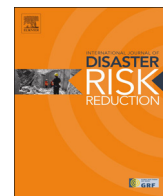




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## How much does it cost residents to prepare their property for wildfire?

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## ABSTRACT

Wildfire has resulted in significant loss of property and lives. Residents can improve the probability of survival of structures and themselves by undertaking suitable preparation. Only a small proportion of residents adequately prepare for wildfire with monetary and time costs cited as significant impediments. Few studies have quantified the monetary and time costs for residents to prepare. Here we use an online survey to estimate the extent to which cost drives the probability of a resident undertaking preparatory actions. Cost was found to be a significant driver if preparatory actions were being undertaken primarily for wildfire, but not if the preparatory actions were partially or primarily for other purposes, e.g. landscape maintenance. Approximate average costs for a resident to prepare for wildfire was \$AUD 10,000, with a subsequent annual maintenance cost of \$AUD 1000. Largest costs were related to altering landscaping features, e.g. fencing, positioning of garden beds. The paper argues that risks from landscape features could be reduced through further development of guidelines or standards for building in fire prone landscapes. Overall, two primary factors were found to predict the extent of preparation of a resident – planned future actions and their risk perception. Residents who intend to evacuate in the event of a wildfire are less likely to prepare than those that plan to stay and defend, which points to a problematic gap between official advice to prepare regardless of intended actions and public tendencies to only prepare if they intend to stay and defend.

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## 1. Introduction

Wildfire (or ‘unplanned fire’) has resulted in significant loss of property and lives in most fire prone regions of the globe [21,25]. In 2007, wildfire resulted in the loss of over 2200 houses in California, USA [31] and approximately 850 buildings in Greece [4]. The Black Saturday fires in Victoria, Australia in 2009, resulted in the loss of more than 2000 houses [1,27]. In 2010, a series of wildfires across Russia destroyed more than 2000 houses [49]. Fire management agencies attempt to protect property and lives with fire suppression resources, but there are simply insufficient funds and resources to protect every house from destructive wildfires [23,24].

Residents can improve the probability of survival of structures and themselves by undertaking suitable preparation [54,61,63,7]. Adequate preparation involves preparing and maintaining the house and grounds, purchase and maintenance of equipment and

the development of an appropriate survival plan [38,47]. Preparing the house and grounds reduces the fuels on and around the structure(s) to decrease the probability of the structure igniting from embers and to reduce the severity of fire behaviour on or around the structure [21,22,33,7]. Equipment may primarily be required by those residents that intend to actively defend their property from fire. However, it is desirable for all residents in fire-prone lands to have safety equipment in case they are unable to leave early and are required to shelter in place [20]. A survival plan guides decision making processes on the day(s) of a fire [42,9] by pre-identified actions and assigned roles for all individuals in the household based on triggers. Survival plans that have been written down, discussed and practiced with all household members are recommended for all households regardless of whether the intention is to leave early or stay and defend their structure [18,2]. Adequate planning to account for multiple contingencies may be required due to the highly variable nature of wildfire [11,42,62]. This may include identification of a place of last resort [58] that residents can safely access.

Studies have found that only a small proportion of residents adequately prepare for wildfire [37,44]. One of the key factors that

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limits adequate preparation by residents for wildfire is the significant cost and time commitment involved. In making the decision to prepare, a resident must determine whether the money and time spent will provide a sufficient return for their investment. Some residents elect not to prepare, as they do not consider the risk to be severe enough to justify the expense in terms of time or money [19,33,45,6]. Some individuals do not directly invest in preparation as they believe the property will be adequately protected by fire suppression or replaceable with disaster recovery funding or insurance [15,35,5,64]. The small proportion that elect to invest to some extent in preparation tend to implement only the lowest cost actions [32,58,9], without necessarily changing the probability of survival for the property.

To our knowledge, there have been no studies which estimate the short and longer term costs of preparation for residents. This is despite the evidence that costs are an important factor in the decision of residents to prepare for wildfires. One of the limiting factors has been the lack of research that defines property preparation in adequate detail [39,50], which affects the possibility of estimating the costs involved. Recently, a comprehensive definition of preparedness for wildfire has been developed [47] using a 'point of failure' model, which is commonly applied in engineering scenarios. These models work by having a single point of failure to stop the system, i.e. unless a resident fulfils all criteria they are considered to be insufficiently prepared. Using these definitions, we are able to quantify the minimum time and costs of preparation for wildfire.

In this paper, we use results of an online survey to examine monetary and time costs to residents in adequately preparing their property for wildfire. Firstly, we test the hypothesis that cost influences the probability of a resident undertaking a specific preparedness action for wildfire. Secondly, we estimate the immediate costs of adequately preparing for wildfires for 607 houses in at-risk communities in Australia. Thirdly, we use these calculations to identify the factors that influence the level of preparedness of residents living in fire-prone landscapes. Finally, we use the results of these analyses to discuss cost-effective strategies that may improve the level of preparedness in at-risk communities.

## 2. Methods

Our study was based on data collected through an online survey of Australian residents during the 2012–2013 fire season. This survey covered a range of topics, including type of property (rural, urban, interface), property exposure (location, access, vegetation), perception of risk, personal level of wildfire preparedness, plan of action, direct personal wildfire experience, and social, environmental and lifestyle values. Rating questions were measured on a Likert scale, using five- or six-level items from 'strong agree' to 'strongly disagree', 'extreme' to 'no threat', 'excellent' to 'poor', and 'very high' to 'very low'. Survey participants were also asked to tick off completed items on a full list of the preparedness actions defined by [47] (Table 1). Circulation of the survey occurred through the email lists and social media of community engagement groups of the fire management agencies throughout Australia, social media of the authors and their institutional affiliations, and additional media coverage in the states of South Australia and Tasmania. We anticipated a biased survey sample as the distribution of the survey was through fire agency networks. The result of this is that the sample represents an optimistic scenario as individuals responding are considered engaged in the fire management scene.

Time and direct monetary costs for preparation were estimated for all preparation actions. Actions were considered to have a one-off cost (e.g., the replacement of combustible outdoor furniture), recurring costs (e.g., tidy yard), and many had both. For example, the purchase of a diesel pump has both a one-off purchase cost and recurring costs of fuel and maintenance. Time costs were allocated as \$AUD 200 per day for an 8 h working day. Where a householder or contractor may undertake the work, costs were estimated for both and the cheapest cost was included. Contractor hourly rates varied according to the company and the nature of the work. Values were estimated for a 1000 m<sup>2</sup> house block with a 20 × 10 m<sup>2</sup> house for a ten-year period. We calculated separately a monetary cost and a time cost, which were also summed for a total cost. Costs are presented in Australian dollars (hereafter \$) unless otherwise specified: at the time of writing one Australian Dollar was \$US 0.92 or € 0.70 (<http://www.ozforex.com.au/>, Accessed September 2013).

The probability of an action being undertaken was analysed using a generalised linear model with a binomial distribution. The

**Table 1**

A summary of the preparedness attributes for houses in the ember zone. For full details and justification see [47].

Group	Justification	Requirements
Survival planning	Guides decision making on the day of the fire.	A written fire survival plan with identified roles and communicated actions, multiple contingencies and identified place of last resort.
Equipment	These will help the resident protect themselves and their property in the event of a fire.	A battery powered radio, water vessels with combined capacity > 300 L, hoses to reach around the structure, spare hoses, multiple water points, rake & spade, and bucket & mop.
Personal protective equipment	These protect the resident from the dangers of the fire	Goggles, helmets, boots, dust mask, clothing, gloves and woollen blanket
Property design	Adequate design of the property minimises the risk of fire reaching the houses	Gutter protection, underfloor and underdeck spaces enclosed, wooden fences and brushwood fences away from the house, no sleepers within 1 m of the house, no dry lawns within 1 m of the house, no flammable mulch within 2 m of the house and no shrubs within 2 m of wooden or glass features
Property maintenance	Minimising or reducing flammable materials in, under or around a structure reduces the chance of ignition	A 2 m gap between tree branches and the ground, gutters clear or leaves and twigs, no trees overhanging the roof, underfloor and underdeck spaces clear of leaves and twigs and roof maintained.
Heavy fuels	Heavy fuels pose a significant threat to properties in the event of a bushfire. Proper maintenance and storage can significantly reduce the risk of a property igniting.	Flammable liquids stored in sheds > 6 m from the house, release valves of all gas bottles facing away from the house, BBQ gas bottles stored securely, no combustible doormats, no wooden outdoor furniture within 2 m of the house or wooden decks and no woodpiles adjacent to the structure.

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