Environmental Science and Policy 81 (2018) 86–94

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

Surviving bushfire: the role of shelters and sheltering practices during the Black Saturday bushfires

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ARTICLE INFO

Keywords:
Sheltering
WUI
policy
bushfire
wildfire

ABSTRACT

The decision of whether to leave or stay and defend is a well communicated public safety policy for those at risk from bushfire in Australia. Advice relating to sheltering practices during bushfire is less developed. This paper presents findings from a study of sheltering practices during the 2009 Black Saturday bushfires. The study examined the circumstances and challenges experienced by residents when sheltering and/or exiting houses, sheds, and personal bunkers. The analysis considered a number of factors including human behaviour and decision making, house design and construction, the surrounding landscape and fire behaviour.

The results show the need for contingency planning and the need for active sheltering, involving regular monitoring of conditions inside and outside the shelter and actions to protect the shelter and its occupants. Also discussed is the tenability and location of the shelters and key questions around how bushfire-related building controls can improve the predictability of shelter failure, reduce the rate of shelter tenability loss and facilitate egress. This research highlights the need for enhanced community engagement and education to encourage residents to plan and prepare for active sheltering.

1. Introduction

Urban development and population growth in the Wildland Urban Interface (WUI) is increasing the exposure of communities to bushfire (or wildfire) risk in many parts of the world (e.g. Gill, 2005; Lampin-Maillet et al., 2010; Theobald and Romme, 2007). In response to bushfire threat, people have the option to evacuate, shelter-in-place or shelter as part of their home defence strategy (e.g. Cova et al., 2009; McCaffrey and Rhodes, 2009; Tibbits and Whittaker, 2007). However, as many studies have highlighted, the decision is not a simple one (e.g. Cova et al., 2009; Handmer et al., 2005; Haynes et al., 2010, 2009; McCaffrey and Rhodes, 2009; Paveglio et al., 2010; Stephens et al., 2009; Tibbits et al., 2008; Tibbits and Whittaker, 2007; Whittaker et al., 2013). Early evacuation has been the preferred option in the United States (US) and in some countries in Europe, but this action is becoming increasingly challenging, and alternatives to evacuation are now being widely considered (Cova et al., 2009; McCaffrey et al., 2015; McCaffrey and Rhodes, 2009; Paveglio et al., 2008, 2010). Early evacuation is not always possible due to an inability to provide early warnings, land use planning and development that is not conducive to swift egress, and dangers associated with mass evacuations such as accidents and traffic jams (McCaffrey et al., 2015). Research on a range of hazards suggests that sheltering during flash floods, cyclones, and radioactive and chemical emergencies may be safer than late evacuations (Haynes et al., 2009; Scanlon, 1992; Yard, 2000).

In Australia, fire agencies have historically encouraged a 'shared responsibility' approach with the objective of developing a range of risk mitigation measures (including self-protection measures) to protect life and assets during bushfires. The fire services have endorsed the 'Prepare, stay and defend or leave early' policy (Australasian Fire Authorities Council 2005, AFAC 2005). Under the policy, residents are advised to prepare, stay and defend their homes against bushfire, or leave before a fire threatens them or blocks their evacuation route (Handmer et al., 2005; Whittaker et al., 2013). The policy, colloquially known as the 'stay or go' policy, drew heavy criticism following the 2009 'Black Saturday' bushfires, which resulted in the deaths of 173 people, 118 of these people perished while sheltering in structures, including 104 in residential buildings (Blanchi et al., 2015). A

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https://doi.org/10.1016/j.envsci.2017.12.013
Received 3 September 2017; Received in revised form 21 December 2017; Accepted 21 December 2017

subsequent Royal Commission into the fires (Teague et al., 2010) concluded that the basic premise of the policy remained sound and specified that "leaving early, before there are fires, is the safest option; staying to defend a well-prepared, defendable home is a sound choice in less severe fires for those who are mentally and physically able". The Royal Commission also recognised that early evacuation is not always possible and recommended that people have contingency plans in the event that they are unable to leave. The Commission identified sheltering as one of the contingencies that people should be prepared for (Teague et al., 2010).

The practice of sheltering during bushfires is not a recent phenomenon in Australia and has been used in rural areas since European settlement (Handmer et al., 2005). Early accounts of sheltering come from people working or living in the bush at the time of the 1939 Black Friday bushfires in Victoria, when people retreated inside structures such as houses, timber mills or dugouts (Stretton, 1939). However, to date, there has been no specific research on sheltering practices in Australia apart from McLennan's report on informal places of shelter used in Black Saturday bushfires (McLennan, 2009).

Research on resident planning and preparation identifies a number of factors and circumstances that may increase the risk to residents taking shelter during a bushfire (Handmer et al., 2005; McCaffrey and Rhodes, 2009; McLennan et al., 2012; Penman et al., 2013; Tibbits et al., 2008; Whittaker et al., 2013). Residents who wait until the last moment before taking action are more likely to be faced with multiple high-risk options ranging from unsafe late evacuation to sheltering in a poorly-prepared structure (McLennan et al., 2012; Whittaker et al., 2009). Buildings and surroundings could be designed to sustain a certain fire exposure and mitigate some of these risks identified. However, variation and unpredictability in fire behaviour make it difficult to characterise the fire exposure and the vulnerability of structures (Blanchi et al., 2014; Cova et al., 2009; McCaffrey and Rhodes, 2009; Paveglio et al., 2008). In addition, there is little research on the compatibility between peoples' behaviour and these measures or their efforts to prepare and maintain structure survivability.

A better understanding of the factors influencing safe sheltering in terms of preparedness, behaviour, types of shelters, response to fire, smoke and vulnerability of the shelter, is needed. Fundamental questions remain regarding residents' knowledge and understanding of safe sheltering practices, the adequacy of peoples' preparation and responses, the adequacy of shelters to withstand the bushfire and the challenges people face when trying to shelter.

In this paper, we examine the following questions:

1. Where did people shelter during the 2009 Black Saturday bushfires?
2. What actions did people take? What risks did they face while sheltering?
3. Is there a relationship between proximity to fuel, or fire severity, and the residents sheltering experiences?
4. What other factors influence shelter survival during a bushfire?

Much can be gained from a better understanding of resident sheltering and egress experiences in combination with a better understanding of how house design and fire severity influence the modes and rates of loss of house tenability. In this study, particular attention has been given to understanding how global parameters such as fire severity, exposure to heat, fire and smoke; and the type and vulnerability of the shelter relate to the perceptions, behaviour and conditions experienced by residents.

2. Methods

2.1. Objective

The work presented here was part of a broader study focused on the sheltering experiences of people affected by the Black Saturday bushfires on 7 February 2009 in Victoria, south-eastern Australia. The broader study used both quantitative and qualitative analyses of sheltering practices. This paper focuses mainly on the quantitative analyses; results of the qualitative analyses are presented in Whittaker et al. (2017). While the Black Saturday fires may be considered an extreme fire event, the data was chosen because it covers a variety of demographics (urban, peri-urban, rural areas), has a significant amount of consistent data available and removes variation in fire weather, operational procedures, policy and guidelines.

A spatial database was specifically developed to facilitate the quantitative analysis. This dataset included tabular data stored in a Microsoft Access database and associated spatial data stored in the Geographical Information System (GIS) software ESRI ArcGIS. A large amount of information on the 2009 bushfires was available to determine accurately the spatial location of the people and shelter(s). A high accuracy level was obtained for most of the cases (precision of ± 10 m). The database contains 325 incidents involving 169 fatalities and 861 survivors. Some of the spatial locations could not be identified and the data associated with those locations are not included in the spatial analysis (n = 169 fatalities, n = 838 surveyed survivors location(s)).

2.2. Data sources

The sources of data used included witness statements presented at the Victorian Bushfire Royal Commission (VBRC, Teague et al., 2010), semi-structured interviews conducted by the Bushfire CRC Research Taskforce with residents in affected areas (Whittaker et al., 2009), a dataset containing bushfire related life and house loss (Blanchi et al., 2012) and other available information from books, reports, journals and personal accounts that are publicly available.

The location of people was recorded utilising available geo-registered high-resolution aerial photography and existing spatial datasets (Blanchi et al., 2012). Information on house locations was obtained from the life loss database (Blanchi et al., 2012), the Bushfire CRC Research Taskforce 2009 bushfire survey (Leonard et al., 2009) and the National Exposure Information System (NEXIS) database that was developed by Geoscience Australia (Nadimpalli et al., 2007).

In addition, other data were also included such as distance and density of surrounding forest using the National Carbon Accounting Forest dataset (Furby et al., 2009). Surrounding vegetation was characterised by the Dynamic Land Cover Map (Lymburner et al., 2011) and the Ecological Vegetation Class (EVC) dataset. A fire severity layer was produced for the Kilmore region (Cruz et al., 2012) and further vegetation characterisation was derived from the vegetation layer developed for this specific study.

2.3. Data collection and analysis

Initial analysis through word searches of the 611 (total) interviews revealed that 315 contained references to sheltering. These interviews were used for this research. All transcripts of evidence from lay witnesses (100 witness statements) and hearings presented to the VBRC were considered in this study together with any associated material such as photography or documentation provided by the witnesses (Teague et al., 2010). Half of the witness statements (50 cases) described sheltering practices and experiences during the fire and were included in this study. Data were collected for a number of variables (Table 1).

The intentions and actions of people involved in sheltering and descriptions of the circumstances of sheltering were recorded as free text. Where available, data were collected on the number of people, and whether they survived or perished while sheltering.

The geographic location of the originating residential address and place of shelter(s) was recorded for each individual (where possible) using Google Earth and Geographical Information System (GIS)