**ORIGINAL PAPER**

# Using an inventory cluster approach for assessing bushfire preparedness and information needs in vulnerable communities

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**Abstract**

Disasters cost the world $US268bn in 2020 in economic, property and human losses. In Queensland, the most disaster-prone of Australian states, flood, cyclone and bushfire will cost $466bn over the next 40 years. Individual preparation for natural hazards has been shown to reduce this cost by reducing adverse experiences, physical health problems and post-traumatic stress, and improving the speed of disaster recovery. This study categorises preparation activity into clusters according to the activity's purpose in order to survey residents of a bushfire-vulnerable area in Queensland, Australia. This cluster approach enabled identification of specific areas of weakness in preparation plans, finding that evacuation planning activity, and safety planning activity were especially weak. These results show that emergency agency communicators and community engagement practitioners can use cluster-based research to better plan messaging within their bushfire preparation communication campaigns to target and motivate specific safety behaviours. Improved safety of people and property will mitigate the costs of bushfires in Queensland in future.

**Keywords** Bushfire · Wildfire · Preparation · Preparedness · Communication · Community engagement

## 1 Introduction

Since 1980, the United Nations Office of Disaster Risk Reduction has recorded an increase in the number and severity of disasters, with a 50% increase in large floods, 28% increase in damaging storms, and almost a 32% increase in the number of large-scale wildfires (Center for Research on the Epidemiology of Disasters 2020). Worldwide, natural hazards cost the world $US1, 504bn, with $US268bn of that occurring in 2020 (Statista 2020). While tropical cyclones generated the highest amounts of human and economic loss that year (Statista, 2020), bushfires, just in Australia, caused the loss of 35 lives (Coates 2020), insured

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damage of \$AU5.94bn (Insurance Council of Australia 2020), and additional health costs as a result of the smoke haze of \$AU1.95bn (Johnston et al. 2021). In the United States in 2018, wildfires are thought to have caused \$US20bn in insured damage, and for the nine months to September 2020 had caused the deaths of 27 people and affected 19% of the American economy (Rooks 2020). In Queensland, the most disaster-prone of the Australian states and territories, natural hazards are expected to cost at least \$466bn between 2021 and 2040 (Deloitte Access Economics 2021).

These rising losses make householder preparation for natural hazards increasingly important. Enhancing preparedness is Priority 4 of the Sendai Framework on Disaster Risk Reduction (United Nations Officer for Disaster Risk Reduction 2015), which sets out to reduce natural hazard risk and "…losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries (United Nations Officer for Disaster Risk Reduction 2015, p. 12)." Preparedness is a key theme of all four Priorities of the Framework. One of the few studies showing the concrete effect of preparation on safety has demonstrated that higher levels of flood preparation can result in fewer adverse experiences, physical health problems, lower post-traumatic stress rates and faster recovery (Grineski et al. 2020). Mitigation work undertaken before a natural hazard impact can save \$4 for every \$1 spent (Godschalk et al. 2009).

In Australia, mitigation and preparation activities within communities are motivated and guided by communication and community engagement by emergency agencies in the lead-up to a natural hazard season, supported by a 'shared responsibility' philosophy (Australian Council of Governments 2011). In fact, the National Strategy for Disaster Resilience (2011) identifies "…having effective arrangements in place to inform people about how to assess risks and reduce their exposure and vulnerability to hazards…" and "…having clear and effective education systems so people understand what options are available and what the best course of action is in responding to a hazard as it approaches…" as the two of the roles of government in achieving shared responsibility (2011 p. iv).

This study will advance agencies' understanding of household preparedness for bushfire at a community level. It will also provide a foundation for using preparation level data to inform clearer community engagement messaging and approaches that have potential to improve preparedness for bushfire at household level.

## 2 Background

Preparation of self and property for a natural hazard is one factor of effective risk management strategies for individuals, communities and agencies (Prior and Eriksen 2012). However, what constitutes effective preparation has been little researched, with the concept of 'well prepared' widely used but not well defined in the Australian bushfire risk management literature. Preparation for bushfire has demonstrated benefits: reducing exposure to risk, reducing losses and damage, and increased resilience allowing a faster return to 'normal' in terms of landscape and facilities, routines and psychological equilibrium. For agencies, better-prepared households reduce pressure on responders when it comes to protecting lives and property (Prior and Eriksen 2012), and research has shown that people who are prepared are more able to protect their houses from bushfires, although preparation is no guarantee a property will survive (McLeod 2003; Teague et al. 2010).

The relationship between natural hazard risk perception by householders and their subsequent preparation or protective action has been discussed in the literature but without definitive conclusions. Paton (2003) and Lindell and Perry (2012) proposed some form of relationship that was supported in a bushfire context (Whittaker et al. 2020), hurricane (Kim and Kang 2010) and landslide (Xu et al. 2018). However, later studies found the link to be tenuous—for instance, Heath et al. (2018) discovered perceptions of threat did not predict protective action for chemical release; and mixed results or no correlation have been achieved for bushfire preparation (Koksal et al. 2019). More recently, and specifically for earthquake, MacPherson-Krutsky et al. (2022) confirmed complexities found in interpretations of risk perception and their potential influence on protective actions (such as by Mărgărint et al. 2021; Peers et al. 2021; Lindell and Perry 1992). While risk perception (understood by householders as expected consequence) and intended protective actions correlated, other risk perception variables (such as perceived shaking zone and perceived liquefaction zone in an earthquake), did not correlate with protective action.

Effective preparation for a bushfire is thought to manifest itself in two ways – psychological preparedness and in physical activity that contributes to preparation (Boylan and Lawrence 2020; Prior and Eriksen 2012). Paton (2020) views preparedness as a combination of eight functional categories that include three physical categories—structural, survival, and personal, family and household planning—as well as psychological, community/capacity building, livelihood and community/agency. These functional categories have roots in previous work (such as Paton 2013; Paton et al. 2015). In addition to Paton's efforts to understand preparedness (2013, 2020), other researchers have also grouped inventory items according to their purpose. Earthquake and tornado preparation activity can be categorised as either mitigation or survival (Chaney et. al 2013; Lindell and Perry 2000; Seidel et al. 2008) with the physical aspects tested and further developed by McLennan et al. (2014) and McLennan et al. (2015a, b). These researchers expanded the clusters of activities by splitting Paton's structural activities into 'reducing danger to the house' and 'reducing the vulnerability of the house' (ie structural and landscaping activities), by adding 'preparation to leave safely', and splitting survival activities into 'safety planning' and 'active house defence' (McLennan et al. 2014, 2015a, b). This was developed into five slightly different clusters for storm preparation (Ryan and King 2020), with active house defence removed, and with the addition of a cluster of activities for preparation for post-impact survival. Ryan and King's (2020) additional, post-impact survival cluster was not one considered by McLennan and Elliott (2011) in their original work, possibly because until 2019–20, bushfires were more localised events in which survivors could more easily reach unaffected areas for aid and post-crisis survival. However, it is a cluster considered in earthquake preparation research.

In tandem with development of these clusters has been the focus of emergency agencies on the use of checklists for motivation for, and guidance on, preparation activities for households (for instance, Department of Civil Defence 2018; Federal Emergency Management Agency 2017; NSW Rural Fire Service n.d.). These inventories list physical hazard adjustments that can prepare a person or household for a natural hazard, whether they decide to stay or leave (Lindell and Perry 2012). Hazard adjustments can include having an emergency plan (Boylan et al. 2013; Mulillis 1999; McLennan et al. 2014), packing a 'go' bag or emergency kit (King 2006), arranging an evacuation route and destination (Moon, 2010; Hung 2017), or clearing rubbish from around the house (Cretikos et al. 2008). However, householders tended to undertake the easiest tasks, rather than those more likely to protect their lives or properties (Ryan and King 2020; Tibbits and Whittaker 2007). This

reflects research by Lindell et al. (2009) that concluded that some protective actions are useful for purposes other than reduction in risk to lives and property.

Researchers have usually gathered information about preparation levels of communities for natural hazards by asking what they did before a specific incident (such as Chaney et al. 2013; Cretikos et al. 2008; Every et al. 2015; Hung 2017; Trigg et al. 2015; Whittaker and Taylor 2018), or what they have done for an expected incident (such as Boon 2014; Onuma et al. 2017; Ryan and King 2020; Strahan et al. 2019). The measures of preparation activity are generally used to show the outcome of the physical preparation process that attempts to understand the mediating variables that lead to preparation action, such as experience, self-efficacy, outcome expectancy and trust in agencies (Paton 2013; 2020), with the preparation actions reflecting elements of the inventory approach recommended by emergency agencies.

The origin of these inventories does not seem to come from academic literature on the efficacy of each action but from agency experience of what seems to work. In fact, Dunlop et al. (2014 p. 887), described quantitative research in this area as "…being hampered by a lack of consistency in, and validation of household wildfire preparedness assessments" with roots in a general lack of agreement on what preparedness is and how it can be "quantitatively operationalised" to make results of preparedness studies, at least on wildfire, comparable.

However, empirical evidence of the efficacy of inventories as motivators for action is found in the field of health prevention, such as guiding behaviour (Keller 2010), staging new activities (Rogers 2010) and motivating action (Connor et al. 2011; Dholakia 2010). Ryan and King (2020) attempted to connect inventories with a more nuanced understanding of how to influence preparation behaviour but were not able to properly test their process beyond a small pilot study on storm preparation, recommending that a random sample survey be the next step. Their research found that inventories find usefulness in providing both a foundation for and measure of academic preparation behaviour research, and as a benchmark for agencies to use in developing community engagement programs that target and improve specific preparation activity (Ryan and King 2020).

The value of the cluster approach to measuring preparation levels is that the variables used to determine the level of preparation can be grouped so that strengths and weaknesses in an individual's preparation plans can be identified. For instance, Ryan and King (2020) found examples of individuals who scored very highly in the cluster of activities that measured preparation for reducing the danger to the house, but very low in preparations to evacuate when evacuation was identified as an option. In public relations and health prevention campaigns, this ability to measure certain aspects of behaviour in segments of a community can guide the design of communication and community engagement campaigns (Austin and Pinkleton 2015; Kim 2019).

## 3 The role of research in developing communication campaign themes and messaging

Public relations is a business activity that aims to change attitudes and behaviours (Luttrell and Capizzo 2021) through a deep understanding of the target publics, and then a campaign with specific aims, objectives and target publics. Research into attitudes, knowledge, motivations and behaviours has long been the foundation public relations campaigns (Stacks and Michaelson 2009) and guides not only the development of campaign aims and

SMART objectives, but the segmentation of target publics, selection of channels for messaging and identification of emotional triggers, or hooks, that will be effective for each target public (Luttrell and Capizzo 2021).

Often, one message, or a nudge (Oliver 2013) can trigger movement on an issue, or a small behaviour change, that can contribute to success for the organisation in its endeavour to encourage safe or healthy behaviour (Austin and Pinkleton 2015; Hanoch et al. 2017; Oliver 2013). These triggers might enable the development of themes and/or messaging that can (a) hook the attention of the target public; (b) get them interested in learning more; and (c) change their behaviour in some way (Stacks 2016). However, to achieve this, the organisation needs to have a deep understanding of the behaviour and the group undertaking this behaviour—the more focused a campaign is able to be as a result of research, the more effective it is likely to be (Stacks 2016).

On this basis, this study will test the usefulness of the cluster approach to examining bushfire preparation as proposed by McLennan et al. (2015a, b) and further developed in a storm context by Ryan and King (2020). It will also explore its potential for use to uncover legitimate messaging hooks, or nudges, as the foundation for successful community engagement and communication activities.

# 4 Study design

This is a two-stage study using qualitative and quantitative methods. Firstly, researchers conducted 33 in-depth interviews of residents living along wildland-urban interface (WUI), a rugged, escarpment area in Queensland, Australia, which had experienced long periods between bushfires but was considered by agencies to be an area vulnerable to the effects of climate change. Bushfires within 40kms of this area had occurred in 2002 and 2019, with very little in between. In fact, until 2018, Queensland had not ever before experienced a day rated on the Forest Fire Danger Rating as 'catastrophic' (Australian Institute of Disaster Resilience n.d.), and up to that point, Queensland had been considered as generally low in terms of bushfire risk and threat compared with other Australian States and Territories (Mullins 2021). WUI (Choi 2004) is an environment where people and their properties meet up with large areas of vegetation (Koksal et al. 2019; Stewart et al. 2007). The results of the in-depth interviews informed the development of the second stage survey instrument. The second stage was a random sample survey ($N = 504$), conducted by computer-aided telephone interview of people living across a larger geographic area than the initial interviews, but featuring similar geology, ecology and weather patterns and within the same local government area as the in-depth interviews. This group featured those living in wildland-urban interface, or within.

## 4.1 In-depth interviews

In-depth interviews with 33 residents of large-block escarpment suburbs north and south of Toowoomba, Queensland, which is Australia's second largest inland city. All of the properties were located close to the eastern boundary of the local council area, which is a natural escarpment up to 700 m (2300 feet) above sea level. Figure 1 shows Toowoomba's location in relation to Brisbane.

The interviews were conducted between September and October 2017, which is midway through fire season in that area. Interviews took between 20 min and one hour and

**Fig. 1** Toowoomba's location in relation to Brisbane, Queensland, Australia (Google Maps 2022)

evaluated residents' physical preparedness activity by asking which inventory activities they had undertaken. The participants were selected randomly from three suburbs identified by the local fire agency as being particularly vulnerable if a bushfire was to start in the area, WUI areas. From satellite pictures of the identified suburbs, the number of homes was counted, and each area allocated a proportionate number of the desired 30 interviews. Houses were selected by starting the count at the start of the street and selecting every fourth house. Interviews were undertaken by cold calling each house. If no one was home or if a dog was present in the yard, a message was left and a second attempt at contact was made before abandoning the potential respondent and moving on to the next house identified in the process.

The in-depth interview instrument was developed from the literature review, using questions relevant to storm and bushfire preparation. The results reported in this paper will focus on bushfire.

The in-depth interviews were designed to investigate perceptions of residents of their own preparation and how those perceptions compared with actual readiness. The questions were grouped into seven sections: connection to the community; risk and preparedness perceptions; risk, experience and bushfire knowledge levels; preparation activities organised into five clusters according to purpose; obstacles to and triggers for preparation; information sources for preparation information and alerts; and demographic and psychographic-type questions. The five clusters of preparation activities are the subject of this study.

## 4.2 Telephone survey

The survey data was collected by random sample telephone survey in October 2020 along the eastern boundary of a Queensland local government area that features Great Dividing Range escarpment. The sample was drawn from a population of 55,000 residents who lived in rural, interface and urban areas within 2 km of WUI and were divided into two groups: WUI ($N = 242$), which were people living on the edge of the bush or within 500 m, and an urban group ($N = 262$), those living between 500 m and 2 kms from the WUI. Each interview took about 15 min to complete. This timing was considered optimum by the data collection team, which had collected data relating to natural hazards in this form and method in the state of Queensland in the past. The survey included 38 questions that were a mix of response styles required from participants including Yes/No, five-point Likert scale, selection from a list, and open-ended responses. Computer-Aided Telephone Interviews (CATI) were used to secure a random and valid sample.

Responses to the initial in-depth interview questions were used to guide the development of the survey items. Survey items aligned with the clusters developed by McLennan et al. (2015a, b) that grouped bushfire preparation activities according to type. Time limits are recommended for random CATI interviews because of response issues stemming from factors such as fatigue (Choi 2004), with 15 min optimum (Hansen 2007). This resulted in a questionnaire of about 40 items. In all, 23 items in the survey were cluster-related (Table 1). This was reduced from the 33 in-depth interview questions because of the time factor.

## 5 Results

### 5.1 In-depth interviews ($n = 33$)

In-depth interviews were conducted with $N = 33$ people across three locations. The people who agreed to be interviewed about preparedness were working (72.7%) or retired (27.3%), aged older than 54 (63.6%), living in a brick or block house (66.7%) on a large lifestyle block (more than one acre) (87.9%), and had been in their house for less than four years (33.3%) or between 10 and 14 years (30.3%). Most (91%) owned their home or were paying it off, which was consistent with the suburbs where they lived (Australian Bureau of Statistics 2016).

We compared people's perception of their own preparedness (indicated on a 5pt scale) with their actual engagement with the preparation activities (Fig. 2). The most notable outcome of this comparison was the low level of preparation that people had undertaken for leaving, and the seeming lack of understanding of how to make a house more impervious (or less vulnerable) to the danger of fire.

Even those who thought they were quite well prepared had undertaken an average of three or fewer activities out of seven possible preparation to leave activities. By far the most popular preparation purpose was reducing the danger to the house, which was mostly gardening and activities to make a premises look tidy, with an average of six activities undertaken out of the eight possible activities identified in the interviews. Reducing house vulnerability—making more structural changes to ensure a house was fire resistant—was rare in the sample, and there were only two activities identified. One person from the

**Table 1** Survey items (23) within preparedness clusters (5)

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**Cluster 1 Safety planning (SP) (8 items)**

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Do you or members of your household use an app for bushfire information?

Do you know what the fire danger rating sign looks like?

Do you have a battery-operated radio?

Once bushfire season has started do you check your fire danger rating via a roadside sign or weather app or report?

Have you or someone in your household attended a community bushfire information session in the last 2 years?

Do you have a household bushfire emergency plan that details what you will do in a bushfire?

Is your bushfire plan written down?

Have you practiced/shared/talked about your bushfire plan within your household?

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**Cluster 2 Preparation for leaving (PL) (7 items)**

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Do you have an evacuation plan?

Does it include capacity for evacuation of pets?

Does it include a place for you and your pets to stay?

Does it include planned alternative evacuation routes?

Have you practiced any aspect of this evacuation plan?

Do you have a plan for where your family will meet if you are separated during a bushfire evacuation?

Do you have a specific fire evacuation kit prepared each fire season that includes items such as mobile phones, chargers and power sources, three days' clothing and food, food for pets, medication, precious documents or other items?

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**Cluster 3 Preparation of house (PH) (3 items)**

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Have you cleared lawns, shrubs or overhanging trees within 20 m of your house?

Have you cleared your buildings' gutters at least once before or during bushfire season?

Have you removed flammable or loose items from around your house and on verandas during bushfire season? *(Examples: outdoor furniture, plants, doormats)*

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**Cluster 4 Preparation of House to reduce vulnerability (PV) (3 items)**

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Have you sealed gaps in ceilings and under your house?

Have you worked with neighbours and/or other people in your community to prepare for bushfire season?

Have you worked with your local fire brigade to reduce the fire hazard on your property or in your area?

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**Cluster 5 Preparation for defence of the property (PD) (2 items)**

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A bushfire emergency kit contains items such as safety clothing, safety equipment, a first aid kit, battery operated radio—do you have one of these setup?

A property that is very well prepared for bushfire might have features like window shutters, special roof sprinklers, a fire pump, a fire bunker, a fire-resistant garden, separate water supply—have you installed this type of fire protection at your property?

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sample had installed one of the possible items—window covers, sprinklers on their roof or other house or garden structural items.

The lack of preparation for leaving was also evident in the open questions of the interviews, particularly the interviews with people who had attended the meetings. Many people commented that they would not do much more than the basic preparation because they were 'just going to leave'. They seemed to imagine that leaving would be
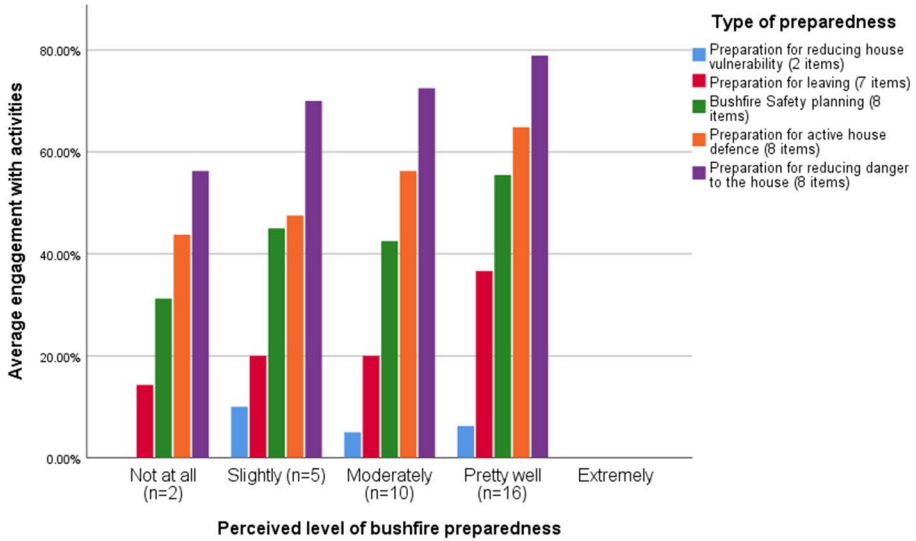
**Fig. 2** Perceived preparedness of 33 in-depth interview households compared with the mean number of activities actually engaged within preparedness clusters (colour)

as simple as locating and collecting a few precious things (often just the animals), shutting the door and driving away. This was in contrast to stressful and extended bushfire evacuation experiences recorded by researchers, characterised by urgency, uncertainty, physical and psychological constraints and subsequent flawed decision-making (Cohn et al. 2006; McLennan et al. 2019), especially when pets were involved (McLennan et al. 2013; Taylor et al. 2015).

## 5.2 Survey (*n* = 504)

The sample was drawn from 55,000 householders who lived on properties considered by the local council to be vulnerable to bushfire within a 170 km long strip that was 5 km wide outside the city boundary and 2 km wide inside that boundary. This strip was considered by authorities to be especially bushfire-vulnerable because of the topography and vegetation, and views and activities of residents were of particular interest because of this vulnerability. The sample comprised 504 people each representing a different household, with 217 males (43.1%) and 287 females (56.9%). In terms of age, 210 (41.7%) of respondents were aged 65 or older, 349 (69.2%) households had no occupants under 18 years, and 151 (30.0%) were unsure if they had bushfire insurance.

The 504 households belonged to one of four household types that were sourced from properties close to the escarpment: rural sized and located blocks, 22 of which were involved in commercial activity; rural residential blocks of at least one acre; wildland-urban interface housing on the escarpment; and urban blocks within 2 km of the Great Dividing Range escarpment bushland. We divided these into two groups: WUI (those in rural or wildland-urban interface areas, $N = 242$) and urban (those living between four blocks and two kilometres from the wildland-urban interface, $N = 262$).

Features of these households are reported in Table 2.

**Table 2** Features of survey respondents

| Household features | WUI (N=242) | | Urban (N=262) | |
|---|---|---|---|---|
| | N | % | N | % |
| Own home (not rent) | 205 | 84.7 | 193 | 73.7 |
| Property insurance (Yes) | 106 | 43.8 | 68 | 26.0 |
| Property Insurance (Unsure) | 71 | 29.3 | 80 | 30.5 |
| Single occupant households | 46 | 19.0 | 70 | 26.7 |
| No children under 18 | 171 | 70.7 | 178 | 67.9 |
| At least 1 person > 70 | 80 | 33.1 | 92 | 35.1 |
| Person with a disability | 44 | 18.2 | 37 | 14.1 |
| Employees/volunteers in fire services | 0 | 0 | 0 | 0 |
| Bushfire emergency plan (Yes) | 58 | 24.0 | 47 | 17.9 |
| Decision to leave (Yes) | 51 | 21.1 | 42 | 16.0 |
| Decision to leave as percentage of planners | | 87.9 | | 89.4 |

**Table 3** Perceptions of risk and readiness

| | WUI (N=242) | | Urban (N=262) | |
|---|---|---|---|---|
| | N | % | N | % |
| Perceived risk (no risk) | 115 | 47.5 | 191 | 72.9 |
| Perceived ready (not ready) | 67 | 27.7 | 112 | 42.7 |

**Table 4** Bushfire risk and readiness perceptions of the WUI group (N=242)

| Risk perceptions | Readiness perceptions | | | Total |
|---|---|---|---|---|
| | Not ready at all | Moderately ready | Very ready | |
| No risk | 45 | 27 | 43 | 115 (47.5%) |
| Moderate risk | 22 | 32 | 51 | 105 (43.4%) |
| High/extreme risk | 0 | 4 | 18 | 22 (9.1%) |
| Total | 67 (27.7%) | 63 (26.0%) | 112 (46.3%) | 242 |

The survey asked questions about householders' perception of their risk and readiness. In the area of greatest vulnerability, the WUI group, 47.5% believed they faced no risk of bushfire, and 27.7% of that group also thought they would not be ready to face a bushfire. Compared to the WUI group, 53% more households in the urban group perceived no risk of bushfires and 54% more thought they would not be ready. The full risk and readiness perception profile of both groups is reported in Table 3.

Only 9.1% (N=22) of the WUI group (Table 4) believed they were at high/extreme risk, however, all believed that they were either moderately (N=4) or very (N=18) ready. Of those who perceived they were at moderate risk 21% (22/105) believed they were 'not ready at all' (Table 3).

Of the urban group (Table 5), 72.9% (N=191) perceived no risk, but despite this, 36.6% (69/191) thought they were 'very ready' for a bushfire.

**Table 5** Bushfire risk and readiness perceptions of the urban group ($N=262$)

| Risk perceptions | Readiness perceptions | | | Total |
|---|---|---|---|---|
| | Not ready at all | Moderately ready | Very ready | |
| No risk | 92 | 30 | 69 | 191 (72.9%) |
| Moderate risk | 18 | 24 | 25 | 67 (25.6%) |
| High/extreme risk | 2 | 0 | 2 | 4 (1.5%) |
| Total | 112 (42.8%) | 54 (20.6) | 96 (36.6%) | 262 |

**Table 6** Descriptive statistics of the proportions of activities per cluster completed by the WUI group ($N=242$)

| Clusters of activities completed | Min | Max | M | SD |
|---|---|---|---|---|
| Safety planning (SP) (8 items) | .00 | .88 | .33 | .20 |
| Preparation for leaving (PL) activities (7 items) | .00 | 1.00 | .15 | .24 |
| Preparation of the house (PH) (3 items) | .00 | 1.00 | .67 | .33 |
| Reducing vulnerability of the house (PV) (3 items) | .00 | 1.00 | .17 | .22 |
| Preparation for defence (PD) (2 items) | .00 | 1.00 | .19 | .30 |
| Total activities | .00 | .87 | .29 | .17 |

**Table 7** Descriptive statistics of the proportions of activities per cluster completed by the urban group ($N=262$)

| Clusters of activities completed | Min | Max | M | SD |
|---|---|---|---|---|
| Safety planning (SP) (8 items) | .00 | .88 | .28 | .19 |
| Preparation for leaving (PL) activities (7 items) | .00 | 1.00 | .15 | .25 |
| Preparation of the house (PH) (3 items) | .00 | 1.00 | .58 | .35 |
| Reducing vulnerability of the house (PV) (3 items) | .00 | 1.00 | .14 | .20 |
| Preparation for defence (PD) (2 items) | .00 | 1.00 | .13 | .24 |
| Total activities | .00 | .82 | .25 | .16 |

To compare perceived readiness with actual readiness (as measured by the number of activities from Table 1 that they had undertaken before fire season) chi-square tests were performed. A significant association between perceived and actual readiness was found for the WUI group ($X^2 = 70.25$, d$f = 4$, $p < 0.001$). Of the 112 households that indicated they were very ready, 24 (21.4%) measured as not ready at all and 85 (75.9%) as only moderately ready based on their survey responses. An association was also found for the urban group ($X^2 = 76.27$ d$f = 4$, $p < 0.001$). Of the 96 households that perceived they were very ready, 29 (30.2%) were actually not ready at all and 65 (67.7%) were moderately ready.

Descriptive statistics for the preparation activities of both WUI and urban groups were generated and are presented in Tables 6 and 7. For the WUI group, the safety planning (SP) cluster had a maximum value of 0.88, indicating that no household had completed all SP activities, however, it also had the largest number of possible activities (8) than any other cluster. All other clusters had a maximum of 1.00, indicating that one or

more households had done every activity in these four clusters: preparation for leaving (PL), preparation of the house (PH), reducing the house's vulnerability using structural methods (PV), and preparing to defend the house (PD). On the whole, all of the clusters saw an average of fewer than half of the activities undertaken by the WUI group. The preparation of the house (PH) activities was most likely to have been completed ($M = 0.67$), while preparation for leaving (PL) was the cluster least likely to have been completed ($M = 0.15$). The safety.

In the least completed cluster of activities by the WUI group ($n = 242$), evacuation planning (PL), people were most likely to have engaged with development of an evacuation plan (24.8%) and yet the activity they had least engaged with was having practiced their evacuation plan (5.8%). The other areas of weakness were reducing the vulnerability of the house (PV), with only 5% having worked with their local fire brigade as part of their preparation and 13.2% having worked with their neighbours. Preparation for defence (PD), included only two activities, however, respondents were equally unlikely to have either a defence-focused kit prepared or access to more sophisticated fire-fighting equipment (both 19.0%). The cluster of activities that were most often undertaken was preparation of the house and garden (PH), with most households cleaning gutters before fire season (75.6%) and 62% clearing vegetation within 20 m of the house, and removing flammable material and loose items from around the house (such as outdoor furniture, mats, pot plants). For a complete list of activity completion in both the WUI and urban groups, see Supplementary Table 1.

In the urban group (Table 7), average levels of activity across the clusters were generally much lower than the WUI group. Unlike the WUI group, which paid the least attention to preparation for leaving, the cluster of activities least engaged with by this group was preparation for defence of the house (PD) during a bushfire ($M = 0.13$), followed by reducing the vulnerability of the house (PV, $M = 0.14$). Preparation for leaving (PL) had the same average participation as the WUI group ($M = 0.15$). Preparation of the house (PH) activities (which also reflect keeping the house and garden neat and tidy) was the most undertaken cluster of activities, however, with an average of $M = 0.58$ and only 3 activities in this cluster, households only completed one or two of these activities on average. In safety planning (SP), with an average of only $M = 0.28$, this group undertook between two and three of the eight activities identified in this cluster.

While we might expect people in urban areas ($n = 262$) to overlook activities for preparation for defence (PD) and reduction of house vulnerability (PV), evacuation planning (PL) activities also featured as a significant weakness within the urban group's bushfire preparation. Within this PL cluster, urban respondents were similar to the WUI group with the activity most engaged with being development of an evacuation plan (24.4%), and with only 6.5% having practiced their plan. Safety planning (SP) was also a cluster of weakness, with an average of just over two of the eight available activities undertaken. These were most often knowing what a fire danger rating sign looks like and whether they check it during fires season, both of which had 64.1% agreement, while the least undertaken activity was attending a community bushfire information session in the past two years (2.7%) and having an emergency plan of what to do in a bushfire written down (4.6%) In the most-often undertaken cluster, preparation of the house and garden (PH), the activity least likely to have been completed was removal of flammable materials from around the house (such as outdoor furniture, mats, pot plants), with 53.8% indicating they had done this. Similar to the WUI group, cleaning of gutters was the most completed activity in the urban group, however at 65.3%, It was lower in the urban group.

Overall, the results show that in four out of the five clusters, both WUI (higher risk) and urban groups had low levels of overall preparation for bushfire, with only the preparation of the house being relatively consistently undertaken.

While households in the WUI group tended to engage slightly more with preparation activities across all five clusters, in both the WUI and urban groups, the least undertaken clusters of activity were evacuation planning, planning for defence of the house, and reducing vulnerability to their house. Overall, both groups over estimated their readiness, possibly because many underestimated their risk. It is important to note that of these, PH and PV contained three activities, while PD contained two—the precursor interviews indicated that these numbers of activities were realistic for these clusters in this region. In other communities, activities could be added to each of these clusters to make them more comprehensive if it was found that a community might be more likely to undertake more activities or different activities.

## 6 Discussion

By using in-depth interviews and a CATI survey, we investigated aspects of bushfire preparedness that might be easily influenced by agency communication and community engagement activity. By ordering our survey questions into clusters based on the purpose of the preparedness activity being studied, we were able to pinpoint areas of preparation weakness within a certain community that may be resolved with targeted and specific community engagement events and messaging. This research advances agencies' understanding of how to gather and use deeper knowledge of household preparedness levels in specific communities to motivate and guide specific positive behaviour change and provides the foundation for a communication approach that is well-understood in public relations campaign planning (Austin and Pinkleton 2015; Luttrell and Capizzo 2021).

For instance, planning to leave (PL) was a clear weakness in the community studied, with householders undertaking one or two of the seven activities listed in this cluster. This was concerning because the earlier in-depth interviews showed us that while most people intended to leave, the sentiment of their comments indicated that this would be as simple as jumping in the car and driving off when the reality is far different. We asked questions within the PL cluster that demonstrated the complexity of evacuating. The evacuation activities least likely to have been undertaken were practice of the evacuation plan, knowing alternative evacuation routes and the capacity to evacuate pets and having a plan that includes a place to stay, including pets. These activities could be focused on during community engagement and communication messaging in areas with similar populations. Because agency preparation materials respect the right of people to stay and defend their homes, education materials often present the binary decision to leave early or to stay and defend if well-prepared (such as NSW Rural Fire Service *Get Ready for a Bushfire* n.d.). The messaging itself could be built around the research results, with a scorecard approach providing a hook articulated by Luttrell and Capizzo (2021) as a necessary component of successful messaging.

Low rates of engagement with safety planning activities were also a concern, which for the WUI group was an average of one-third of the eight activities presented, and the urban group only 28% of the eight activities. This cluster presented activities such as knowing how and where to source good information (such as a fire services app and/or a battery-operated radio), having a bushfire plan (not an evacuation plan) and having practiced the

plan. These results mean that agencies should be creative in how they connect with communities once bushfire season starts (and risk perceptions are higher) to point them to reliable and official sources of information that can be familiar before they are needed.

Being well-prepared to stay and defend was also shown to be a significant weakness in this population, with a low engagement with setting up for active defence such as a having a firefighting kit, possessing firefighting equipment, house sprinklers etc. (68.2% of WUI and 77.1% of urban households not completing either of the two PD activities) and very few of the more serious and/or structural activities aimed at reducing house vulnerability such as sealing gaps, undertaking mitigation work with neighbours and/or the local fire brigade. The number of activities presented in these two clusters can be increased in further research—the small number was selected to achieve the short timeframe for each interview on the basis that the in-depth interviews sample rarely undertook the activities in these two clusters. This is thought to be a result of the lack of bushfire experience of the sample groups located in Queensland, which has not traditionally been a state affected by serious bushfires, although this was not explored in the survey. Lack of experience and its effect on preparation might confirm the findings of Heath et al. (2018) that the LEVEL of household risk perception is important, and that studies should explore this further instead of presenting the choice as binary 'at risk'/'not at risk' to future research participants.

The strongest cluster of bushfire planning activity in both the WUI and urban groups was preparation of the house and its surrounds—mowing, clearing gutters, clearing shrubs and trees and ensuring everything was generally clear and tidy. These are also activities that are undertaken year-round by most people to improve the appearance of their property and might be coincidental with bushfire preparation, but this was not explored. Lindell et al. (2009) made similar findings about protective actions that also had other purposes, which indicates that communication around the activities involved in preparing the house might motivate early action. It does indicate that the focus of education sessions and communication messaging could be moved away from activities within this cluster and onto one of the less prioritised, but more important, clusters of activity, such as evacuation planning.

The reasons that survey respondents were more likely to have undertaken more activities in one cluster than another were not explored in detail because of the time constraints of the CATI survey, but this should be examined in further research to refine messaging. Further research is also required to definitively determine the relationship between risk perception and preparedness, and previous experience and preparation: the literature was unclear on this, and this study did not examine the potential for correlations between the two. Further research should also be conducted to examine the obstacles to undertaking preparation activities using the cluster perspective, as this information can be used in developing the first two steps, the effective hook and further information, in Luttrell and Capizzo's (2021) key messaging format.

## 7 Conclusions

We found that it is likely that a focus on just two clusters of bushfire preparation activity could provide the best effect for communication and community engagement conducted by agencies in regions similar to the one subject to this study. In an inexperienced, urbanised, and bushfire-vulnerable community, safety planning and preparation for leaving are two groups of activity that are particularly overlooked by households. The cluster preparation of homes was completed at a reasonable level in this particular study (around two-thirds

of possible activities completed by most people), so we recommend that agencies could focus more on ensuring that households undertake activities to keep themselves safe and evacuate safely during bushfire. By reducing the emphasis on activities already undertaken regularly (keeping the house and yard tidy) messaging can target more specific behaviour toward greater bushfire preparedness, regardless of the experience or other characteristics of a community. Research by agencies into what certain communities do to get ready for bushfire, classification of these activities into clusters, and then analysis of levels of preparedness within each cluster, will potentially provide a valuable foundation for future community communication, engagement and education.

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## Declarations

**Conflict of interest** Each of the authors declares they have no financial interests that could present a conflict in relation to this or previous research.

**Ethical approval** The in-depth interviews and process were approved by the University of Southern Queensland Ethics Committee, (H17REA150). The survey and data collection process were approved by University of Southern Queensland Human Ethics Committee (H20REA150).

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