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Predicting self-evacuation in Australian bushfire

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Predicting self-evacuation in Australian bushfire.

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Predicting self-evacuation in Australian bushfire.

Abstract

Australian bushfire safety policy does not require mandatory evacuation from bushfire as practiced in North America and other jurisdictions. Australian householders confronted with a bushfire threat must decide whether they remain and defend their property or evacuate. A better understanding of factors that influence householders' decisions to self-evacuate can inform bushfire safety policy. Studies have identified variables that motivate evacuation from various hazards, including wildfire, but factors shaping the decision processes are not well understood. The Protective Action Decision Model (PADM) provided a theoretical framework of factors influencing protective response to hazard to analyse the actions of householders affected by two bushfires. Three factors that predict self-evacuation were identified: the perception that evacuation is effective in protecting personal safety; the receipt of official warnings; and perceived threat to property. These findings reinforce the importance of increasing householder awareness and sensitivity to the danger posed by bushfire; the adequacy of people's bushfire preparedness; the effectiveness of early evacuation in protecting personal safety; and the potential persuasiveness of accurate, relevant and timely official warning messages in influencing safe evacuation from bushfire.

Keywords: official warning, wildfire, threat, personal safety, property protection, long-run hazard adjustment.

Introduction

Following the 2009 ‘Black Saturday’ bushfires in Victoria, Australia, major changes were made to bushfire safety policy, practice and advice reflecting the recommendations of the Victorian Bushfires Royal Commission (Teague, McLeod, & Pascoe, 2010). Major elements of the new policy, framed around the message ‘Prepare, Act, Survive’ (PAS), have not been adopted by many householders (Gilbert, 2014; J. McLennan, Paton, & Wright, 2015; Rhodes, 2011) and the fundamental choice that they confront during a bushfire is still whether to evacuate or to remain and defend (Tibbits, Handmer, Haynes, Lowe, & Whittaker, 2008).

The wildfire literature reports a range of factors that influence evacuation including: perception of imminent threat and receipt of official warnings (J. McLennan, Elliott, & Omodei, 2012); information on evacuation options (Cao, Boruff, & McNeill, 2016; J. McLennan, et al., 2012; Tibbits and Whittaker, 2007); responsibility for pets or livestock (Smith, Taylor, & Thompson, 2015; M. Taylor, Burns, Eustace, & Lynch, 2015); and survivability of evacuated property (Whittaker, Haynes, Handmer, & McLennan, 2013). Recently McCaffrey (2018) found that three key factors predict evacuation from wildfire in North America: perception of evacuation as an effective way to minimize risk; official cues or warnings; and attitude to risk. The research reported in this paper utilised the Protective Action Decision Model (PADM) (M. Lindell, 2018; M. K. Lindell and Perry, 1992, 2004, 2012) to identify factors predicting self-evacuation in two Australian bushfires. Within the PADM, environmental and social cues, information and warnings, comprising the environmental and social context, initiate a ‘series of pre-decisional processes that in turn elicit core perceptions of the environmental threat, of alternative protective actions and of relevant stakeholders’ (M. K. Lindell and Perry, 2012, p. 617). These perceptions underpin protective action decision-making whereby decision-makers consider whether a real threat exists, the need for protective action, available protective options, the best protective alternative and the timing of its implementation. This process in turn

generates behavioural responses including information search and emotion focused coping. Information search continues as a feedback loop involving decision-makers assessing the adequacy of information, identifying information sources and channels and establishing its required timing. This continues until there is enough certainty to allow householders to make decisions about appropriate protective actions (M. Lindell, 2018; M. K. Lindell and Perry, 1992, 2004, 2012)

..

The decision to evacuate is not as clear cut as the PAS message implies. Those who plan to evacuate must determine the prompt or trigger for, and the timing of that action. Others wait to see how the bushfire develops before deciding whether they will remain or leave (Dunlop, McNeil, Skinner, & Morrison, 2012; Gilbert, 2014; J. McLennan and Elliott, 2012; Rhodes, 2005; Whittaker and Handmer, 2010). Evacuators who lack a clear trigger for implementing their protective action and others who ‘wait and see’ risk late evacuation, which is potentially dangerous (Handmer and Tibbits, 2005; Haynes, Handmer, McAneney, Tibbits, & Coates, 2010). Personal safety is enhanced by timely evacuation. Bushfire safety and communication strategies during bushfire emergencies are enhanced by a better understanding of factors that are influential in decision-making.

In North America, mandatory evacuation is practiced (Bonkiewicz and Ruback, 2012; S. McCaffrey, Toman, Stidham, & Shindler, 2014; T. B. Paveglio, M. Carroll, & P. Jakes, 2010), although not generally enforced (Settles, 2012), so compliance has been attributed to householders’ interpreting a mandatory order as indicating a severe or dangerous hazard warning from agencies that have a responsibility to reliably communicate this (Baker, 1991; Huang, Lindell, & Prater, 2016) although obedience to authority figures and concern about legal penalties may also play a role (Baker, 1991). Mandatory orders create a context of evacuation compliance that contrasts strongly with that faced by Australian householders’ who have the option of evacuating or remaining to defend against a bushfire (S. McCaffrey, Rhodes,

& Stidham, 2014; S. M. McCaffrey and Rhodes, 2009; T. B. Paveglio, et al., 2010; Teague, et al., 2010).

Factors motivating protective decisions have been explored using qualitative and univariate research designs but multivariate modelling of factors predicting evacuation has not until recently been presented, but only in the context of mandatory evacuation orders (S. McCaffrey, Wilson, & Konar, 2017)

The research reported in this paper further extends the international literature on wildfire evacuation by identifying predictors of evacuation in a public policy context of decision-making choice.

The paper begins by discussing changes in Australian bushfire safety policy reflected in the adoption of the ‘Prepare, Act Survive’ (PAS) policy, and research documenting the reluctance of many householders’ to accept and implement major elements of this policy. It canvasses the international hazard literature dealing with evacuation and discusses the application of social psychological theories from health promotion and injury prevention; and the application of the Protective Action Decision Model to the analysis of protective action behaviour in wildfire.

Results are presented from an analysis of Australian householder decision-making during the 2014 Parkerville bushfire in the Perth Hills and the 2015 Sampson Flat bushfire in the Adelaide Hills. The paper concludes by discussing how a better understanding of factors that predict self-evacuation from wildfire can extend and sharpen the focus of Australian bushfire safety policy and practice.

Australian bushfire safety policy and protective response

Following the 2009 ‘Black Saturday’ bushfires in Victoria, Australia in which 173 people perished and more than 2000 homes were destroyed (Whittaker, et al., 2013), substantial changes were made to bushfire safety policy and practice framed around the message ‘Prepare, Act, Survive’ (PAS) (J. McLennan, Paton, & Beatson, 2015; Whittaker, et al., 2013). The aim

of Australian bushfire safety policy is both greater predictability of bushfire risk and enhanced capability for responding in ways that will increase safety and survival. The policy promotes a decision to evacuate, well before a bushfire becomes a threat, as the safest option, and encourages comprehensive planning to support those actions. Fire Danger Ratings (FDRs) are issued forecasting levels of bushfire danger at least 24 hours in advance. For the most dangerous forecast fire danger days, people are advised in advance to leave even if a bushfire is not in progress in that area (Country Fire Authority, 2014). The policy advises close monitoring of bushfire, including being alert to official bushfire warnings, to avoid dangerous late evacuation (Australasian Fire and Emergency Services Authorities Council, 2012)

Evidence suggests that many householders do not take protective actions or behave in the manner promoted by bushfire safety policy. Most do not remove themselves from areas of potential disaster risk on days of the highest bushfire danger (J. McLennan, Paton, & Wright, 2015; Reid and Beilin, 2013; Whittaker and Handmer, 2010; Whittaker and Taylor, 2018). Many only undertake ‘easy to do’ preparations (Gilbert, 2014; J. McLennan, Paton, & Wright, 2015; Rhodes, 2011) such as gardening and general property maintenance. Many householders do not undertake systematic planning of property defence or of their evacuation. Few bushfire plans are written, take account of possible unexpected contingencies or are practiced by the household (Gilbert, 2014; J. McLennan, Paton, & Wright, 2015; Rhodes, 2011; Whittaker, et al., 2013). Many householders intend to ‘wait and see’ how a bushfire develops before deciding whether they will remain or evacuate (Dunlop, et al., 2012; Gilbert, 2014; Whittaker and Handmer, 2010) notwithstanding the strong emphasis of bushfire safety policy on making a clear-cut decision to leave early. Householders who wait and see tend to undertake fewer preparations of their property and for their evacuation compared to those who make a definite decision in advance to stay and defend or to evacuate (Dunlop, et al., 2012). Some of those who plan to stay and defend have only a partial commitment to that course of action and retain late evacuation as an option (Tibbits and Whittaker, 2007). Uncertainty about when to leave and the inability to recognise when leaving is no longer safe was a major problem for the previous ‘Prepare, Stay and Defend or Leave Early’ (PSDLE) policy (Tibbits and Whittaker, 2007; Whittaker, et al., 2013) and continues to be a central issue for bushfire safety policy even with its increasing emphasis on planning for unexpected contingencies. Essentially the PSDLE remains at the heart of Australian bushfire safety policy, modified since 2009 to give a greater emphasis on evacuating.

Notwithstanding substantial policy changes following the ‘Black Saturday’ bushfires, householders must still decide to evacuate from or to remain and defend their property against a bushfire. Reforms of bushfire safety policy that have sought to change householders’ response to bushfire have had limited effect (Gilbert, 2014; Muir, Gilbert, O’Hara, Day, & Newstead, 2017; Rhodes, 2014).

Theoretical models of emergency evacuation

The early hazard literature addressed evacuation in the context of warning as a pivotal evacuation trigger including message characteristics such as content, source and frequency (Drabek, 1986; D. S. Mileti, 1975) and the complex interactions of risk perceptions, warning characteristics and recipient characteristics (Baker, 1991; M. K. Lindell and Perry, 1992; D. Mileti and O’Brien, 1992; D. S. Mileti and Sorensen, 1990a; Perry and Lindell, 1991). Factors identified as critical to understanding evacuation decision-making also included risk perceptions, defined in terms of the probability and impacts of a hazard event (M. K. Lindell, 1994; D. S. Mileti and Peek, 2000); decision-makers’ unique frames of reference (Slovic, 1987) and personalised interpretations or assessments (D. S. Mileti and Sorenson, 1987; Zhang, Prater, & Lindell, 2004); and environmental, psychological, social, cultural, economic and technological context (Dash and Gladwin, 2007; White, 1994). While there is considerable research that addresses compliance with voluntary and mandatory evacuation orders (Dash and Gladwin, 2007) there has been little research on evacuation decision-making in Australian bushfire where mandatory orders are uncommon. Influential research has considered evacuation as a process rather than simply an outcome, addressing environmental and social cues and information sources (M. K. Lindell, J. C. Lu, & C. S. Prater, 2005); the cognitive routes householders take to a protective decision (Gladwin, Gladwin, & Peacock, 2001); the dynamics of the evacuation process including constraints and problems faced by householders (Cohn, Carroll, & Kumagai, 2006); consideration of Shelter in Place as a back-up option or strategic alternative to evacuation (T.J. Cova, Drews, Siebeneck, & Musters, 2009); and actual and intended protective response to wildfire including remaining to defend and delaying a decision to evacuate or remain (S. McCaffrey and Winter, 2010). A recent statistical meta-analysis of studies of actual and expected response to hurricanes found that official warnings, expectation of severe personal impact, environmental and social cues and risk area residence, influenced decisions to evacuate (Huang, et al., 2016). In a recent review of studies on actual

and intended evacuation from a range of hazards Thompson et al. (2017) reported that evacuation was consistently related to evacuation expectations, prior evacuation behaviour, receipt of evacuation warnings from trusted sources, receipt of a mandatory evacuation order and perception of threat from a dangerous, proximate hazard. One study found self-efficacy to be an important predictor of intention to evacuate from flood (Samaddar, Misra, Chatterjee, & Tatano, 2012). Having an evacuation plan was associated with expectations of future evacuation (Burnside, Miller, & Rivera, 2007) but there was no evidence that having a plan prospectively predicts evacuation behaviour (Thompson, et al., 2017).

A more extensive review of the international hazard literature is beyond the scope of this paper because of the emphasis of much of that literature on voluntary and mandatory evacuation, in the context of evacuation compliance, rather than decision-making choice in which self-evacuation decisions are made, which is the focus of this paper.

Protective decision-making knowledge applicable to other hazards needs to be used to investigate the factors influencing householders' wildfire evacuation decision-making to protect personal safety and property. (Dash and Gladwin, 2007). The Protective Action Decision Model (PADM) discussed later in this section will be used as a conceptual framework for this purpose. Research on protective action decision-making during bushfire and how householders come to decisions is limited (J. McLennan, et al., 2012; J. McLennan, Elliott, Omodei, & Whittaker, 2013) and much of it qualitative. This existing research suggests that householders chose to remain because they believe they can successfully defend their property (J. McLennan, et al., 2012; J. McLennan, Elliott, et al., 2013; J. McLennan, Paton, & Wright, 2015; Whittaker, et al., 2013) while others evacuate due to a perception of risk to personal safety, evacuation advice, and social and environmental cues (J. McLennan, Beatson, & Elliot, 2013; J. McLennan, et al., 2012). Notwithstanding these insights, the factors influencing householders' decisions to remain or evacuate during a specific bushfire event are not well understood (J. McLennan, Beatson, et al., 2013; J. McLennan, et al., 2012). Quantitative research on the factors that predict whether people facing a bushfire threat will evacuate or remain, in a public policy context of decisional choice rather than mandatory orders and evacuation compliance, is not widely reported. Therefore, this paper presents the findings of a study to identify predictors of householder evacuation from wildfire in a context where public policy supports decisional choice rather than compliance with mandatory evacuation orders.

Social psychological theories, primarily expectancy-valence based models (Vroom, 1964) including the theory of reasoned action (TRA; (Fishbein and Ajzen, 1975), the theory of planned behaviour (TPB; (Ajzen, 1991), protection motivation theory (PMT: (Rogers, 1983) and personal relative to event theory (PrE: (Mulilis and Duvall, 1997), have recently had some use in Australian (Beatson and McLennan, 2011; J. McLennan, Cowlshaw, Paton, Beatson, & Elliot, 2014; J. McLennan, Paton, & Beatson, 2015) and international (S. McCaffrey, Toman, Stidham, & Shindler, 2013; S. McCaffrey, Toman, et al., 2014) wildfire research (Trifeletti, Gielen, Sleet, & Hopkins, 2005). These theories provide a useful framework to explain how householders form perceptions of personal risk and take protective responses, to predict and analyse protective action decision-making and identify areas of potential improvement in community bushfire safety policy and practice (Beatson and McLennan, 2011). However these theories do not incorporate environmental and social factors, social context and ongoing social routines which influence “...how individuals and households *arrive at a decision* [emphasis added] to evacuate or not” and specifically “what factors people consider as they make their decisions and how important those factors are in the process”(Dash and Gladwin, 2007, p. 74)

The Protective Action Decision Model (PADM), as illustrated in Figure 1, is based on expectancy-valence theory and incorporates important aspects of it and related theories such as self-efficacy, response efficacy and personal protection responsibility (S. McCaffrey, et al., 2017). Unlike other widely used behaviour models, PADM takes account of situational conditions (M. K. Lindell and Hwang, 2008) including social context, environmental cues and social information as factors that affect the process of decision-making and protective action adoption and is consequently preferred as a theoretical and analytical framework for this paper. The model encompasses environmental and social cues, and warnings (comprising the environmental and social context) (Huang, Lindell, Prater, Wu, & Siebeneck, 2010; M. Lindell, J.-C. Lu, & C. S. Prater, 2005) in householder decision-making, that initiate a “series of pre-decisional processes, that in turn elicit core perceptions of the environmental threat, of alternative protective actions and of relevant stakeholders” (M. K. Lindell and Perry, 2012, pp., p. 617). These perceptions become the basis of protective action decision-making in which decision-makers consider whether a real threat exists, the need for protective action, available protective options, the best protective alternative and the timing of its implementation (M. K. Lindell and Perry, 1992, 2004, 2012). This process in turn generates behavioural responses including information search and emotion- focused coping. Information search continues as decision-makers assess the adequacy of information, identify information sources and

channels, and determine when information is needed, until there is sufficient certainty for a protective decision (M. K. Lindell and Perry, 2012) (c.f. Table 2). In this paper the PADM provides a framework of factors influencing householders protective responses to a bushfire (M. K. Lindell and Hwang, 2008; M. K. Lindell and Perry, 2012) and specifically, the factors that predict short-run hazard adjustment or protective response to an imminent threat i.e. whether they evacuate or remain and defend.

Figure 1. The Protective Action Decision Model here.

Previous research on factors influencing evacuation from wildfire

Much of the international wildfire evacuation literature is based on North American research and focused, within the context of mandatory and voluntary orders, on mathematical modelling of evacuation decision making (T. J. Cova, Dennison, & Drews, 2011), traffic management (T. J. Cova and Johnson, 2002; Wolshon and Marchive, 2007) and evacuation triggers (T. Cova et al., 2016). Communication in wildfire evacuation is addressed, including the importance of reliable information (Steelman, McCaffrey, Velez, & Briefe, 2015; Stidham, Toman, McCaffrey, & Shindler, 2010), householder information needs (S. McCaffrey, Knox Velez, & Briefel, 2013; J. G. Taylor et al., 2007) and the use of social media (Wang, Ye, & Tsou, 2016). Both before and after the ‘Black Saturday’ bushfires, the relevance of the Australian ‘Stay or Go’ paradigm in the North American setting was discussed (Cote and McGee, 2014; S. McCaffrey, Rhodes, et al., 2014; S. M. McCaffrey and Rhodes, 2009; Mutch, Rogers, Stephens, & Gill, 2011; T. Paveglio, Carroll, & Jakes, 2008; T. B. Paveglio, Boyd, & Carroll, 2012). Studies have considered the role of demographic characteristics in evacuation such as gender, age, numbers in the household, income, education and length of residency (Mozumder, Raheem, Talberth, & Berrens, 2008; T. B. Paveglio, Prato, Dalenberg, & Venn, 2014) Studies have considered a range of other factors influencing evacuation decisions, including prior protective action under threat (S. McCaffrey and Winter, 2010), preference for waiting to see how the circumstances of a wildfire develops (S. McCaffrey and Winter, 2010; T. B. Paveglio, et al., 2014), perceptions of risk and intrusiveness, fire experience (Mozumder, et al., 2008), choices to evacuate or shelter in place (T.J. Cova, et al., 2009) and difficulties assessing threat and interpreting information relevant to the decision to evacuate or remain (Cohn, et al., 2006).

Intentions and pre-event plans for protective action are found to influence protective decision-making in Australian bushfires in some studies (J. McLennan, 2014; J. McLennan, Dunlop, Kelly, & Elliott, 2011; Jim McLennan, Elliott, & Omodei, 2011; J. McLennan, Elliott, et al., 2013). Within this context research has identified factors that influence evacuation that include: perception of imminent threat and receipt of official warnings (J. McLennan, et al., 2012); information on evacuation options (Cao, et al., 2016; J. McLennan, et al., 2012; Tibbits and Whittaker, 2007); responsibility for pets or livestock (Smith, et al., 2015; M. Taylor, et al., 2015); and survivability of evacuated property (Whittaker, et al., 2013). While these studies identify factors influencing evacuation, how these factors cohere in the process of evacuation decision-making is largely unexplored. A few studies have examined failure to undertake long-run hazard adjustments, protective response to a future or prospective threat, including property preparation and equipping for wildfire, in influencing evacuation decision-making (J. McLennan, et al., 2012; J. McLennan, Paton, & Beatson, 2015). Those who stay and defend in a wildfire may become self-evacuators due to failure to defend property, physical or emotional incapacity, injury, or failure of equipment (J. McLennan, et al., 2012; Tibbits and Whittaker, 2007).

Findings of a study (J. McLennan, Cowlshaw, et al., 2014) on householders' strength of intention to self-evacuate, using a TPB model, indicated that subjective norms and behavioural controls about leaving, attitudes to leaving as a safe action, and self-determination, were significant positive independent predictors of strength of intention to leave. Attitudes to staying and defending and self-determination were significant predictors of intentions to stay and defend. Using a PMT model the same study identified self-efficacy and response efficacy as significant predictors of leaving, and self-efficacy and susceptibility to threat as predicting the intention to stay and defend. In interpreting these results from the two models, the intention to leave represented an expression of 'true self' rather than being controlled by the bushfire threat, and the intention to remain reflected a commitment to protect property and accept personal risk rather than to protect personal safety. A recent study by McNeill et al (2016) reported that householders intending to evacuate as soon as they were aware of a bushfire threat, perceived survival of their home as significantly less important than those who intended to remain or to delay their protective decision. Home contents and work equipment were also significantly less important for evacuators than those who intended to remain. McNeill et al's study (2016) also found that those intending to immediately evacuate believed they were generally less likely to achieve positive outcomes by defending, compared to those intending to defend throughout or

until threatened, and those who intended to delay their decision. Both authors recognised that a range of factors limited their studies including; geographic specificity, and partial consideration of action expectancies and factors influencing decision-making (I. M. McNeill, et al., 2016); and self-selection of respondents, geographic specificity and the use of single item measures (J. McLennan, Cowlshaw, et al., 2014).

The limitations of research by McLennan et al (2014) and McNeill et al (2016) suggest a need for broadening the understanding of the factors influencing protective action decision-making during a wildfire including evacuating. This paper reports on research into the factors that influenced residents' decisions to self-evacuate in the face of bushfires in three suburbs of the Perth Hills, Western Australia in January 2014 and in townships and surrounding rural areas in the Adelaide Hills, South Australia in January 2015.

Method

Participants

The Parkerville, Stoneville Mt Helena bushfire ignited on Sunday 12 January 2014 in three peri-urban suburbs of Perth approximately 35 kilometres east of the Central Business District. The temperature on Sunday reached 42° C, humidity was extremely low and winds strong and gusty. Although the fire was relatively small, burning 392 hectares, it destroyed 57 homes over a period of 48 hours. No lives were lost. (State Emergency Management Committee., 2014, p. 35). The 2015 Sampson Flat bushfire started on Friday 2 January approximately 30 kilometres north-east of Adelaide burning rural and agricultural regions and threatening townships and small villages. A Catastrophic Fire Danger Rating for the area had been declared with temperatures exceeding 45° C. The fire burnt across areas of woodland, forest, scrub and pasture fanned by strong, rapidly shifting and unpredictable winds. The bushfire was extinguished on 7 January 2015 after it had burned more than 12,500 hectares and destroyed 24 houses and 140 other structures. No lives were lost (Every et al., 2015).

This paper reports data from 457 residents affected by a January 2014 bushfire in Parkerville, Stoneville and Mt Helena in the Perth Hills (n = 217) and in thirteen towns and surrounding rural areas in the Adelaide Hills (n = 240) in January 2015 with an overall response rate of 54% (cf. Table 1). 182 men (40%) and 275 women (60%) aged 18-44

(14%), 45-64 years (60%) and 65 and over (36%) were included. Households without dependents constituted 69% of the total. Of the remainder 69% had dependent children and 31% dependent adults. 12% included a household member with a disability who required assistance or care. Most lived in homes within 100 metres (70%) or between 100 and 500 metres (21%) of bushland. They resided in a home on a residential block (30%), a small acreage (63%) or a large farm (7%).

Table 1 here

Measures

A telephone survey was used to collect data from randomly selected residents living in areas that were directly impacted by the bushfires. The design framework of the survey instrument was influenced by the PADM (M. K. Lindell, 2013, 2014; M. K. Lindell and Hwang, 2008; M. K. Lindell and Perry, 2004, 2012; M. K. Lindell et al., 2015) (cf. Figure 1). The measures used in the survey and the characteristics of the variables included in the model are detailed in Table 2.

Table 2 here.

Procedures

A study of factors influencing householder self-evacuation in Australian bushfire involved randomly selected households with a landline or mobile telephone service listed in the Telstra White pages (the directory of telephone numbers provided by the preeminent Australia telephone network provider), located in the bushfire affected areas of the Perth and Adelaide Hills. Data in Perth were collected between mid-March and mid-April 2014 with the survey commencing approximately two months after the bushfire. Adelaide Hills data were collected in early February, 30 days after the fire, and concluded late March 2015. The lead author completed all 457 telephone interviews.

Data analysis

For the purposes of this research evacuating or remaining (short-run hazard adjustment) during a bushfire is a binary decision that may be predicted by a range of independent variables,

incorporated in the PADM as described in Table 1. The motivations behind these protective decisions which are concealed by this analytical procedure are addressed elsewhere (Strahan, Whittaker, & Handmer, 2018).

Binary logistic regression using SPSS 24 was undertaken that generated a model identifying factors predicting householder evacuation. Variables reflecting an underlying construct not directly measured were created by averaging several measured, or observed, variables (cf. Table 1). A unidimensional factor structure was confirmed for each of these hypothesised higher-order variables involving: principal axis factoring constraining all component item loadings to a single dimension; confirmation of a unidimensional structure using eigen values indicating the dominance of a single eigen vector that accounted for common variance amongst the items; and assessment of factor loadings within the structure matrix to ensure they were all adequately larger than .40. To test the reliability of the variables created, Cronbach's alpha was used to measure the internal consistency of each item.

The Omnibus Test of Model Coefficients, the Nagelkerke pseudo R^2 , the Hosmer and Lemeshow Test and the percentage of group membership correctly classified using the set of predictors, establishing the viability of the logistic model are reported in Table 2.

Two-way factorial ANOVAs were competed to establish the extent that perceptions that a protective action was best for personal safety or for property protection were related to undertaking various long-run hazard adjustments that include property preparation activities, purchase of fire-fighting equipment and having personal protective clothing.

Results

Generating the model

Table 3 summarizes sixteen independent variable statistics including the partial regression coefficients (B), the Wald test, odds ratio ($\text{Exp}[B]$) and the 95% confidence limits (CI) for the odds ratio. The Wald test indicates that the nine highlighted variables and their associated odds in the lower half of the table were statistically significant predictors of evacuating or not evacuating. The odds ratio measures the multiplier effect of one variable on predicting evacuation with all other variables held constant. The final three highlighted variables although

significant, have small odds ratios that do not allow them to be included in the analysis. All remaining variables were not significant predictors of evacuation but contributed to the model outcome, explaining some of the variance of the dependent variable, and to the odds that a householder would decide to evacuate.

Factors in the model

Nine variables predicted evacuating or not evacuating. Perceptions of the effectiveness of evacuating or remaining (hazard related perceptions) were by far the main predictors of evacuation. Householders who felt that their protective action was the best way to protect themselves and their family from the bushfire were significantly more likely to evacuate [Exp (B) = 10.7]. The perception that protective action was the best way to protect property from the bushfire predicted not evacuating [Exp (B) = .05]. Perception that knowledge and skills (resource related perceptions) were needed to carry out protective action predicted not evacuating [Exp (B) = .44] while householders who felt that their protective action was not expensive to implement were more likely to evacuate [Exp (B) = 2.3].

The receipt of official warning messages from the fire authorities [Exp (B) = 4.9] and threat perception, reflected in the likelihood of the bushfire impacting property [Exp (B) = 1.80], were also significant predictors of evacuation. Threat to property appeared to act as a proxy for threat to personal safety based on the logic that if a person was at their property when a bushfire threatened, their personal safety would also be threatened. Householders may have evacuated due to the threat to their personal safety, but this was not a significant predictor of evacuation in the model.

Table 3 here.

Householders' perceptions that the media had a responsibility to protect them, their family and their property predicted evacuation [Exp (B) = 1.2], suggesting that providing evacuation advice was how householders saw the media take responsibility. Their perceptions that the media had knowledge of bushfire behaviour, were informed about the fire, and gave good advice about it, predicted not evacuating [Exp (B) = .72]. Householders' perceptions that their neighbours had a responsibility to protect them predicted not evacuating [Exp (B) = .84].

However, none of the media or neighbour related factors could be included in the model due to their small odds ratios and an a priori power analysis suggesting considerably more cases than were sampled for this research, are required to detect a small effect.

Effect of undertaking long-run hazard adjustments on hazard adjustment perceptions

Whether householders undertook or failed to undertake certain long-run hazard adjustments reflected significant differences in their perception of the effectiveness of evacuating or remaining as demonstrated in the two-way factorial ANOVA's summarised in Table 4. Remainers who had maintained their property, equipped to fight fire or spot fires, had personal protective clothing, or filled gutters with water, perceived remaining as best for protecting property more positively than those remainers who had not undertaken these adjustments. Having fire-fighting equipment or protective clothing also meant these remainers more positively assessed remaining in protecting personal safety than remainers who were not so equipped.

Evacuees who had not prepared fire-fighting or spot fire equipment; had not prepared against fire by moving combustibles or watering around the property; or did not have personal protective clothing, had a more positive perception of evacuating as best for personal safety, than evacuees who had implemented these adjustments.

Evacuees who had not prepared fire-fighting or spot fire equipment; had not prepared the property by clearing around it or covering gaps and vents; or did not have personal protective clothing had a more positive perception of evacuating as best for property protection, than evacuees who had implemented these adjustments.

Table 4 here

Discussion

Perceptions of the effectiveness of protective actions in protecting personal safety or property (hazard related adjustment perceptions), reflecting protective action perceptions in the PADM,

were central to predicting evacuating or not evacuating. The perception that a protective action is best for personal safety or for protecting property predicted evacuating and not evacuating respectively. Resource related hazard adjustment perceptions, the expense of an action or the knowledge and skills required to take the action, had a significant but lesser role in predicting evacuating or not evacuating. Perceptions of the effectiveness of protective actions were significantly correlated with undertaking long-run hazard adjustments, including property maintenance, equipping to fight bushfire and spot fires and having personal protective clothing, which therefore also indirectly influenced evacuating or not evacuating. The PADM does not address the influence of hazard adjustments on protective action perceptions and is the subject of a paper that is under consideration for publication. The receipt of official bushfire warnings (*warning messages* in PADM) was also an important predictor of evacuation that was secondary only to hazard adjustment perceptions. Perceived likelihood of bushfire damaging or destroying property (*threat perceptions* in PADM) was the least influential significant predictor of evacuation. Figure 2 illustrates factors predicting evacuation. Dotted boxes indicate the factors predicting evacuating while cross hatched boxes indicate those that predict not evacuating. The findings presented here are similar to those of a recently published study (S. McCaffrey, et al., 2017).

Figure 2. Factors Predicting Evacuation here.

Hazard adjustment perceptions

Householders' decisions to evacuate or not were predicted by the perception that this action protected personal safety or property or both (hazard-related attributes), required knowledge and skill, and was inexpensive (resource-related attributes). Consistent with Terpstra (2013) these hazard-related attributes were more powerful in predicting evacuation than were the resource-related attributes.

The perceived effectiveness of evacuating or remaining in protecting personal safety or property were the two nuclei around which households' decisions revolved. In the hazard literature concern for personal safety is the best predictor of intended adoption of long-run hazard adjustments while protection of property is of lesser importance (Terpstra and Lindell,

2013). In this study, effectiveness in protecting personal safety is the key to predicting evacuation. Protecting property is even more important in predicting not evacuating. These findings are consistent with those reported in the literature (Cohn, et al., 2006; Cote and McGee, 2014; S. McCaffrey, Rhodes, et al., 2014; I. M. McNeill, et al., 2016). Factors that influence the perception of hazard-related adjustments are themselves extremely important. The literature concludes that hazard-related, more than resource-related, attributes influence hazard adjustment adoption.

North American research on long-run hazard adjustments, that is, preparatory actions and actions directed at defending against wildfire have generally recognised the influence of these actions on perceptions of appropriate protective responses (Cote and McGee, 2014; T. Paveglio, M. Carroll, & P. Jakes, 2010; Winter and Fried, 2000). Studies of factors influencing householder wildfire mitigation behaviour identified perception of wildfire threat (Martin, Martin, & Kent, 2009; McFarlane, McGee, & Faulkner, 2011; McGee, McFarlane, & Varghese, 2009), perceived effectiveness of mitigation measures in reducing damage and lack of financial resources, and self-efficacy and full time seasonal status (McFarlane, et al., 2011). A study of predictors of household wildfire risk mitigation identified information from fire specialist and neighbours, evacuation experience and perceived risk to property as positively associated with higher levels of mitigation (Brenkert-Smith, Champ, & Flores, 2012).

While there is also Australian research on householder preparation and mitigation for wildfires (J. McLennan, Elliott, & Wright, 2014; I. McNeill, Dunlop, Skinner, & Morrison, 2013; Paton, Kelly, Buergelt, & Doherty, 2006; Penman, Eriksen, Horsey, & Bradstock, 2016), few have examined the influence of the adoption of long-run hazard adjustments on the perception of short-run hazard adjustment. Two studies touched on the failure to undertake long-run hazard adjustments, including property preparation and equipping for wildfire, in influencing protective decision-making. They found that few of those who intended to evacuate undertook preparations that would protect their undefended property and those who remained believed

their defence preparations were adequate to meet the perceived threat (J. McLennan, et al., 2012; J. McLennan, Paton, & Beatson, 2015).

Because Australian householders may choose to defend their property while protecting their personal safety, long-run hazard adjustments, including property maintenance and preparation, and equipping for property defence, may be part of their ‘way of life’ or arise out of an ideology of preparedness, reinforcing the need to be prepared in case of a bushfire (J. Becker, Paton, Johnston, & Ronan, 2012; J. S. Becker, Paton, Johnston, & Ronan, 2013). The findings of this paper, that undertaking long-run hazard adjustment influences householders’ perceptions of the effectiveness of their short-run protective responses, are consistent with conclusions in the literature (Cote and McGee, 2014; J. McLennan, et al., 2012; J. McLennan, Paton, & Beatson, 2015; T. Paveglio, et al., 2010).

The two resource-related attributes – the need for knowledge and skill to implement, and the expense of, a protective action, are of lesser importance, but significantly predict the decision to evacuate or not to evacuate. Believing that knowledge and skills were required to evacuate or to remain predicted not evacuating. Both remainers and evacuator who applied knowledge and skill to identify, contemplate and plan aspects of their protective actions were less likely to evacuate. This suggests that in a wildfire event, a defensive stance requires knowledge and skill to remain, in contrast to a non-defendable hazard, such as a hurricane, where remaining may reflect a lack of knowledge or ability to act (Riad, Norris, & Ruback, 1999).

It also suggests that evacuator who had thought through their evacuation may take more considered steps toward evacuation than others who more reactively evacuate. This is consistent with the finding that intended unprepared (reactive) evacuees perceived evacuation as a ‘simple matter’ (J. McLennan, Elliott, et al., 2014).

The perception of evacuating or remaining (short-run hazard adjustment) as inexpensive, in predicting evacuation, suggests that evacuees perceived small or no costs in evacuating but significant costs in remaining. Evacuees may have known they could avoid major costs by staying at the home of a family member or friend, whereas remainers incurred costs in property preparation such as fireproofing structures, removing vegetation, covering gaps where embers could enter, and installing watering systems (Penman et al., 2013). There were also considerable costs in property defence such as the purchase of firefighting pumps, hoses, and

generators and in establishing a reliable water source. The total cost over ten years of adequately preparing a property, estimated at AUD 10,000, was found to be ‘a predictor of whether residents would undertake wildfire specific preparatory actions’ (Penman, et al., 2016, p. 94) confirming householders’ perceptions of the high cost associated with remaining to defend. The findings in the literature on resource related attributes and the adoption of long-run adjustments are not definitive and conclusions have not been drawn, although negative correlations between the two have been hypothesised (M. K. Lindell and Perry, 2012). Findings on the relationship between short-run hazard adjustment and resource related attributes are not reported in the literature. This study found that the perceived lower cost of evacuating predicted evacuation.

Threat perceptions

Both evacuator and remainers interpreted bushfire threat primarily in terms of its likely impact on their home and property as reflected in the significance of the ‘likelihood of impact on property’ variable in the model. If property was likely to be impacted, the personal safety of householders would similarly be impacted unless they evacuated. For this reason, likely impact on property deputised for threat to personal safety while the householder was at their property so threat to personal safety was not a significant predictor of evacuating or not evacuating. Householders’ beliefs that the bushfire was likely to have an impact on their home and property predicted evacuation. Householders’ inability to defend against bushfire due to lack of fire-fighting and personal protective equipment; and failure to carry out property preparation, specifically clearing fuels or combustibles, watering, or covering gaps allowing entry of embers were significantly related to the perception of evacuation as protective of personal safety and property. This may be because of householders’ expectations that the fire services would defend their property in their absence.

The findings reported here, that threat perceptions are related to evacuation and to defensive and preparatory actions are consistent with reports in the literature of the influence of threat perception on long and short-run hazard adjustments (Bourque et al. 2012; Lindell 2013) including evacuation (M. K. Lindell et al., 2016; Sorenson, 2000). The findings are significant because of the limited attention given in the literature to the relationship between threat perceptions and short-run hazard adjustment and the extremely mixed results that have been reported in relation to this for earthquake (Whitney, Lindell, & Nguyen, 2004), flood

(Blanchard–Boehm, Berry, & Showalter, 2001) and tornado (Weinstein, Lyon, Rothman, & Cuite, 2000).

Official warnings

The receipt of an official warning from the emergency authorities was a critical factor in predicting evacuation. Most householders received multiple text warnings on their mobile telephone at heightening levels of urgency, culminating with advice to evacuate, or to prepare to remain and defend against an imminent bushfire threat. The influence of these official warnings on evacuation may have had two key causes. Following the recommendations of the VBRC into the ‘Black Saturday’ bushfires, official text and landline warning messages have been extensively used during emergencies and are now ubiquitous in bushfire events. Both text and landline warnings to alert and advise householders in the Perth and Adelaide Hills bushfires were widely employed.

Heightened awareness of the impact of climate change on the frequency and severity of wildfires globally (Clarke, Lucas, & Smith, 2013; Head, Adams, McGregor, & Toole, 2014; Sharples et al., 2016), and the evidence provided by international media coverage of its impact on natural hazards (Chand, 2017; Escobar and Demeritt, 2014; Ford and King, 2015), may have increased the seriousness of and authority with which official warnings were treated by those who were conscious of the extreme danger posed.

The status of an official warning may also provide it with the authority to influence both the decision to evacuate and when to evacuate. Its social authority separates an official warning from environmental and social cues and information that householders use as inputs to their decision-making process. This is consistent with the conclusions of Steelman et al (2015), citing Slovic (1987, 1993), that source credibility influences receivers’ perception of and response to messages about environmental risk, and Mileti (2006), that householders are more likely to believe and respond to official warnings .

The importance of official warnings, provided in text messages on mobile telephones, in predicting householder evacuation in an Australian bushfire, is a key finding of this study that has not been reported elsewhere in the published literature. The finding is important because in previous studies (Whittaker, et al., 2013) official warnings did not play a significant part in

protective action decision-making. The finding may capture the impact of the change in official warning practices following the ‘Black Saturday’ bushfires and the recommendations of the VBRC. The finding is also significant because Australian literature has reported that the forecast of Code Red or Catastrophic bushfire conditions convinced only a tiny proportion of householders (~2%) to evacuate early from bushfire prone areas (J. McLennan, Elliott, et al., 2013; Whittaker and Handmer, 2010). It is also significant because the North American literature, focusing on hazards other than bushfire (wildfire) and on compliance or non-compliance to mandatory evacuation orders, has reported that ‘household evacuation decisions are being influenced more by the media and other household characteristics than by actual warning’ and risk perception ... (is) the more consistent indicator of evacuation behaviour’ (Dash and Gladwin, 2007, p. 70). It is also significant because, although the hazard literature has identified a wide range of variables that influence, motivate or even trigger the adoption of hazard adjustments (M. K. Lindell, 2013), factors predicting the voluntary choice of evacuation are less well canvassed.

A major study of residents affected by the Black Saturday bushfires (Handmer et al., 2011) and the grey literature (Gilbert, 2014) has reported substantial and growing community expectations that official telephone based warnings will always be provided. The role of official warnings as one of a number of influential evacuation triggers reported in this study is consistent with the literature (S. McCaffrey and Winter, 2010). The continued role of official warnings in encouraging evacuation that has been extensively reported in the literature, depends in part on their providing access to timely, credible, understandable, influential and relevant information and advice (Bean et al., 2015; Drabek, 1986; D. Mileti, ., et al., 2006; D. S. Mileti and Sorensen, 1990b) specifically aimed at enabling householders to make better informed protective action decisions (Cao, et al., 2016; Cube Group., 2014; Ipsos Social Research Institute., 2014).

Implications for emergency services

The findings of this study suggest that the three factors predicting evacuation can be productively used to design more effective strategies to influence appropriate householder self-evacuation behaviour during bushfire. While bushfire safety messaging has consistently emphasised risk, and has attempted to raise householders’ threat perception, the findings of this study suggest a persuasive case for further elevating awareness of and sensitivity to the extreme

danger posed by bushfire. Householders' concern about the impact of the adequacy of their property and personal bushfire preparedness on their personal safety can be harnessed by the emergency services to more effectively encourage them to evacuate quickly rather than 'wait and see' how the bushfire situation develops, as many do, (S. McCaffrey and Winter, 2010; J. McLennan, Beatson, et al., 2013; J. McLennan, et al., 2012; J. McLennan, Paton, & Beatson, 2015; Tibbits and Whittaker, 2007; Whittaker, et al., 2013) and evacuate dangerously late (Rhodes, 2005; Whittaker and Handmer, 2010; Whittaker, et al., 2013). Those who are partially committed to defending their property and retain evacuating as an option (Tibbits and Whittaker, 2007; Whittaker, et al., 2013) may also be influenced. Further, because all householders, to varying degrees, are concerned with both personal and property protection (Strahan, 2017), emphasising the extreme danger posed by bushfire is likely to be broadly influential. The effectiveness of early evacuation in protecting householders' personal safety should be emphasised in official bushfire safety messaging. Official warnings during bushfire can effectively communicate the extreme threat and the effectiveness of evacuation in protecting personal safety. By providing clear, geographically accurate and timely information and advice about the threat and appropriate evacuation options, the high status and credibility of official warnings can be harnessed to promote desirable evacuation behaviour by householders. Further emphasising and making real, the danger caused by failure to act, waiting to see how the fire develops, and subsequent late evacuation is a crucial policy strategy. Official warnings provided as text messages on mobile telephones as reported in this study, are both widely heeded and strongly influence self-evacuation. Their effectiveness should be strengthened by ensuring warnings are up-to-date, detailed, accurate and relevant to the receiver.

Conclusions

This study contributes to the international hazard evacuation literature by providing insights into the factors that predict evacuation from wildfire where householders have protective action choice rather than responding to mandatory evacuation orders. In North America, where mandatory evacuation is practiced (Bonkiewicz and Ruback, 2012; S. McCaffrey, Toman, et al., 2014; T. B. Paveglio, et al., 2010) householders' choice is considerably more limited. However, there has been ongoing discussion of alternatives to mass evacuation (T.J.

Cova, et al., 2009; T. J. Cova, Theobald, Norman Iii, & Siebeneck, 2013; S. McCaffrey, Rhodes, et al., 2014; S. M. McCaffrey and Rhodes, 2009; T. B. Paveglio, et al., 2012). This study informs the theoretical understanding of protective action decision-making by presenting three predictors of wildfire evacuation: perception of the effectiveness of evacuating in protecting personal safety; the receipt of official warnings; and threat to property. It also links firefighting equipping and property preparation with perceptions of the effectiveness of evacuation in protecting personal safety and confirms the influence of preparatory actions on evacuation decision-making (Cote and McGee, 2014; J. McLennan, et al., 2012; J. McLennan, Paton, & Beatson, 2015; T. Paveglio, et al., 2010).

To the extent dispositional factors such as pre-event intentions are less well represented in the PADM than situational factors, its use as a conceptual framework limited this study. By positing householders' protective behaviour as a choice between evacuating or remaining to enable analysis based on binary logistics regression, the differing motivations of evacuees and remainers are not discussed. A recent publication attempts to address this shortcoming (Strahan, et al., 2018)

Responding to a potential bushfire threat requires householders to adjust their daily lives, something they are reluctant to do unless they think it is absolutely necessary (Dash and Gladwin, 2007). This research has established that householders' stasis, in continuing their daily routine, may be disturbed by three key factors that predict evacuation. First, if householders believe their personal safety is best protected by leaving they are more likely to self-evacuate, especially if they have not adequately prepared their property or themselves. Undertaking long-run hazard adjustments influences the decision to evacuate or remain by shaping householders' perceptions of the effectiveness of those actions in protecting personal safety and property. The influence of long-run hazard adjustments on household behaviour needs to be more closely examined through further research.

Second, the receipt of an official warning message, primarily as a text on mobile telephone, also predicts evacuation. Third, the belief that the bushfire will damage or destroy their

property and implicitly, is a threat to their personal safety, also predicts that householders will self-evacuate.

Bushfire education and engagement programs have consistently emphasised the potential threat to personal safety of remaining or of late evacuation. This study reinforces the need for these programs to stress the risk to personal safety from decisions that delay evacuation and result in dangerous, late evacuation. It suggests that further efforts are required to clarify the extent of the risk to personal safety from bushfire and the extreme danger posed by late evacuation. The study highlights the need for householders to recognise that the extent of their bushfire preparations impacts on their safety and for the need to more extensively prepare in advance for evacuation (J. McLennan, Paton, & Beatson, 2015).

There is also currently a unique opportunity to build on the extensive use, acceptance and credibility of official bushfire warnings that prevails within Australian communities. These warnings, especially those delivered by text messages on mobile telephones and audio recordings on landline, currently have the ear and eye of the public. This study suggests that official warnings that provide access to up-to-date, accurate, and detailed information that is relevant to the receiver are likely to be accessed, accepted, and acted upon. Official warnings can be even more extensively used to influence decisions to evacuate and to leave well in advance of an imminent bushfire threat.

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Table 1: Response Rate

	Parkerville, Stoneville, Mt Helena Bushfire (n=1000)	Sampson Flat Bushfire (n=917)
<i>Complete</i>	217	240
<i>Refused</i>	143	54
<i>Not qualified</i>	320	293
<i>Not contacted</i>	320	391
Response Rate	53.7%	54.5%

Table 2: Measures

PADM Element	Question stem	Item	Variable Name	Scale	Construct
Environment and social cues Information source	Which of the following were the main sources of information that you used when you were at home during the bushfire?	<ul style="list-style-type: none"> • Environmental cues – flames, embers and smoke, wind, heat” • Information Radio Television Fire agency (CFS/DSE/DFES) website • Social cues Twitter on my computer Facebook on my computer Family and/ or friends Neighbours Twitter on my mobile Facebook on my mobile 	<ul style="list-style-type: none"> • Environmental cues • Information • Social cues 	0 = <i>No</i> , 1 = <i>Yes</i>	Single item Sum of 3 variables Sum of 6 variables
Warning messages	Did you receive any of the following bushfire warnings from the fire authorities?	<ul style="list-style-type: none"> • Alert – informed that there was a non-threatening fire • Watch and Act – informed there was a threatening fire • Emergency Warning - that you were in danger and should leave or prepare to fight • Emergency Warning - that it was too late to leave 	• Official warnings	0 = <i>No</i> , 1 = <i>Yes</i>	Response of 1 for any variables, recorded as receipt of warning
Threat perceptions	At the height of the bushfire, when you were still at home, how much of a threat did you feel the bushfire was to...? At the height of the bushfire, when you were still at home, how much of an impact did you think the bushfire would have on...?	Your property?	• Threat/ impact on property	1 = <i>No threat / impact</i> 2 = <i>Very small threat/impact</i> 3 = <i>Small threat/ impact</i> 4 = <i>Medium threat/ impact</i> 5 = <i>Large threat/ impact</i> 6 = <i>Very large threat/ impact</i>	Average of sum of two variables
Likelihood of impact	At the height of the bushfire, when you were still at home, how likely did you think it would have the following impacts...?	<ul style="list-style-type: none"> • Damage or destroy your house? • Damage or destroy other property? • Cause death or injury to livestock? 	• Likelihood of impact on property	1 = <i>Very unlikely</i> 2 = <i>Unlikely</i> 3 = <i>Neither likely or unlikely,</i> 4 = <i>Likely</i> 5 = <i>Very likely</i> Not applicable–non-metric	Average of sum of three variables

Short-run hazard adjustment perceptions	I would like you to think about the following statements and tell me if you strongly agree, agree, neither agree or disagree, disagree or strongly disagree with them... 1. Evacuating... 2. Remaining...	<ul style="list-style-type: none"> • Best way to protect myself (and my family) • Best way to protect my property • It is not expensive • I need knowledge and skills 	<ul style="list-style-type: none"> • Best for personal safety • Best to protect property • Not expensive • Need knowledge/ skill 	1 = <i>Strongly disagree</i> 2 = <i>Disagree</i> 3 = <i>Neither agree or disagree</i> 4 = <i>Agree</i> 5 = <i>Strongly agree</i>	Average of each variable
Stakeholder perceptions	Now thinking about your experience of this bushfire and bushfire generally, and the following individuals and organisations, on a scale from 1 to 10, where 1 is <i>not at all</i> and 10 is <i>a great extent</i> , to what extent do you/ neighbours/ media/ Emergency Services	<ul style="list-style-type: none"> • Influence your thinking and what you do during a bushfire? • Have specialist knowledge and understanding of how a bushfire is likely to behave? • Responsible for protecting you (and your family) and your property against a bushfire 	<ul style="list-style-type: none"> • Householder influence actions • Neighbours knowledge • Media knowledge • Neighbours responsible • Media responsible • ES responsible 	1 through 10	Average of each variable
Long-run hazard adjustments undertaken	Before or during the bushfire did you do any of the following things... [Long-run hazard adjustments]	<ul style="list-style-type: none"> • Cleared gutters of leaves • Cleared leaves, twigs and long grass 20 – 30 metres around the house? • Moved combustible materials like firewood or garden furniture away from the house? • Removed bushes close to the house and cut back overhanging tree branches? • Covered all gaps and vents to reduce the risk of embers entering the house or cavities? • Obtained and prepared firefighting equipment like a pump and hoses? • Turned on sprinklers or sprayed your house and surrounding area with water? • Obtained and prepared equipment such as ladder, bucket, and mop to put out spot fires? • Filled gutters with water • Prepared personal items and memorabilia for evacuation? • Prepared a kit of personal protective clothing for each household member? • Moved your car into a position for quick evacuation? 	Long-run hazard adjustments	1 = <i>Before the bushfire started</i> , 2 = <i>During the bushfire</i> 3 = <i>No – neither before nor during the bushfire</i>	
Short-run hazard adjustments (protective response)	Did you at any stage during the bushfire, evacuate yourself (and your family) from your home or did you remain at you home throughout the bushfire?		Evacuate Remain	1 = <i>Evacuate yourself (and your household)</i> 2 = <i>Remain at your home throughout</i> 3 = <i>Other.</i>	

Table 3: Variables in the equation

Variable	B	Wald	Sig.	Exp(B)
df=1				
Environmental cues	-.699	2.319	.128	.497
Social cues	-.350	1.276	.259	.704
Information	-.346	1.523	.217	.708
Threat/ impact on property	.307	1.660	.198	1.359
Householder influence actions	.261	3.257	.071	1.298
Neighbours knowledgeable	.028	.097	.755	1.029
Emergency services responsible	.087	.943	.331	1.091
Best to protect personal safety	2.369	41.102	.000	10.686
Best to protect property	-3.027	71.808	.000	.048
Need knowledge/ skill	-.833	12.615	.000	.435
Not expensive	.836	7.415	.006	2.308
Likelihood of impact on property	.588	5.888	.015	1.800
Official warnings	1.582	7.977	.005	4.865
Neighbours responsible	-.174	3.934	.047	.840
Media responsible	.218	6.859	.009	1.244
Media knowledgeable	-.328	8.303	.004	.720
Constant	-4.101	3.448	.063	.017
Model fit measures: χ^2 (16 N=429) = 393.381, $p < .001$; Nagelkerke pseudo $R^2 = .822$; Hosmer and Lemeshow Test = .503; Classification results: evacuation=93.4%, remaining=91.0%, overall =92.5%.				

Table 4: Factorial ANOVA – Hazard Adjustments

			Moved combustible materials			Cleared gutters			Filled gutters with water			Turned on sprinklers/watered			Equipment for spot fires		
			<i>t test for equality of means</i>			<i>t test for equality of means</i>			<i>t test for equality of means</i>			<i>t test for equality of means</i>			<i>t test for equality of means</i>		
			<i>Mean</i>	<i>(Sig)</i>	<i>Partial Eta²</i>	<i>Mean</i>	<i>(Sig)</i>	<i>Partial Eta²</i>	<i>Mean</i>	<i>(Sig)</i>	<i>Partial Eta²</i>	<i>Mean</i>	<i>(Sig)</i>	<i>Partial Eta²</i>	<i>Mean</i>	<i>(Sig)</i>	<i>Partial Eta²</i>
Best way to protect personal safety	Remain	Did	3.44	.437		3.41	.768		3.48	.611		3.43	.558		3.48	.129	
		Did not	3.31		.008	3.35		.000	3.39		.003	3.33		.007	3.22		.019
	Evacuate	Did	3.97	.025		4.05	.551		3.94	.229		3.95	.015		3.91	.006	
		Did not	4.15			4.00			4.07			4.15			4.14		
Best way to protect property	Remain	Did	4.03	.195		4.05	.026		4.28	.004		4.05	.079		4.07	.049	
		Did not	3.84		.011	3.54		.034	3.86		.021	3.76		.016	3.74		.032
	Evacuate	Did	2.25	.054		2.28	.054		2.20	.164		2.25	.074		2.16	.001	
		Did not	2.43			2.62			2.35			2.41			2.45		

			Prepared fire-fighting equipment			Kit of protective clothing			Covered gaps and vents			Cleared round house			Cleared bushes		
			<i>t test for equality of means</i>			<i>t test for equality of means</i>			<i>t test for equality of means</i>			<i>t test for equality of means</i>			<i>t test for equality of means</i>		
			<i>Mean</i>	<i>(Sig)</i>	<i>Partial Eta²</i>	<i>Mean</i>	<i>(Sig)</i>	<i>Partial Eta²</i>	<i>Mean</i>	<i>(Sig)</i>	<i>Partial Eta²</i>	<i>Mean</i>	<i>(Sig)</i>	<i>Partial Eta²</i>	<i>Mean</i>	<i>(Sig)</i>	<i>Partial Eta²</i>
Best way to protect personal safety	Remain	Did	3.60	.001		3.56	.013		3.51	.291		3.45	.087		3.55	.003	
		Did not	3.03		.047	3.15		.054	3.34		.008	3.05		.009	3.04		.023
	Evacuate	Did	3.93	.018		3.74	.000		3.91	.099		4.04	.540		4.03	.706	
		Did not	4.12			4.16			4.08			4.11			4.06		
Best way to protect property	Remain	Did	4.14	.003		4.15	.002		4.04	.469		4.01	.144		4.04	.089	
		Did not	3.67		.051	3.67		.039	3.93		.011	3.71		.017	3.80		.008
	Evacuate	Did	2.14	.000		2.16	.013		2.09	.001		2.28	.037		2.30	.548	
		Did not	2.45			2.38			2.38			2.63			2.35		

			Prepared fire-fighting equipment			Kit of protective clothing			Covered gaps and vents			Cleared round house			Cleared bushes		
			Partial Eta ²	Mean	t test for equality of means (Sig)	Partial Eta ²	Mean	t test for equality of means (Sig)	Partial Eta ²	Mean	t test for equality of means (Sig)	Partial Eta ²	Mean	t test for equality of means (Sig)	Partial Eta ²	Mean	t test for equality of means (Sig)
Remain	Best way to protect personal safety	Did	.047	3.60	.001	.054	3.56	.013	.008	3.51	.291	.009	3.45	.087	.023	3.55	.003
		Did not		3.03			3.15			3.34			3.05			3.04	
Evacuate		Did		3.93	.018		3.74	.000		3.91	.099		4.04	.540		4.03	.706
		Did not		4.12			4.16			4.08			4.11			4.06	
Remain	Best way to protect property	Did	.051	4.14	.003	.039	4.15	.002	.011	4.04	.469	.017	4.01	.144	.008	4.04	.089
		Did not		3.67			3.67			3.93			3.71			3.80	
Evacuate		Did		2.14	.000		2.16	.013		2.09	.001		2.28	.037		2.30	.548
		Did not		2.45			2.38			2.38			2.63			2.35	

Figure 1. The Protective Action Decision Model. Reprinted from “The Protective Action Decision Model: theoretical modifications and additional evidence,” by M.K. Lindell and R.W. Perry, 2012, Risk Analysis, 32 (4), p.617

Figure 2. Factors Predicting Evacuation

The authors declare no conflicts of interest.