release message. AFAC17, 4-7 September 2017, Sydney, Australia.

23 Mehta, A., Bradley, L., Miller, S., & Tippett, V., (2018). *Community trust and responses to multi-agency warnings: Findings from phase one of research package 1: Encouraging protective action and enhancing trust with multi-agency risk and warning communication strategies*. AFAC18, 6-7 September 2018, Perth, Australia.

24 Greer, D., Dootson, P., Miller, S., & Tippett, V. (2019). Do current emergency warning messages encourage readiness to act? AFAC19, 27-30 August 2019, Melbourne, Australia.

25 Greer, D., Dootson, P., Miller, S., & Tippett, V. (2020). Adding colour and icons to emergency warning messages. AFAC20 Conference, 25-28 August 2020, Adelaide, Australia. *Conference cancelled due to COVID-19*.

CONSULTANCY REPORTS (COMMERCIAL-IN-CONFIDENCE)

26 QFES: QFES commissioned Associate Professor Dominique Greer and Associate Professor Amisha Mehta to facilitate a series of workshops designed to review and revise the public messaging templates for fires issued by QFES, as well as summarise existing evidence for changes to messages.

27 NSW SES: NSW SES commissioned Associate Professor Amisha Mehta, Associate Professor Dominique Greer, Dr Paula Dootson and Professor Vivienne Tippett to review and revise the public messaging templates for floods issued by NSW SES, and test their efficacy via community surveys.

28 ACT ESA: The ACT Emergency Services Agency commissioned Associate Professor Dominique Greer and Dr Paula Dootson to facilitate a workshop designed to review and revise the public messaging templates for bush/grass fires issued by ACT ESA.

MEDIA PUBLICATIONS

29 Turner, T. (2020, January). 80 per cent of Queensland household underprepared for fire. *The Courier Mail. Retrieved from* https://www.couriermail.com.au/sponsored/TzhMtkMATdapcWaLVE8T/80-per-cent-of-queensland-households-underprepared-for-fire/?utm_source=taboola&utm_medium=native.

30 QUT: Institute for Future Environments (2020, February 26). *Clearing the air after the QUT bushfire forum [Web blog]*. Retrieved from https://www.qut.edu.au/institute-for-future-environments/about/news/news?news-id=159328.

31 Mehta, A. (2020, January 9). *Financial lifeline: Online support for businesses in fire zones/Interviewer: Samantha Butler.* 10 News First Queensland. Retrieved from https://twitter.com/10NewsFirstQLD/status/1215193171975712768?s=20.

32 Weaver, A. (2020, January 28). Bushfire experts converge for forum at QUT – 31 January [Web blog repost]. Retrieved from QUT News & Events Wrap https://www.qut.edu.au/news?id=157814.

33 Doyle, M. (2020, January 29). Emergency alerts 'ignored over scam fears'. *The Canberra Times.* Retrieved from https://www.canberratimes.com.au/story/6604138/emergency-alerts-ignored-over-scam-fears/?cs=14231.

34 Mehta, A. (2020, January 31). *Fire Forum: Lessons learned from the disasters.* 10 News First Queensland. Retrieved from https://twitter.com/10NewsFirstQLD/status/1223146208404832256?s=20.

35 Rowbotham, J. (2019, November 20). Keeping message simple during a bushfire emergency. The *Australian (Higher Education Supplement)*.

36 Dootson, P., Greer, D., Miller, S. A., & Tippett, V. (2019). Impacts of *conflicting cues in emergency warning*. Fire Australia, Issue 3. Retrieved from: https://www.bnhcrc.com.au/resources/fireaustralia-edition/5874.

37 Dootson, P., Greer, D., Miller, S. A., & Tippett, V. (2019). *Conflicting cues with emergency warnings impacts protective action*. Asia Pacific Fire, Issue 70. Retrieved from https://apfmag.mdmpublishing.com/asia-pacific-fire-magazine-issue-70-july-2019/.

38 Mehta, A., Bradley, L., & Miller, S. A. (2018, April 2). Natural disasters expose women's emergency preparedness gap. *ABC News*. Retrieved from http://www.abc.net.au/news/2018-04-02/helping-women-overcome-disaster-preparedness-gaps/9549862?pfmredir=sm&user_id=d679219a086daf5a14c07ee9f75ee0e0caf4b4fa3c4189cc43e540618071ddd4.

39 Deacon, B. (2018, January 6). Emergency announcements alone during disasters not reliable in saving lives. *ABC News: Weather.* Retrieved from http://www.abc.net.au/news/2018-01-06/emergency-

announcements-alone-during-disasters-not-reliable/9304666?pfmredir=sm.
40 Tippett, V. (2018). Emergency messaging in the face of predicted weather events that don't eventuate/Interviewer: Ben Deacon. ABC Emergency Channel.
41 Mehta, A. (2018). Alert SA app failure/Interviewer: Nadia Mitsopoulous and Russell Woolf. ABC Perth Radio. Retrieved from http://www.abc.net.au/radio/perth/programs/breakfast/breakfast/9299986.
42 Bradley, L. (2018). *Risk and Warning Communication that Supports Women during Disasters/Interviewer: Andy Touslon*. ABC North Queensland Radio.
43 Turner, T. (2018, November 15). Complacency is a killer. *Daily Mercury*. Retrieved from https://www.pressreader.com/australia/daily-mercury/20181115/281878709403359.
44 Mehta, A. (2017). Live ABC Perth RadioMehta, A., Bradley, L., & Miller, S. A. (2018, January 2). Natural disasters expose women's emergency preparedness gap. *ABC News*. Retrieved from https://www.abc.net.au/news/2018-04-02/helping-women-overcome-disaster-preparedness-gaps/9549862?pfmredir=sm&user_id=d679219a086daf5a14c07ee9f75ee0e0caf4b4fa3c4189cc43e540618071ddd4.

BLOG POSTS

45 BNHCRC (2020, February 10). Breaking down Australia's bushfires [Web blog]. Retrieved from https://www.bnhcrc.com.au/news/2020/breaking-down-australia-s-bushfires.
46 Dootson, P., Greer, D., Miller, S. A., & Tippett, V. (2019, June 19). Effective risk and warning communication during natural hazards [Web blog post]. Retrieved from https://anzdmc.com.au/risk-warning-communication-natural-hazards.
47 Dootson, P., Greer, D., Miller, S. A., & Tippett, V. (2019, September 13). Australia: Impacts of conflicting cues in emergency warnings [Web blog repost]. Retrieved from the UN's Prevention Web https://www.preventionweb.net/news/view/67598.
48 Mehta, A., Bradley, L., & Miller, S. (2018, March 7). Risk and warning communication that supports women during disasters [Web blog post]. Retrieved from QUT Business School online newsletter for International Women's Day (AMPR's social media) https://blogs.qut.edu.au/business-insights/risk-and-warning-communication-that-supports-women-during-disasters/.
49 Mehta, A., Bradley, L., & Miller, S. (2018, March 8). Risk and warning communication that supports women during disasters [Web blog repost]. Retrieved from BNHCRC's website https://www.bnhcrc.com.au/news/blogpost/amisha-mehta/2018/risk-and-warning-communication-supports-women-during-disasters.
50 Mehta, A., Bradley, L., & Miller, S. (2018, March 12). News – Floods and fires: getting evacuation messages across [Web blog repost]. Retrieved from main QUT news site and QUT News and Events Wrap (QUTs weekly new summary) https://www.qut.edu.au/news?id=128433.
51 Mehta, A., Bradley, L., & Miller, S. (2018, April 5). Risk And Warning Communication That Supports Women During Disasters [Web blog repost]. Retrieved from the UN's Prevention Web https://www.preventionweb.net/news/view/57732.
52 Mehta, A. (2018, May 21). International insights and local lessons: Themes from the International Risk and Crisis Communication Conference [Web blog post]. Retrieved from BNHCRC website https://www.bnhcrc.com.au/news/blogpost/amehta/2018/international-insights-and-local-lessons-themes-international-risk-and.

AWARDS

This research has received recognition via external awards including an Excellence in Research Innovation (CRC Association, 2019) and awards for Excellence in Emergency Communication (Emergency Media and Public Affairs 2018, 2019, 2020). These awards are illustrated in Figure 11. The work has been shared internationally through the UN Office for Disaster Risk Reduction platform and in the World Health Organisation.

FIGURE 11: AWARDS FOR THE RESEARCH PROGRAM.

TEAM MEMBERS

CHIEF INVESTIGATORS

- Professor Vivienne Tippett – Faculty of Health, QUT
- Associate Professor Amisha Mehta – Faculty of Business and Law, QUT
- Associate Professor Dominique Greer – Faculty of Business and Law, QUT
- Dr Paula Dootson – Faculty of Business and Law, QUT
- Professor Lisa Bradley – Faculty of Business and Law, QUT

RESEARCHERS

- Dr Scott Murray, Faculty of Business and Law, QUT
- Dr Michaela Jackson, Faculty of Business and Law, QUT
- Ms Michelle Lambert, Faculty of Business and Law, QUT
- Peter Townson, Faculty of Business and Law, QUT
- Dr T.J. Thomson, Digital Media Research Centre, QUT
- Associate Professor Daniel Angus, Digital Media Research Centre, QUT
- Dr Edward Hurcombe, Digital Media Research Centre, QUT
- Mr Adam Smith, Digital Media Research Centre, QUT
- Dr Erica Kuligowski, National Institute for Science and Technology, USA (now RMIT, Australia)
- Professor Brooke Fisher Liu, National Consortium for the Study of Terrorism and Responses to Terrorism, University of Maryland, USA
- Dr Sophie Miller, Faculty of Business and Law, QUT

END-USERS

The project's end-user group is the AFAC National Warnings Group, comprising representatives from emergency services agencies across Australia, plus the Australian Institute for Disaster Resilience and the ABC.

CONCLUSION

The comprehensive and representative data collection described here provides insights into how warning messages, across multiple hazards, can be optimised to encourage the community to appropriately (a) perceive and assess risk and (b) take protective action. The research described here has met its key objectives to:

- develop evidence-based strategies that motivate appropriate protective action and support informed decision-making in the community during the response and early recovery phases across multiple natural hazards
- work with end-users to share research findings and support research integration into practice

This research has provided new insights in the body of natural hazard risk communications evidence in several important ways. It has emphasised the very real opportunities that exist to protect lives and property during extreme events by ensuring that warnings:

- use language, sentence structure and the order of information most likely to improve comprehension
- improved understanding of the threat and recommended actions using appropriate visual information, infographics, and colour
- include clearly stated action statements to minimise the need for interpretation under pressure

Cumulatively, the insights derived from the research highlight the importance of close engagement between official agencies and the communities they serve; as well as the benefits of research led by the identified challenges faced by official warning agencies and more broadly the media.

It is widely accepted that natural hazard event types in Australia and across the globe are changing, both in terms of their complexity and severity. Consequently, research into the ability of the community to respond appropriately to warnings is likely to require revision and re-testing. Similarly, as the community's preferences for information seeking change over time, ensuring that warnings remain effective across the wide variety of digital and other media platforms is likely to be required. New opportunities also exist to extend the work described here by exploring international comparisons and the applicability of these findings to vulnerable sub-populations within the Australian community. Opportunities also exist for collaborative engagement with our regional neighbours, many of whom have developing warning systems and face threats less familiar in Australia (e.g., tsunami).

For example, further investigation of the impact of colour and/or icons is required. Although our work shows that colour and/or icons appear to have little impact on the optimisation of warning messages, they may provide a more useful aid to interpretation and reduce uncertainty in some sub-sets of the population.

NEXT STEPS

The immediate next steps in this program will involve the finalisation of data analysis and write up of the visual media project to ascertain best practice in video design to improve knowledge, elicit risk, and encourage protective action intention in the community, and dissemination of the findings through academic publications and presentations.

The researchers will continue their close engagement with end-users to seek ongoing opportunities to embed research findings into national doctrine. In the first instance with will include requested edits of AIDR's *Public Information and Warnings Handbook* and *Guideline 1: Warning Message Construction: Choosing Your Words*. The team will also continue to support agencies in the translation of the research findings and assist with the delivery of research directed to the risk communication needs of these providers.

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