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SUPPLEMENTING EMERGENCY WARNING MESSAGES TO ENCOURAGE READINESS TO ACT: THE EFFECT OF COLOUR AND ICONS

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ABSTRACT

Current Australian emergency warning messages that have been refined to match evidence-based practice strongly encourage community members' readiness to act on emergency instructions (Greer, Dootson, Miller & Tippett, 2019). Given the written elements of warning messages are optimised to encourage readiness to act, this research examines the effect of adding icons and/or colours to official warnings. In this research, we draw on a socio-psychological model of precautionary adaption (Grothmann & Reusswig, 2006) underpinned by Protective Motivation Theory (PMT; Rogers, 1975, 1983; Rogers & Prentice-Dunn, 1997) to investigate whether emergency warning messages can be further optimised by adding colours and/or icons to encourage even higher levels of readiness to act on emergency instructions.

In order to achieve the aims of this research, an online survey was conducted in which participants were exposed to one of 16 mock 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. Mock emergency warnings were developed using existing end-user emergency warnings to improve realism and maximise the usefulness of the findings, as well as building on previous QUT-conducted BNHCRC research (see Greer *et al.*, 2019). A total of 2,482 Australians living across all states and territories were recruited to participate in the research. Participants were recruited by the Market Research firm Dynata. Approximately 150 participants responded to each of the 16 stimuli.

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. The other three messages showed no improvement (or loss) in message comprehension, effectiveness, threat appraisal, or coping appraisal as a result of adding colours and/or icons.

END-USER STATEMENT

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.

INTRODUCTION

Since the release of the *National Review of Warnings and Information* (Emergency Management Victoria, 2014), emergency service agencies across Australia have adopted a range of evidence-based practice when constructing emergency warning messages. After five years of development, research shows that current emergency warning messages that have been refined to match evidence-based practice do encourage community members' readiness to act on emergency instructions (Greer *et al*., 2019). As the written elements of warning messages are unlikely to be able to be further optimised to encourage readiness to act, this research examines the effect of adding icons and/or colours to official warning messages. This research complements the increasing industry interest in developing a National Multi-Hazard Warning System that can promote clear understanding of warnings and appropriate protective action across Australian jurisdictions (Metrix, 2019).

In this research, we aim to investigate whether adding colours and/or icons to optimised emergency warning messages further encourages community members' readiness to act on emergency instructions. Both colour and icons are perceptual elements that can be added to warning messages to increase the salience of a warning (Wogalter, Conzola & Smith-Jackson, 2002; Wogalter *et al.*, 1987; Wogalter, Mayhorn & Zielinska, 2015; Wogalter, Conzola & Vigilante, 2006). Such design elements are intended to increase community safety by increasing rapid recognition of the hazard warning (Wogalter *et al.*, 2015; Wogalter *et al.*, 2006) and encouraging appropriate protective actions to be taken (Braun & Silver, 1995). Thus, it is important to investigate whether the addition of colour and/or icons changes how emergency warning messages are interpreted.

To execute this research, we draw on a socio-psychological model of precautionary adaption developed by Grothmann and Reusswig (2006). This model uses Protective Motivation Theory (PMT; Rogers, 1975, 1983; Rogers & Prentice-Dunn, 1997) as a foundation to understand the extent to which emergency warning messages with added colour and/or icons encourage community members' readiness to act on emergency instructions.

The overarching research question guiding this research package is: *Can emergency warning messages be further optimized with colours and/or icons to encourage higher levels of readiness to act on emergency instructions?* The research required to address this question will be executed across four phases:

Prove: First, we measure the extent to which current emergency warning messages encourage readiness to act on emergency instructions.

Assess: Second, we develop and test optimised emergency warning messages that encourage higher levels of readiness to act on emergency instructions.

Utilise: Third, we engage with end-users to translate the findings in order to improve readiness to act in accordance with emergency instructions.

Evaluate: Finally, we will assist end-users to develop evaluation strategies for their changes (if any) to emergency warning communications.

This report provides insight into the second phase of the research, *Assess*.

RESEARCH BACKGROUND

Emergency warnings are issued to inform community members about potential hazards and suggest appropriate protective actions that support their safety and well-being (Wogalter *et al.*, 2015). Warnings also aim to capture attention, aid understanding, and communicate risk (Wogalter *et al.*, 1987; Wogalter *et al.*, 2015; Wogalter *et al.*, 2006). Both national and international bodies (e.g., the International Organization for Standardization; ISO) have developed generic warning design guidelines that incorporate elements such as colour (e.g., red, orange), icons (e.g., pictures), and signal words (e.g., 'WARNING') to increase the salience of a warning (Wogalter *et al.*, 2002; Wogalter *et al.*, 1987; Wogalter *et al.*, 2015; Wogalter *et al.*, 2006). These design elements are intended to improve community safety through rapid recognition of the hazard warning (Wogalter *et al.*, 2015; Wogalter *et al.*, 2006) and encourage appropriate protective actions to be taken (Braun & Silver, 1995). This study examines the impact of adding colours and/or icons to warning messages for natural hazards as these design elements are (i) ubiquitous in society, (ii) powerful ways to communicate and aid the interpretation of warning information, and (iii) may be proposed as part of a national multi-hazard warning system in Australia (Danesi, 2007; Elliot & Maier, 2012; Metrix, 2019; Wogalter *et al.*, 2015).

THE ROLE OF COLOUR

Although colour is ubiquitous in our human environment, there is limited research on how colour affects human cognition, affect, and behaviour (Elliot & Maier, 2007, 2012). To address this gap, Elliot and Maier (2012) developed Color-in-context Theory to explain the relationships that exist between colour perception and behaviour (e.g., approach or avoidance), cognition (e.g., perceptions, mental processes) and affect (e.g., emotions). There are six core guiding principles of Colour-in-context Theory:

(i) colour carries meaning, because it is 'nonlexical visual stimulus that can symbolically convey various types of information' (p. 67);
(ii) seeing colour impacts on psychological functions in a way that is 'consistent with the meaning of the color' (p. 67);
(iii) colour effects are automatically processed, such that colour affects psychological functioning without the explicit awareness of the perceiver;
(iv) colour meanings (and subsequent responses) are both socially learnt (e.g., pink is feminine) and biologically based (i.e., red fruit is ripe);
(v) associations between colour and behaviour, cognition and affect are reciprocal (i.e., visual perception is influenced by the psychological state of the perceiver); and
(vi) the meanings and effects associated with colour are context specific, such that 'color carries different meaning in different contexts and, therefore, has different implications for feelings, thoughts and actions in different contexts' (Elliot & Maier, 2012).

Empirical support for the theory has been demonstrated in a variety of contexts and domains, such as competitive sport performance (Hill & Barton, 2005), video gaming (Ilie *et al.*, 2008), and motor performance (Elliot *et al.*, 2007).

Color-in-context Theory is particularly useful to explain how colours, particularly red, serve as environmental cues that assist us to perceive, interpret and respond to stimuli. Traffic lights with their 'green = go' and 'red = stop' behavioural associations provide an example of common learned colour cues (Garrido, Prada, Simao & Semin, 2019). The colour red is also associated with aggression/dominance in animals that is likely to be an innate response (Pryke, 2009). Additional research suggests the red-danger association observed in humans is implicit in nature (Pravossoudovitvh, Cury, Young & Elliot, 2014). Across multiple studies, many red-danger pairings obtained the highest hazard risk ratings (e.g., Braun & Silver, 1995; Chapanis, 1994; Ng & Chan, 2018), followed by orange (e.g., Braun & Silver, 1995; Chapanis, 1994). Further, Kline, Braun, Peterson and Silver (1993) demonstrated that participants rated perceived hazardousness and readability of warning labels higher when they were presented in chromatic colour (e.g., red, green, blue) compared to achromatic colour (e.g., black, grey, white). To understand the effects of colour further, the context colour is perceived in is an important factor to consider. Specifically, research demonstrates that the colour red elicits both approach and avoidance behaviours in romance and achievement contexts respectively (Meier, D'Agostino, Elliot, Maier & Wilkowski, 2012). In romantic contexts, red is considered attractive and encourages the viewer to approach, whereas in achievement contexts, red is considered threatening and is something to be avoided. It is thus pertinent to assess the effects of colour in the context of the multi-hazard warning messages.

THE ROLE OF ICONS

The study of signs is known as semiotics. Peirce, a founder of semiotics, proposed that a sign is 'something that stands to somebody for something in some respect or capacity' (1932, p. 135). According to Peirce, the three interactive factors that comprise a sign are (i) the Representamen (i.e., the representation), (ii) the sign's Object (i.e., the represented object), and (iii) the Interpretant (i.e., the mental interpretation process).

Peirce (1932) identified three types of signs: *icons*, which include pictures, diagrams, and ideographs; *indexes*, which are figures such as arrows on a map or time units such as hours or days; and *symbols*, such as the cross figure that represents Christianity. Of particular interest to this research is icons, as they resemble an object's qualities. Iconicity has roots in early human systems and cultures through prehistoric inscriptions, cave drawings and pictographic signs, such as the hieroglyphs in ancient Egypt and cuneiform in ancient Mesopotamia (Danesi, 2007). Iconicity is also evident in early childhood 'scribble' drawings and extends through to pictures denoting male and female toilets, road signs and chemical label warnings (Danesi, 2007). Icon developers need to carefully consider their end-users as cultural contexts (among other factors like knowledge

and familiarity with the icon) will likely influence the interpretation of the icon (Chan & Courtney, 2001; Danesi, 2007; Jacobs *et al.*, 1991; Kitao & Kitao, 1986).

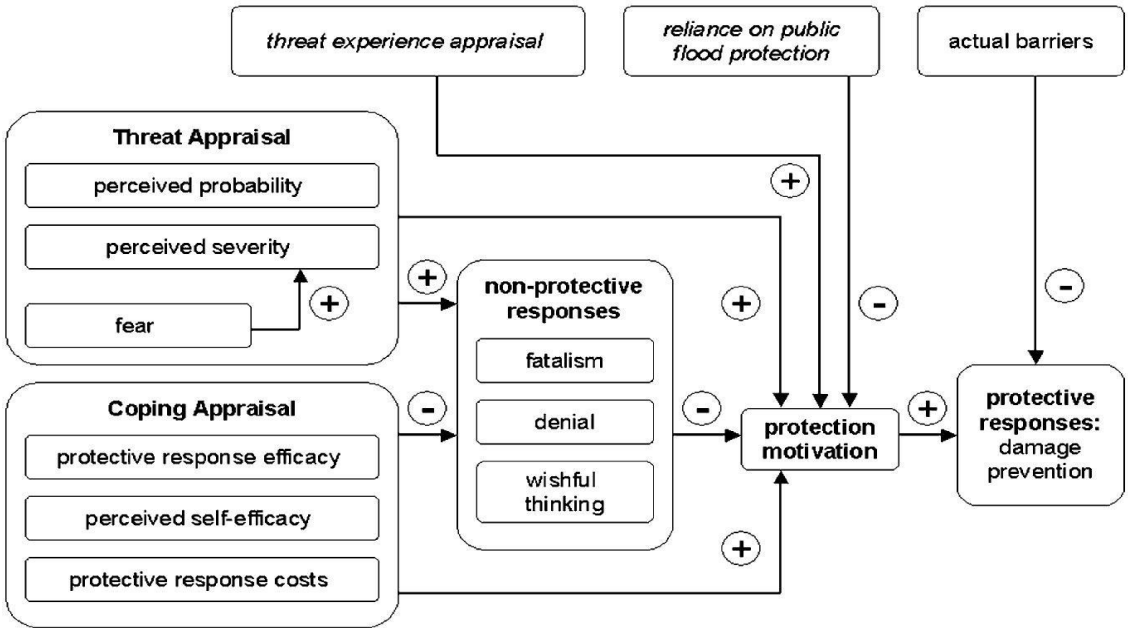
The power of icons has been recognised as an important visual element in communication. Icons can be used to clarify, illustrate and supplement written information (Rodriguez Estrada & Davis, 2015; Trumbo, 1999). What is less clear, however, are the behaviours, cognitive performance and/or affect associated with the icons in the context of natural hazards (Rodriguez Estrada & Davis, 2015). The uncertainty of natural hazards provides further challenges to using icons. Information pertaining to a hazard and its anticipated impact needs to be communicated via warnings whether or not (i) the hazard is currently occurring in the immediate area and (ii) environmental cues are absent (i.e., blue sky flooding; Anderson-Berry *et al.*, 2018). Given that icons can enhance communication, it is important to assess the utility of icons in the context of natural hazard warnings.

INVESTIGATING THE IMPACT OF COLOUR AND ICONS ON EMERGENCY WARNING MESSAGES

Given that colour and icons are added to improve the protective impact of emergency warnings, this research uses Protection Motivation Theory (PMT; Rogers, 1975, 1983; Prentice-Dunn & Rogers, 1986) as a guiding theoretical framework. PMT is an educational and motivational model that has been adapted to understand self-protection intentions and behaviours across a range of contexts, including natural hazards (Floyd, Prentice-Dunn & Rogers, 2000; Maddux & Rogers, 1983; Milne, Sheeran & Orbell, 2000). PMT proposes that individuals engage in protective behaviour in accordance with (i) the perceived severity of the threat, (ii) the perceived probability the threat will occur (i.e., their vulnerability), (iii) the perceived efficacy of the protective behaviour, and (iv) their perceived self-efficacy to engage in the behaviour (Rogers, 1975). Thus, protection motivation stems from both a threat appraisal and a coping appraisal. Further details of this theoretical approach are reported in previous research by Greer and colleagues (2019).

Grothmann and Reusswig's (2006) Precautionary Adaptation Model is based on the Protective Motivation Theory and was developed to describe why protective action is enacted by some and not others from a socio-psychological perspective (see Figure 1). 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 1: PRECAUTIONARY ADAPTION MODEL BASED ON PROTECTION MOTIVATION THEORY



Source: Reproduced from Grothmann & Reusswig (2006)

In order to investigate whether the addition of colour and/or icons altered message impact, the following constructs were examined (reproduced from Greer *et al.*, 2019):

Threat appraisal was determined using two dimensions of risk judgment: the vulnerability/probability and severity of an event occurring (adapted from Yang, 2012). According to Martin and colleagues (2007) one's perception of **risk vulnerability/probability** is the likelihood of harm experienced to one's person or property provided no behavioural change is adopted. Perception of **risk severity** was also defined by Martin and colleagues (2007) as the level of adversity that would result from experiencing the perceived risk.

Affective responses (i.e., the emotional response to an event) have been shown to influence both heuristic and systematic processing to risk. Not only can negative and positive emotions influence the level of attention given to risk information, like emergency warning messages, but affective responses can also impact the way ambiguous events like hazards are interpreted (Griffin, Neuwirth, Dunwoody & Giese, 2004). **Fear** was thus determined by assessing the level of fear, anxiety and worry warning messages generate.

Perceived self-efficacy is defined as one's belief regarding their capability of performing or not performing suggested protective actions (Martin *et al.*, 2007). An individual's level of self-efficacy (e.g., high versus low) is an important predictor of behavioural outcomes (Ajzen, 1991; Bandura 1986, 2000). Similarly, the extent to which people believe specific recommended protective actions will alleviate or deter a threat is known as **protective response efficacy** (adapted from Martin *et al.*, 2007). **Response costs** (adapted from Neuwirth, Dunwoody & Griffin, 2000) are the costs incurred due to the potential course of action.

Two additional constructs were investigated in this research:

Perceived comprehension captures an individual's ability to understand the message. Individual's will likely retain the message if they have a clear understanding of the messages' claims (Smith, Chen & Yang, 2008). Eliminating ambiguity from a message is likely to result in successful perceived message comprehension (Peracchio & Meyers-Levy, 1994; Smith *et al.*, 2008).

Individual attitudes towards public messages have been assessed using constructs like credibility, likeability and persuasiveness. These types of measures can be categorised under the larger conceptual framework of **perceived effectiveness** (Davis, Duke, Shafer, Patel, Rodes & Beistle, 2017). Perceived effectiveness has an intuitive meaning as it captures whether or not individuals perceive a message as effective and worth remembering (Dillard, Shen & Vail, 2007).

Overall, understanding how to design emergency warning messages to encourage readiness to act is important to aid successful decision making in a complex environment, such as during a natural hazard, and may help reduce the need for emergency services during hazard events.

RESEARCH METHOD

The aim of this research was to examine whether current emergency warning messages can be further optimised with colours and/or icons to encourage community members' readiness to act on emergency instructions. To achieve this aim, a survey was conducted in which participants were exposed to one of 16 mock emergency warnings about either a bushfire or a riverine flood and were then asked a series of questions relating to their protective motivations. Mock emergency warnings not attributed to any particular agency were developed in previous research by Greer and colleagues (2019) based on existing end-user emergency warnings provided by CFS (SA), DFES (WA), MFB (VIC), MFS (SA), NSW SES, TAS SES, VIC SES and QFES. This study further developed those mock emergency warning messages to improve study realism and maximise the usefulness of the findings.

The 16 mock emergency warnings comprised a *Prepare to Evacuate (Bushfire)* message, a *Prepare to Evacuate (Flood)* message, an *Evacuate Now (Bushfire)* message, and an *Evacuate Now (Flood)* message that contained different combinations of a header strip and an icon in colour or greyscale. More specifically, messages contained either a grey header strip only, a coloured header strip only, a grey header strip and hazard icon, or a coloured header strip and hazard icon. The *Prepare to Evacuate* messages contained orange header strips and icons, while the *Evacuate Now* messages contained red header strips and icons. The icons, which depicted a flame or flooded house, were developed for this research. The 16 stimuli are presented in Appendix A and B.

A total of 2,482 Australians living across all states and territories were recruited to participate in the research. Participants were recruited by the Market Research firm Dynata and had not previously participated in the Greer *et al*. (2019) study. Approximately 150 participants responded to each of the 16 stimuli.

This research was conducted by QUT researchers in adherence with QUT ethics and integrity principles. Ethics clearance involved the review of the research, its value, the capabilities of the research team, and the risks and benefits to the participants involved. All participants were asked to consent to the research. The QUT ethics approval number for this research project is 1800000371.

SURVEY PROCEDURE

After consenting to participate in the survey, two screening questions (i.e., Do *you have any visual impairment(s) that make it hard for you to detect different colours?* and *Given your current living location and circumstances, are you more likely to be exposed to a bushfire or a flood*?) were used to allocate participants to one of the 16 stimuli. Only a small number of participants (4.6%) reported that they had one or several visual impairment(s) that made it hard to detect different colours. These participants were allocated to a random greyscale message to control the effects of misperceiving colour.

When reporting on their likelihood of exposure to natural hazards, 335 (13.5%) reported that they were more likely to be exposed to a flood, 823 (33.2%) reported that they were more likely to be exposed to a bushfire, 208 (8.4%) reported that they were equally likely to be exposed to a flood or a bushfire, and 1116 (45.0%) reported that they were not likely to be exposed to either hazard. If

participants indicated they were more likely to be exposed to a bushfire, they were randomly allocated to either a *Prepare to Evacuate (Bushfire)* or *Evacuate Now (Bushfire)* message. Similarly, if participants responded that they were more likely to be exposed to a flood, they were randomly allocated to either the *Prepare to Evacuate (Flood)* or *Evacuate Now (Flood)* message condition. Participants who indicated that they were likely to be exposed to *both* a bushfire and a flood, or *neither* a bushfire or flood, were randomly allocated to one of the 16 stimuli. This partially random stimuli allocation strategy was designed to maximise the relevance of the stimuli while minimising self-selection bias.

The first section of the survey collected demographic information including gender, age, highest level of education, primary language spoken at home, postcode, country of birth, level of insurance for a range of assets, involvement with emergency services (either as an employee or volunteer), visual impairment(s), and past experience with both natural hazards. The second section of the survey presented the stimuli (i.e., one emergency warning) and then asked a series of questions about that stimuli (see Measures section below). The third section of the survey asked participants to indicate which sources and platforms they typically use to seek information about natural hazards.

MEASURES

In accordance with Grothmann and Reusswig's (2006) Precautionary Adaptation Model, which was used to guide the research, a series of multi-item scales were collected.

Threat appraisal was established by measuring the perceived probability and perceived severity of the potential event. Both ***perceived probability*** (M= 4.71; SD= 2.028) and ***perceived severity*** (M= 5.57; SD= 1.603) were measured using a single item adapted from Yang (2012). The scale was scored on a seven-point Likert scale (1 = Very unlikely, 7 = Very likely).

Given that fear heightens the perceived severity of the risk, **negative emotions** were measured using a scale adapted from Yang (2012). The scale comprised three items (i.e., Afraid, Anxious and Worried) scored on an 11-point Likert scale (0 = None of this feeling, 10 = A lot of this feeling). The scale shows strong internal consistency (M= 19.40; SD= 7.975; Cronbach's α= .945; inter-item correlations from .822 to .902).

In order to establish **coping appraisal**, the survey measured the ***perceived self-efficacy***, ***protective response efficacy***, and ***protective response cost*** of each set of instructions issued in the randomly allocated warning. Participants were asked to consider each instruction presented in their stimulus (e.g., Check and follow your Bushfire Survival Plan) and to determine (a) how confident they felt in their ability to complete the action (perceived self-efficacy), (b) how effective they thought the action would be at reducing their risk of impact (protective response efficacy), and (c) how costly in terms of time, money or effort each action would be (protective response cost). The responses were scored on a seven-point Likert scale (1 = Very unlikely, 7 = Very likely).

The nine instructions included in the *Prepare to Evacuate (Bushfire)* message were as follows:

- Check and follow your Bushfire Survival Plan.
- Tell family or friends where you are planning on evacuating to.
- Put on protective clothing (e.g., a long-sleeved cotton shirt, boots with thick soles).
- Fill containers such as your bath, sinks, and buckets with water so you have access to drinking water and firefighting water.
- Close windows and doors, sealing the gaps under doors and screens with wet towels.
- Bring pets inside and restrain them with a leash, a cage, or inside a secure room prior to transport. Provide them with plenty of water.
- Move flammable materials such as doormats, wheelie bins, and outdoor furniture away from your house.
- If you have time and it is safe, tell your neighbours about this warning.
- Listen to your local ABC radio station for updates.

When summated to assess perceived self-efficacy when preparing to evacuate due to a bushfire, the nine-item scale shows strong internal consistency (M= 53.31; SD= 9.619; Cronbach's α= .931; inter-item correlations from .466 to .811). When summated to assess protective response efficacy when preparing to evacuate due to a bushfire, the nine-item scale shows strong internal consistency (M= 52.36; SD= 10.520; Cronbach's α= .939; inter-item correlations from .533 to .820). When summated to assess protective response cost when preparing to evacuate due to fire, the nine-item scale shows strong internal consistency (M= 22.15; SD= 14.882; Cronbach's α= .971; inter-item correlations from .679 to .900).

The ten instructions included in the *Evacuate Now (Bushfire)* message were as follows:

- If the way is clear, leave now for a safer place.
- Check for road closures and then advise family and friends of your intended travel route.
- Put on protective clothing (e.g., a long-sleeved cotton shirt, boots with thick soles).
- Take the items you need to be away from home for three days. Include clothing, medications, important documents (e.g., passports, birth certificates), food and water, and personal care essentials like nappies.
- Secure your pets for safe transport.
- Drive with caution in low-visibility conditions.
- Drink plenty of water to stay hydrated.
- Listen to your local radio station or visit the Rural Fire Service (RFS) website for regular updates.
- If you cannot leave, you need to get ready to shelter in your home and actively defend it.
- If your home catches on fire and the conditions inside become unbearable, you need to get out and go to an area that has already been burnt.

When summated to assess perceived self-efficacy when evacuating due to a bushfire, the ten-item scale shows strong internal consistency (M= 58.42; SD= 9.994; Cronbach's α= .896; inter-item correlations from .271 to .768). When

summated to assess protective response efficacy when evacuating due to a bushfire, the ten-item scale shows strong internal consistency (M= 58.53; SD= 10.594; Cronbach's α= .926; inter-item correlations from .335 to .741). When summated to assess protective response cost when evacuating due to a bushfire, the ten-item scale shows strong internal consistency (M= 29.77; SD= 16.520; Cronbach's α= .951; inter-item correlations from .444 to .881).

The ten instructions included in the *Prepare to Evacuate (Flood)* message were as follows:

- If you have a flood plan, use it now.
- Decide where you will go. This may be to family and friends away from the area or to your nearest temporary evacuation centre.
- Raise belongings by placing them on tables, beds and benches. Put electrical items on top. You may be able to place light items in the roof space.
- Find out how to turn off your power, water and gas supplies.
- Contact family members, friends and neighbours (especially vulnerable people such as the elderly, etc.) to alert them of the potential for flooding.
- Pack an emergency kit, including warm clothes, medicine, valuables, mementos and photos, personal and financial documents, canned food and water in waterproof bags.
- Create sandbags by filling pillow cases or shopping bags with sand and be ready to place them in doorways, toilets, and over drains to prevent sewerage backflow.
- Make arrangements to care for pets or other animals, or make a plan to take pets with you when you evacuate.
- Make sure you have enough food, drinking water, medications and pet food to survive 3-5 days in case you become isolated.
- Listen to your local ABC radio station for updates.

When summated to assess perceived self-efficacy when preparing to evacuate due to a flood, the ten-item scale shows strong internal consistency (M= 55.55; SD= 11.194; Cronbach's α= .913; inter-item correlations from .322 to .704). When summated to assess protective response efficacy when preparing to evacuate due to a flood, the ten-item scale shows strong internal consistency (M= 56.61; SD= 12.070; Cronbach's α= .942; inter-item correlations from .475 to .809). When summated to assess protective response cost when preparing to evacuate due to a flood, the ten-item scale shows strong internal consistency (M= 32.53; SD= 14.917; Cronbach's α= .939; inter-item correlations from .364 to .825).

The nine instructions included in the *Evacuate Now (Flood)* message were as follows:

- If you have a flood plan, use it now.
- Go immediately to a safer place. This may be to family and friends away from the area or to your nearest temporary evacuation centre.
- Turn off your power, water and gas supplies.

- Lock your doors and windows.
- Take your emergency kit, including warm clothes, medicine, valuables, mementos and photos, personal and financial documents, canned food and water, with you in waterproof bags.
- Take pets with you when you evacuate.
- Drive to the conditions and with extra care.
- If you cannot leave the area, take shelter in the upper storey of a sturdy brick or concrete multi-storey building.
- Listen to your local ABC radio station for updates.

When summated to assess perceived self-efficacy when evacuating due to a flood, the nine-item scale shows strong internal consistency (M= 52.38; SD= 10.088; Cronbach's α= .901; inter-item correlations from .291 to .684). When summated to assess protective response efficacy when evacuating due to a flood, the nine-item scale shows strong internal consistency (M= 51.86; SD= 11.334; Cronbach's α= .939; inter-item correlations from .526 to .804). When summated to assess protective response cost when evacuating due to a flood, the nine-item scale shows strong internal consistency (M= 25.49; SD= 14.718; Cronbach's α= .955; inter-item correlations from .605 to .879).

In addition to the measures suggested by Grothmann and Reusswig's (2006) Precautionary Adaptation Model, the following additional multi-item scales were used to collect data:

Perceived message comprehension was measured using a scale adapted from Jeong and Hwang (2012). The scale comprised four items scored on a seven-point Likert scale (1 = Strongly disagree, 7 = Strongly agree). The scale showed some internal consistency (M= 23.44; SD= 4.186; Cronbach's α= .614; inter-item correlations of .041 to .828). After removing one reverse-coded item, the three-item scale showed good internal consistency (M= 17.50; SD= 3.441; Cronbach's α= .765; inter-item correlations of .419 to .835) and thus the shorter scale was used.

Perceived message effectiveness was measured using a scale adapted from Davis and colleagues (2017). The scale comprised six items scored on a seven-point Likert scale (1 = Strongly disagree, 7 = Strongly agree). The scale shows strong internal consistency (M= 35.10; SD= 6.934; Cronbach's α= .941; inter-item correlations from .681 to .810).

FINDINGS

SAMPLE CHARACTERISTICS

The sociodemographic characteristics of the research participants were representative of the Australian population in terms of gender, age, and living location across the eight states/territories (see Table 1) and almost identical to previous research in this area (Greer *et al.*, 2019).

TABLE 1: SOCIODEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS IN THE AUSTRALIAN POPULATION (2016) AND THE RESEARCH SAMPLE (2019)

Sociodemographic characteristics	2016 Australian Population[a] (*N* = 18,190,217)		2019 Survey Sample (*N* = 2,482)	
	N	%	N	%
Gender				
Male	8,871,649	48.8	1207	48.6
Female	9,318,599	51.2	1264	50.9
Other	--	--	4	0.2
Prefer not to disclose	--	--	7	0.3
Age				
18-24	2,144,694	11.8	275	11.1
25-34	3,367,877	18.5	457	18.4
35-44	3,144,282	17.3	428	17.2
45-54	3,104,305	17.1	418	16.8
55-64	2,753,018	15.1	395	15.9
65-74	2,076,226	11.4	297	12.0
75 and over	1,599,836	8.8	212	8.5
Location by Australian States/Territories				
Australian Capital Territory	309,609	1.7	42	1.7
New South Wales	5,827,183	32.0	761	30.7
Northern Territory	170,695	0.9	15	0.6
Queensland	3,611,943	19.9	506	20.4
South Australia	1,323,883	7.3	200	8.1
Tasmania	400,776	2.2	50	2.0
Victoria	4,638,882	25.5	649	26.1
Western Australia	1,907,246	10.5	259	10.4

Note: [a] Australian population sample calculated for those aged 18 to 75+ years

Within the sample, 71.8% of participants were born in Australia. The other 28.2% of participants were born overseas, predominately in the United Kingdom (6.7%), New Zealand (2.4%), India (2.0%), Malaysia (1.6%) and the Philippines (1.2%). A small proportion of participants (1.8%) did not appropriately respond to the question.

Nearly all (94.5%) of the participants indicated they spoke English as their primary language at home. Of the 5.5% who did not speak English as the primary language at home, the most common primary languages were Mandarin (0.6%), Cantonese (0.5%) and Hindi (0.3%). These statistics are likely under-representative of the language diversity of Australian residents, due to the nature of the research method (i.e., an online survey conducted in English).

Participants reported completing a variety of education levels (see Table 2): over a third of participants (39.4%) had attained an undergraduate or postgraduate university qualification, nearly a third (29.6%) had completed a TAFE qualification, and over a quarter (28.7%) had completed high school to at least Grade 10. 2.3% of participants left formal education prior to Grade 10.

TABLE 2: PEAK EDUCATION ATTAINMENT OF PARTICIPANTS

Level of Education	n(%)
Postgraduate award (e.g., Masters degree, graduate diploma, graduate certificate)	332(13.4)
Bachelor degree	645(26.0)
TAFE qualification (e.g., Certificate II, III, or IV)	735(29.6)
High school (to Year 12)	452(18.2)
High school (to Year 10)	260(10.5)
Left school before Year 10	58(2.3)

Participants predominately reported that they fully insured their house (61.0%), contents (62.4%), and vehicle(s)(76.1%)(see Table 3). This finding suggests that many participants believe they are fully covered for an incident; however, this perception may be inaccurate as many Australian households are known to be underinsured (Commonwealth of Australia, 2014). Of the minority of participants that owned a farm (14.5%), most (65.5%) reported holding no insurance.

TABLE 3: SELF-REPORTED LEVEL OF INSURANCE BY ASSET

Asset	Fully insured	Underinsured	No insurance	Not applicable
	n(%)	n(%)	n(%)	n(%)
House	1515(61.0)	89(3.6)	430(17.3)	448(18.0)
Contents	1549(62.4)	173(7.0)	533(21.5)	227(9.1)
Vehicle(s)	1888(76.1)	140(5.6)	222(8.9)	232(9.3)
Farm	75(3.0)	48(1.9)	237(9.5)	2122(85.5)

The majority of participants (91.0%) reported that neither they nor other members of their household were a current or past employee or volunteer of an emergency services agency (see Table 4).

TABLE 4: LEVEL OF EMERGENCY SERVICE AGENCY INVOLVEMENT

Item	Yes	No
	n(%)	n(%)
Is anybody in your household a current or previous member of an emergency service agency (e.g. Fire Service, State Emergency Services (SES) etc.), either as an employee or a volunteer?	223(9.0)	2259(91.0)

The majority of participants had not experienced either a fire (75.9%) or a flood (73.9%) (see Table 5). Those participants who had experienced either a fire or a flood were most likely to report that it was a moderately severe event (M_{Fire}=4.68 out of 7, SD=1.58; M_{Flood}=4.72, SD=1.52).

TABLE 5: THREAT EXPERIENCE APPRAISAL FOR FIRE AND FLOOD

Items	Yes	No
	n (%)	n (%)
Have you ever experienced a **fire** caused by a weather event (e.g., grass fire, lightning strike, hot weather) in your area?	598(24.1)	1884(75.9)
Have you ever experienced a **flood** caused by a weather event (e.g., rain, cyclone or storm) in your area?	648(26.1)	1834(73.9)

Participants typically accessed substantially similar sources of information through substantially similar platforms during both floods and bushfires. The most popular sources of information aside from emergency service agencies were the Bureau of Meteorology, media, and local councils for both hazards (see Figure 2). The most popular platforms to seek information were radio, television and online Google searches (see Figure 3).

FIGURE 2: TYPICAL SOURCES OF INFORMATION ABOUT FIRES AND FLOODS (BY NUMBER OF PARTICIPANTS)

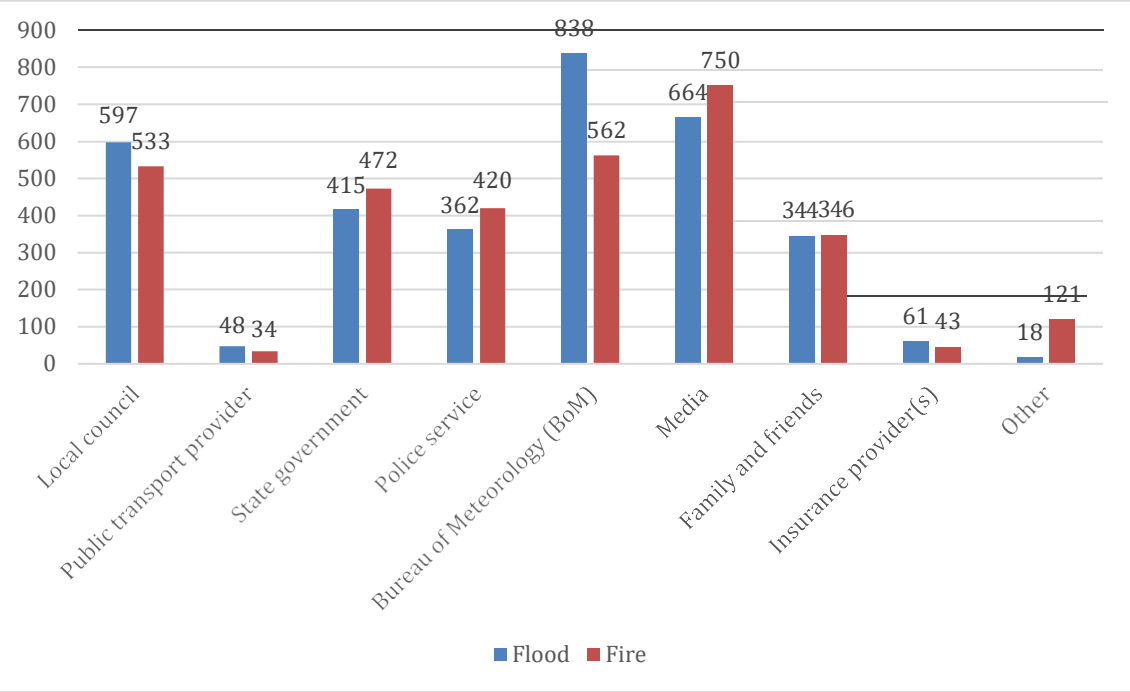
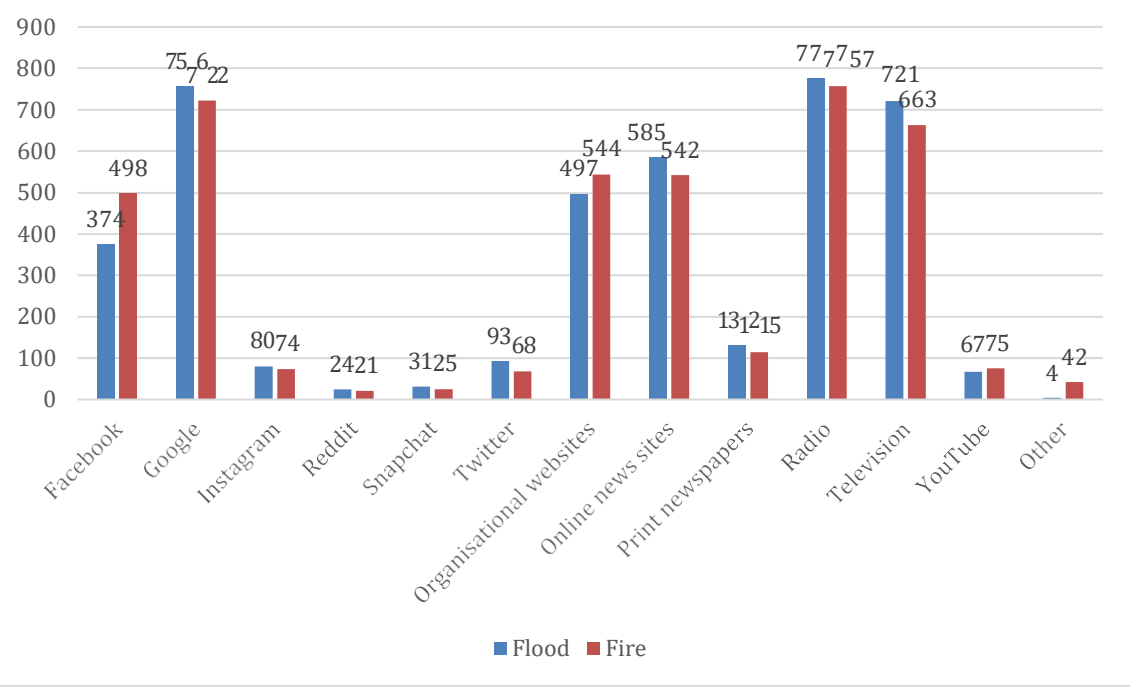


FIGURE 3: TYPICAL PLATFORMS USED TO SEEK INFORMATION ABOUT FIRES AND FLOODS (BY NUMBER OF PARTICIPANTS)



MESSAGE COMPREHENSION AND EFFECTIVENESS

Previous research demonstrates that the text of current emergency warning messages is perceived to be comprehensible and effective (Greer *et al.*, 2019). However, the effects of adding colour and icons to these messages is not yet known.

Prepare to Evacuate (Flood)

A two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived message comprehension for the *Prepare to Evacuate (Flood)* message. There were no statistically significant main effects for colour, $F(1, 596) = .050$, $p = .82$, or icons, $F(1, 596) = .520$, $p = .47$. The interaction effect between colour and icons was not statistically significant, $F(1, 596) = .852$, $p = .36$.

A second two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived message effectiveness for the *Prepare to Evacuate (Flood)* message. There were no statistically significant main effects for colour, $F(1, 596) = .032$, $p = .86$, or icons, $F(1, 596) = .577$, $p = .45$. The interaction effect between colour and icons was not statistically significant, $F(1, 596) = 1.13$, $p = .29$.

In summary, the results showed that adding colour and/or icons to the *Prepare to Evacuate (Flood)* message **did not change** its perceived comprehensibility or effectiveness.

Evacuate Now (Flood)

A two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived message comprehension for the *Evacuate Now (Flood)* message. There were no statistically significant main effects for colour, $F(1, 651) = .227$, $p = .63$, or icons, $F(1, 651) = .099$, $p = .75$. The interaction effect between colour and icons was not statistically significant, $F(1, 651) = .151$, $p = .70$.

A second two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived message effectiveness for the *Evacuate Now (Flood)* message. There were no statistically significant main effects for colour, $F(1, 651) = .322$, $p = .57$, or icons, $F(1, 651) = .003$, $p = .95$. The interaction effect between colour and icons was not statistically significant, $F(1, 651) = .009$, $p = .93$.

In summary, the results showed that adding colour and/or icons to the *Evacuate Now (Flood)* message **did not change** its perceived comprehensibility or effectiveness.

Prepare to Evacuate (Bushfire)

A two-way between-groups analysis of variance (ANOVA) was conducted to investigate the effect of colour and icons on perceived message comprehension for the *Prepare to Evacuate (Bushfire)* message. There were no statistically significant main effects for colour, $F(1, 599) = 2.02$, $p = .15$, or icons,

F(1, 599) = 2.71, *p* = .10. The interaction effect between colour and icons was not statistically significant, *F*(1, 599) = 0.00, *p* = .99.

A second two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived message effectiveness for the *Prepare to Evacuate (Bushfire)* message. There were no statistically significant main effects for colour, *F*(1, 599) = 1.22, *p* = .27, or icons, *F*(1, 599) = .543, *p* = .46. The interaction effect between colour and icons was not statistically significant, *F*(1, 599) = 2.55, *p* = .11.

In summary, the results showed that adding colour and/or icons to the *Prepare to Evacuate (Bushfire)* message **did not change** its perceived comprehensibility or effectiveness.

Evacuate Now (Bushfire)

A two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived message comprehension for the *Evacuate Now (Bushfire)* message. Kolmogorov-Smirnov and Levene's tests show that the data violate assumptions of normality and homogeneity of variance respectively, but these violations are likely offset by the large sample size and equal group sizes. There was a statistically significant main effect for colour, *F*(1, 620) = 6.18, *p* = .01; however, the effect size is small (partial eta squared = .01). There was no statistically significant main effect for icons, *F*(1, 620) = 2.40, *p* = .12. The interaction effect between colour and icons was not statistically significant, *F*(1, 620) = .486, *p* = .49. This analysis suggests that the *Evacuate Now (Bushfire)* message with a red header (M= 6.00, SD= .99) is perceived to be more comprehensible than the same message with a greyscale header (M= 5.78, SD= 1.23).

A second two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived message effectiveness for the *Evacuate Now (Bushfire)* message. Kolmogorov-Smirnov tests show that the data are non-normally distributed, but this violation is likely offset by the large sample size. Levene's test demonstrated homogeneity of variance. There was a statistically significant main effect for colour, *F*(1, 620) = 6.20, *p* = .01; however, the effect size is small (partial eta squared = .01). There was no statistically significant main effect for icons, *F*(1, 620) = .521, *p* = .47. The interaction effect between colour and icons was not statistically significant, *F*(1, 620) = .626, *p* = .43. This analysis suggests that the *Evacuate Now (Bushfire)* message with a red header (M= 6.12, SD= 1.02) is perceived to be more effective than the same message with a greyscale header (M= 5.90, SD= 1.20).

In summary, the results showed that adding **colour** (i.e., red) to the *Evacuate Now (Bushfire)* message **improved** the comprehensibility and effectiveness of the message to a small degree.

THREAT APPRAISAL

In accordance with Grothmann and Reusswig's (2006) Precautionary Adaptation Model, the threat appraisal of each message was investigated. Threat appraisal was determined using two dimensions of risk judgment: the probability and severity of an event occurring. Risk probability is the likelihood of harm experienced to one's person or property provided no behavioural change is adopted (Martin *et al.*, 2007). Perception of risk severity is the level of adversity that would result from experiencing the perceived risk (Martin *et al.*, 2007). Affective responses (i.e., the emotional response to an event) have been shown to influence both heuristic and systematic processing to risk, so negative emotion was determined by assessing the level of fear, anxiety and worry warning messages generate.

Overall, the perceived probability, perceived severity and negative emotion (particularly fear/worry) generated by each of the four warning messages was moderate and appropriately aligned to the message design (see Table 6).

TABLE 6: DESCRIPTIVE STATISTICS FOR PERCEIVED THREAT APPRAISAL

Message		N	Min	Max	Mean	Std. Dev.
Prepare to Evacuate (Bushfire)	Risk Probability	603	1.00	7.00	4.80	1.981
	Risk Severity	603	1.00	7.00	5.69	1.504
	Negative Emotion	603	0.00	10.00	6.80	2.522
Evacuate Now (Bushfire)	Risk Probability	624	1.00	7.00	5.04	1.984
	Risk Severity	624	1.00	7.00	5.90	1.416
	Negative Emotion	624	0.00	10.00	7.09	2.458
Prepare to Evacuate (Flood)	Risk Probability	600	1.00	7.00	4.40	1.971
	Risk Severity	600	1.00	7.00	5.16	1.685
	Negative Emotion	600	0.00	10.00	5.81	2.719
Evacuate Now (Flood)	Risk Probability	655	1.00	7.00	4.67	2.164
	Risk Severity	655	1.00	7.00	5.56	1.695
	Negative Emotion	655	0.00	10.00	6.18	2.787

Prepare to Evacuate (Flood)

A two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived risk probability for the *Prepare to Evacuate (Flood)* message. There were no statistically significant main effects for colour, $F(1, 596) = .018$, $p = .89$, or icons, $F(1, 596) = 1.05$, $p = .31$. The interaction effect between colour and icons was not statistically significant, $F(1, 596) = .258$, $p = .61$.

A second two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived risk severity for the *Prepare to Evacuate (Flood)* message. There were no statistically significant main effects for colour, $F(1, 596) = .170$, $p = .68$, or icons, $F(1, 596) = .135$, $p = .71$. The interaction effect between colour and icons was not statistically significant, $F(1, 596) = 1.09$, $p = .30$.

A third two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on negative emotions for the *Prepare to Evacuate (Flood)* message. There were no statistically significant main effects for colour, $F(1, 596) = .013$, $p = .91$, or icons, $F(1, 596) = 1.04$, $p = .31$. The interaction effect between colour and icons was not statistically significant, $F(1, 596) = 1.78$, $p = .18$.

In summary, the results showed that adding colour and/or icons to the *Prepare to Evacuate (Flood)* message **did not change** the perceive risk probability, risk severity or negative emotions surrounding the event.

Evacuate Now (Flood)

A two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived risk probability for the *Evacuate Now (Flood)* message. There were no statistically significant main effects for colour, $F(1, 651) = .333$, $p = .56$, or icons, $F(1, 651) = .001$, $p = .97$. The interaction effect between colour and icons was not statistically significant, $F(1, 651) = .165$, $p = .68$.

A second two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived risk severity for the *Evacuate Now (Flood)* message. There were no statistically significant main effects for colour, $F(1, 651) = .118$, $p = .73$, or icons, $F(1, 651) = .158$, $p = .69$. The interaction effect between colour and icons was not statistically significant, $F(1, 651) = .237$, $p = .63$.

A third two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on negative emotion for the *Evacuate Now (Flood)* message. There were no statistically significant main effects for colour, $F(1, 651) = .006$, $p = .94$, or icons, $F(1, 651) = .695$, $p = .41$. The interaction effect between colour and icons was not statistically significant, $F(1, 651) = .424$, $p = .52$.

In summary, the results showed that adding colour and/or icons to the *Evacuate Now (Flood)* message **did not change** the perceive risk probability, risk severity or negative emotions surrounding the event.

Prepare to Evacuate (Bushfire)

A two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived risk probability for the *Prepare to Evacuate (Bushfire)* message. There were no statistically significant main effects for colour, $F(1, 599) = .724$, $p = .40$, or icons, $F(1, 599) = .062$, $p = .80$. The interaction effect between colour and icons was not statistically significant, $F(1, 599) = .437$, $p = .51$.

A second two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived risk severity for the *Prepare to Evacuate (Bushfire)* message. There were no statistically significant main effects for colour, $F(1, 599) = .381$, $p = .54$, or icons, $F(1, 599) = .187$, $p = .67$. The interaction effect between colour and icons was not statistically significant, $F(1, 599) = 2.84$, $p = .09$.

A third two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on negative emotions for the *Prepare to Evacuate (Bushfire)* message. There were no statistically significant main effects for colour, $F(1, 599) = .057$, $p = .81$, or icons, $F(1, 599) = .160$, $p = .69$. The interaction effect between colour and icons was not statistically significant, $F(1, 599) = 1.85$, $p = .17$.

In summary, the results showed that adding colour and/or icons to the *Prepare to Evacuate (Bushfire)* message **did not change** the perceive risk probability, risk severity or negative emotions surrounding the event.

Evacuate Now (Bushfire)

A two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived risk probability for the *Evacuate Now (Bushfire)* message. Kolmogorov-Smirnov tests show that the data are non-normally distributed, but this violation is likely offset by the large sample size. Levene's test demonstrated homogeneity of variance. There were no statistically significant main effects for colour, $F(1, 620) = 1.58$, $p = .21$, or icons, $F(1, 620) = 2.07$, $p = .15$. However, there was a statistically significant interaction effect, $F(1, 620) = 6.54$, $p < .05$, although the effect size was small (partial eta squared = .01). This analysis suggests that risk probability is perceived differently when colour and icons are combined. When messages are presented in greyscale, the *Evacuate Now (Bushfire)* message is perceived to describe a more probable event when the icon is absent (M= 5.25, SD= 1.76) than when it is present (M= 4.61, SD= 2.15). When messages are presented in colour, the *Evacuate Now (Bushfire)* message is perceived to describe a more probable event when the icon is present (M= 5.22, SD= 1.98) than when it is absent (M= 5.04, SD= 1.97).

This result suggests that deeper investigation is needed into the role that icons play in signalling risk probability when they are not presented in colour. It is possible that community members would not expect to see an icon that was not in colour, and thus the lack of colour degrades its communicative capacity. Alternately, it is possible that warning messages presented in plain greyscale require less cognitive capacity to interpret and act on, whereas warning messages presented with coloured icons provide enough information to satisfy the increased cognitive capacity they require for interpretation.

A second two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived risk severity for the *Evacuate Now (Bushfire)* message. There were no statistically significant main effects for colour,

F(1, 620) = .691, *p* = .41, or icons, *F*(1, 620) = .494, *p* = .48. The interaction effect between colour and icons was not statistically significant, *F*(1, 620) = .002, *p* = .96.

A third two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on negative emotions for the *Evacuate Now (Bushfire)* message. There were no statistically significant main effects for colour, *F*(1, 620) = .062, *p* = .80, or icons, *F*(1, 620) = .023, *p* = .88. The interaction effect between colour and icons was not statistically significant, *F*(1, 620) = .043, *p* = .84.

In summary, the results showed that adding colour and/or icons to the *Evacuate Now (Bushfire)* message **did not change** the perceive risk severity or negative emotions surrounding the event. However, the probability of the event described in the *Evacuate Now (Bushfire)* message is perceived differently when colour and icons are combined. The event is considered more likely when either a coloured icon *or* no colour/icon is used.

COPING APPRAISAL

In accordance with Grothmann and Reusswig's (2006) Precautionary Adaptation Model, the coping appraisal for each message was investigated. Coping appraisal aims to determine (a) how confident the participant felt in their ability to complete the action (i.e., perceived self-efficacy), (b) how effective the participant thought the action would be at reducing their risk of impact (i.e., protective response efficacy), and (c) how costly in terms of time, money or effort each action would be (i.e., protective response cost).

Prepare to Evacuate (Flood)

A two-way between-groups analysis of variance (ANOVA) was conducted to investigate the effect of colour and icons on perceived self-efficacy for the *Prepare to Evacuate (Flood)* message. There were no statistically significant main effects for colour, $F(1, 596) = .904$, $p = .34$, or icons, $F(1, 596) = .741$, $p = .39$. The interaction effect between colour and icons was not statistically significant, $F(1, 596) = .316$, $p = .57$.

A second two-way between-groups analysis of variance (ANOVA) was conducted to investigate the effect of colour and icons on perceived response efficacy for the *Prepare to Evacuate (Flood)* message. There were no statistically significant main effects for colour, $F(1, 596) = .751$, $p = .39$, or icons, $F(1, 596) = .003$, $p = .96$. The interaction effect between colour and icons was not statistically significant, $F(1, 596) = .001$, $p = .98$.

A third two-way between-groups analysis of variance (ANOVA) was conducted to investigate the effect of colour and icons on perceived response cost for the *Prepare to Evacuate (Flood)* message. There were no statistically significant main effects for colour, $F(1, 596) = ..031$, $p = .86$, or icons, $F(1, 596) = .222$, $p = .64$. The interaction effect between colour and icons was not statistically significant, $F(1, 596) = .964$, $p = .33$.

In summary, the results showed that adding colour and/or icons to the *Prepare to Evacuate (Flood)* message **did not change** how confident participants felt in their ability to complete the instructions, how effective participants thought the instructions would be at reducing their risk of impact, or how costly in terms of time, money or effort each instruction would be.

Evacuate Now (Flood)

A two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived self-efficacy for the *Evacuate Now (Flood)* message. There were no statistically significant main effects for colour, $F(1, 651) = .38$, $p = .54$, or icons, $F(1, 651) = .301$, $p = .58$. The interaction effect between colour and icons was not statistically significant, $F(1, 651) = 1.05$, $p = .31$.

A second two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived response efficacy for the *Evacuate Now (Flood)* message. There were no statistically significant main effects for colour, $F(1, 651) = .095$, $p = .76$, or icons, $F(1, 651) = .938$, $p = .33$. The interaction effect between colour and icons was not statistically significant, $F(1, 651) = .808$, $p = .37$.

A third two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived response cost for the *Evacuate Now (Flood)* message. There were no statistically significant main effects for colour, $F(1, 651) = 2.44$, $p = .12$, or icons, $F(1, 651) = 3.23$, $p = .07$. The interaction effect between colour and icons was not statistically significant, $F(1, 651) = 2.89$, $p = .09$.

In summary, the results showed that adding colour and/or icons to the *Evacuate Now (Flood)* message **did not change** how confident participants felt in their ability to complete the instructions, how effective participants thought the instructions would be at reducing their risk of impact, or how costly in terms of time, money or effort each instruction would be.

Prepare to Evacuate (Bushfire)

A two-way between-groups analysis of variance (ANOVA) was conducted to investigate the effect of colour and icons on perceived self-efficacy for the *Prepare to Evacuate (Bushfire)* message. There were no statistically significant main effects for colour, $F(1, 599) = .046$, $p = .83$, or icons, $F(1, 599) = .117$, $p = .73$. The interaction effect between colour and icons was not statistically significant, $F(1, 599) = 1.45$, $p = .23$.

A second two-way between-groups analysis of variance (ANOVA) was conducted to investigate the effect of colour and icons on perceived response efficacy for the *Prepare to Evacuate (Bushfire)* message. There were no statistically significant main effects for colour, $F(1, 599) = .142$, $p = .71$, or icons, $F(1, 599) = 1.91$, $p = .17$. The interaction effect between colour and icons was not statistically significant, $F(1, 599) = 2.05$, $p = .15$.

A third two-way between-groups analysis of variance (ANOVA) was conducted to investigate the effect of colour and icons on perceived response cost for the *Prepare to Evacuate (Bushfire)* message. There were no statistically significant main effects for colour, $F(1, 599) = .399$, $p = .53$, or icons, $F(1, 599) = .400$, $p = .53$. The interaction effect between colour and icons was not statistically significant, $F(1, 599) = .785$, $p = .38$.

In summary, the results showed that adding colour and/or icons to the *Prepare to Evacuate (Bushfire)* message **did not change** how confident participants felt in their ability to complete the instructions, how effective participants thought the instructions would be at reducing their risk of impact, or how costly in terms of time, money or effort each instruction would be.

Evacuate Now (Bushfire)

A two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived self-efficacy for the *Evacuate Now (Bushfire)* message. Kolmogorov-Smirnov and Levene's tests show that the data violate assumptions of normality and homogeneity of variance respectively, but these violations are likely offset by the large sample size and equal group sizes. There was a statistically significant main effect for colour, $F(1, 620) = 9.24$, $p = .002$; however, the effect size is small (partial eta squared = .015). There was no statistically significant main effect for icons, $F(1, 620) = .175$, $p = .68$. The interaction effect between colour and icons was not statistically significant, $F(1, 620) = .004$, $p = .95$. This analysis suggests that the *Evacuate Now (Bushfire)*

message with a red header (M= 5.99, SD= .89) is perceived to offer instructions that people feel more capable of actioning than the same message with a greyscale header (M= 5.75, SD= 1.10).

A second two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived response efficacy for the *Evacuate Now (Bushfire)* message. There were no statistically significant main effects for colour, $F(1, 620) = 3.71$, $p = .05$, or icons, $F(1, 620) = 1.27$, $p = .26$. The interaction effect between colour and icons was not statistically significant, $F(1, 620) = .402$, $p = .53$.

A third two-way between-groups ANOVA was conducted to investigate the effect of colour and icons on perceived response cost for the *Evacuate Now (Bushfire)* message. There were no statistically significant main effects for colour, $F(1, 620) = .273$, $p = .60$, or icons, $F(1, 620) = .155$, $p = .69$. The interaction effect between colour and icons was not statistically significant, $F(1, 620) = .002$, $p = .97$.

In summary, the results showed that adding colour and/or icons to the *Prepare to Evacuate (Flood)* message **did not change** how effective participants thought the instructions would be at reducing their risk of impact or how costly in terms of time, money or effort each instruction would be. However, adding **colour** (i.e., red) to the *Evacuate Now (Bushfire)* message improved (to a small degree) how confident participants felt in their ability to complete the action.

SUMMARY OF FINDINGS

This report presents the findings of the second phase of this research, *Assess*, which investigated whether emergency warning messages could be further optimised by adding colours or icons to encourage even higher levels of readiness to act on emergency instructions. The results suggest that adding colours and/or icons to the *Evacuate Now (Bushfire)* message creates small improvements in message comprehension, effectiveness, perceived probability and perceived self-efficacy. This is perhaps unsurprising given that this message is likely considered the most "threatening" of the set. 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 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. This finding aligns with previous research that shows that red-danger pairings obtain the highest hazard risk ratings (e.g., Braun & Silver, 1995; Chapanis, 1994; Ng & Chan, 2018). 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 (e.g., Braun & Silver, 1995; Chapanis, 1994). 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 (Rodriguez Estrada & Davis, 2015; Trumbo, 1999), 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 when 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 emergency warning messages if they reduce uncertainty.

NEXT STEPS

By adopting current evidence-based practice, emergency service agencies have created effective emergency warnings that encourage readiness to act and may be improved to a small degree with the addition of colour and/or icons. The next phase of research, termed *Utilise*, will engage end-users to translate the findings into products that may include briefing notes, hazard notes, workshops and personalised consultation to optimise emergency warnings messages in order to improve readiness to act in accordance with emergency instructions.

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APPENDIX A: EMERGENCY WARNING STIMULI (BUSHFIRE)

BUSHFIRE SET 1: GREYSCALE; NO ICON

PREPARE TO EVACUATE

Fire services advise there is a bushfire approaching your local area and conditions are getting worse.

You need to be ready to follow your bushfire survival plan. If you do not have a plan, or intend to leave, you should **be ready to leave** the area because the situation could get worse quickly.

Fire crews are working to contain the fire but firefighters may not be able to protect every property. You should not expect a firefighter at your door.

People in the area will be affected by smoke, which will reduce visibility and air quality.

Call Triple Zero (000) immediately if you believe your property is under threat.

How to Prepare for Evacuation:

- Check and follow your Bushfire Survival Plan.
- Tell family or friends where you are planning on evacuating to.
- Put on protective clothing (e.g., a long-sleeved cotton shirt, boots with thick soles).
- Fill containers such as your bath, sinks, and buckets with water so you have access to drinking water and firefighting water.
- Close windows and doors, sealing the gaps under doors and screens with wet towels.
- Bring pets inside and restrain them with a leash, a cage, or inside a secure room prior to transport. Provide them with plenty of water.
- Move flammable materials such as doormats, wheelie bins, and outdoor furniture away from your house.
- If you have time and it is safe, tell your neighbours about this warning.
- Listen to your local ABC radio station for updates.

Drive with caution in low-visibility conditions.

Keep up to Date:

- Following EMS on Facebook (@EmergencyManagementService) and Twitter (@AusEMS)
- Staying tuned to your local radio station. Find your local ABC radio station at https://radio.abc.net.au/help/offline and your local commercial radio station at http://www.commercialradio.com.au/find-a-station/queensland
- Visiting the EMS website at www.emsfire.gov.au/maps
- For bushfire preparation tips, visit the EMS website at www.emsfire.gov.au/bushfiresafety
- For information about road closures, call 13 55 77 or visit www.traffic.gov.au

BUSHFIRE SET 1: GREYSCALE AND ICON

PREPARE TO EVACUATE

Fire services advise there is a bushfire approaching your local area and conditions are getting worse.

You need to be ready to follow your bushfire survival plan. If you do not have a plan, or intend to leave, you should **be ready to leave** the area because the situation could get worse quickly.

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- For information about road closures, call 13 55 77 or visit www.traffic.gov.au

BUSHFIRE SET 1: COLOUR; NO ICON

PREPARE TO EVACUATE

Fire services advise there is a bushfire approaching your local area and conditions are getting worse.

You need to be ready to follow your bushfire survival plan. If you do not have a plan, or intend to leave, you should **be ready to leave** the area because the situation could get worse quickly.

Fire crews are working to contain the fire but firefighters may not be able to protect every property. You should not expect a firefighter at your door.

People in the area will be affected by smoke, which will reduce visibility and air quality.

Call Triple Zero (000) immediately if you believe your property is under threat.

How to Prepare for Evacuation:

- Check and follow your Bushfire Survival Plan.
- Tell family or friends where you are planning on evacuating to.
- Put on protective clothing (e.g., a long-sleeved cotton shirt, boots with thick soles).
- Fill containers such as your bath, sinks, and buckets with water so you have access to drinking water and firefighting water.
- Close windows and doors, sealing the gaps under doors and screens with wet towels.
- Bring pets inside and restrain them with a leash, a cage, or inside a secure room prior to transport. Provide them with plenty of water.
- Move flammable materials such as doormats, wheelie bins, and outdoor furniture away from your house.
- If you have time and it is safe, tell your neighbours about this warning.
- Listen to your local ABC radio station for updates.

Drive with caution in low-visibility conditions.

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BUSHFIRE SET 1: COLOUR AND ICON

PREPARE TO EVACUATE

Fire services advise there is a bushfire approaching your local area and conditions are getting worse.

You need to be ready to follow your bushfire survival plan. If you do not have a plan, or intend to leave, you should **be ready to leave** the area because the situation could get worse quickly.

Fire crews are working to contain the fire but firefighters may not be able to protect every property. You should not expect a firefighter at your door.

People in the area will be affected by smoke, which will reduce visibility and air quality.

Call Triple Zero (000) immediately if you believe your property is under threat.

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- Check and follow your Bushfire Survival Plan.
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- For information about road closures, call 13 55 77 or visit www.traffic.gov.au

BUSHFIRE SET 2: GREYSCALE; NO ICON

EVACUATE NOW

Fire services advise there is a bushfire approaching your local area.

Follow your bushfire survival plan now. If you do not have a plan, your safest option is to **leave immediately** if it is clear to do so. If you cannot leave, **identify where you will seek shelter** from the bushfire. If you are not in the area, **do not return**, as conditions are too dangerous.

Fire crews are working to contain the fire but firefighters may not be able to protect every property. You should not expect a firefighter at your door. Power, water, and mobile phone service may be lost.

People in the area will be affected by smoke, which will reduce visibility and air quality.

An evacuation centre has been opened at the local community centre.

Call Triple Zero (000) immediately if you believe you are under threat.

How to Evacuate:

- If the way is clear, leave now for a safer place.
- Check for road closures and then advise family and friends of your intended travel route.
- Put on protective clothing (e.g., a long-sleeved cotton shirt, boots with thick soles).
- Take the items you need to be away from home for three days. Include clothing, medications, important documents (e.g., passports, birth certificates), food and water, and personal care essentials like nappies.
- Secure your pets for safe transport.
- Drive with caution in low-visibility conditions.
- Drink plenty of water to stay hydrated.
- Listen to your local radio station or visit the Rural Fire Service (RFS) website for regular updates.
- If you cannot leave, you need to get ready to shelter in your home and actively defend it.
- If your home catches on fire and the conditions inside become unbearable, you need to get out and go to an area that has already been burnt.

Keep up to Date:

- Following EMS on Facebook (@EmergencyManagementService) and Twitter (@AusEMS)
- Staying tuned to your local radio station. Find your local ABC radio station at https://radio.abc.net.au/help/offline and your local commercial radio station at http://www.commercialradio.com.au/find-a-station/queensland
- Visiting the EMS website at www.emsfire.gov.au/maps
- For bushfire preparation tips, visit the EMS website at www.emsfire.gov.au/bushfiresafety
- For information about road closures, call 13 55 77 or visit www.traffic.gov.au

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EVACUATE NOW

Fire services advise there is a bushfire approaching your local area.

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BUSHFIRE SET 2: COLOUR; NO ICON

EVACUATE NOW

Fire services advise there is a bushfire approaching your local area.

Follow your bushfire survival plan now. If you do not have a plan, your safest option is to **leave immediately** if it is clear to do so. If you cannot leave, **identify where you will seek shelter** from the bushfire. If you are not in the area, **do not return**, as conditions are too dangerous.

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- Visiting the EMS website at www.emsfire.gov.au/maps
- For bushfire preparation tips, visit the EMS website at www.emsfire.gov.au/bushfiresafety
- For information about road closures, call 13 55 77 or visit www.traffic.gov.au

BUSHFIRE SET 2: COLOUR AND ICON

EVACUATE NOW

Fire services advise there is a bushfire approaching your local area.

Follow your bushfire survival plan now. If you do not have a plan, your safest option is to **leave immediately** if it is clear to do so. If you cannot leave, **identify where you will seek shelter** from the bushfire. If you are not in the area, **do not return**, as conditions are too dangerous.

Fire crews are working to contain the fire but firefighters may not be able to protect every property. You should not expect a firefighter at your door. Power, water, and mobile phone service may be lost.

People in the area will be affected by smoke, which will reduce visibility and air quality.

An evacuation centre has been opened at the local community centre.

Call Triple Zero (000) immediately if you believe you are under threat.

How to Evacuate:

- If the way is clear, leave now for a safer place.
- Check for road closures and then advise family and friends of your intended travel route.
- Put on protective clothing (e.g., a long-sleeved cotton shirt, boots with thick soles).
- Take the items you need to be away from home for three days. Include clothing, medications, important documents (e.g., passports, birth certificates), food and water, and personal care essentials like nappies.
- Secure your pets for safe transport.
- Drive with caution in low-visibility conditions.
- Drink plenty of water to stay hydrated.
- Listen to your local radio station or visit the Rural Fire Service (RFS) website for regular updates.
- If you cannot leave, you need to get ready to shelter in your home and actively defend it.
- If your home catches on fire and the conditions inside become unbearable, you need to get out and go to an area that has already been burnt.

Keep up to Date:

- Following EMS on Facebook (@EmergencyManagementService) and Twitter (@AusEMS)
- Staying tuned to your local radio station. Find your local ABC radio station at https://radio.abc.net.au/help/offline and your local commercial radio station at http://www.commercialradio.com.au/find-a-station/queensland
- Visiting the EMS website at www.emsfire.gov.au/maps
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APPENDIX B: EMERGENCY WARNING STIMULI (FLOOD)

FLOOD SET 1: GREYSCALE; NO ICON

PREPARE TO EVACUATE

People in your local area should PREPARE TO EVACUATE due to flooding.

The Bureau of Meteorology has advised that heavy rainfall may result in widespread flooding over the next 24 hours. It may pose a threat to lives and property.

You do not need to evacuate at this time, but you should prepare to evacuate if the situation changes.

How to Prepare for Evacuation:

- If you have a flood plan, use it now.
- Decide where you will go. This may be to family and friends away from the area or to your nearest temporary evacuation centre.
- Raise belongings by placing them on tables, beds and benches. Put electrical items on top. You may be able to place light items in the roof space.
- Find out how to turn off your power, water and gas supplies.
- Contact family members, friends and neighbours (especially vulnerable people such as the elderly, etc.) to alert them of the potential for flooding.
- Pack an emergency kit, including warm clothes, medicine, valuables, mementos and photos, personal and financial documents, canned food and water in waterproof bags.
- Create sandbags by filling pillowcases or shopping bags with sand and be ready to place them in doorways, toilets, and over drains to prevent sewerage backflow.
- Make arrangements to care for pets or other animals, or make a plan to take pets with you when you evacuate.
- Make sure you have enough food, drinking water, medications and pet food to survive 3-5 days in case you become isolated.
- Listen to your local ABC radio station for updates.

Never drive, ride, swim, or walk through floodwater as it is dangerous and potentially toxic.

Keep Up to Date:

Road closures:	www.traffic.gov.au	Phone: 1300 100 200
Weather warnings and river heights:	www.bom.gov.au	Phone: 1300 659 217
SES Information:	www.ses.gov.au	Phone: 1300 842 000
Transport:	www.transport.gov.au	Phone: 13 10 00

If You Need Assistance:

For SES assistance, call 1300 842 000. For life threatening emergencies, call 000.

FLOOD SET 1: GREYSCALE AND ICON

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FLOOD SET 2: GREYSCALE; NO ICON

EVACUATE NOW

People in your local area should EVACUATE NOW due to flooding.

The Bureau of Meteorology has advised that heavy rainfall may result in widespread flooding over the next 24 hours.

You need to leave now and go immediately to a safer place. Your safest option may be to visit family or friends who live away from the affected area. Alternatively, you may evacuate to a temporary evacuation centre that has been set up at the local Community Centre.

Do not delay your evacuation, as roads may be congested or closed.

How to Evacuate:

- If you have a flood plan, use it now.
- Go immediately to a safer place. This may be to family and friends away from the area or to your nearest temporary evacuation centre.
- Turn off your power, water and gas supplies.
- Lock your doors and windows.
- Take your emergency kit, including warm clothes, medicine, valuables, mementos and photos, personal and financial documents, canned food and water, with you in waterproof bags.
- Take pets with you when you evacuate.
- Drive to the conditions and with extra care.
- If you cannot leave the area, take shelter in the upper storey of a sturdy brick or concrete multi-storey building.
- Listen to your local ABC radio station for updates.

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