A STATISTICAL ANALYSIS OF BUSHFIRE PENETRATION INTO PERI-URBAN AREAS

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INTRODUCTION

Bushfires are a serious threat for land managers and property owners. Over the last few decades this threat has expanded as a result of increased peri-urban and rural development. Many factors affect the probability of house survivability. Wilson and Ferguson (1986) identified that fireline intensity and the presence of homeowners were the two most critical factors influencing house survival.

Peri-urban areas of Australia contain an inherent risk of fire damage to values and assets. Heavy fuels abutting the peri-urban area initially expose structures to flames, radiant heat, and embers that can rain down on homes over a wide area. In this study, eleven major historical fires were investigated to establish risk profiles of houses adjacent to vegetation.

STUDY DESIGN

Using case study information and post-fire aerial images, a set of distance, fireline intensity and bark hazard based statistics to quantify the fire penetration and damage of peri-urban areas was developed.

The relationships between house loss (Y) and the independent variables, intensity (I_B), bark hazard, and distance from the nearest forest (d) was modelled. Y was a binary variable taking the values 0 (no loss), and 1 (loss) for which a binomial distribution was assumed.

The probability of house loss (π) was modelled using a Generalised Linear Model with the logit link function:

$$\log(\pi/(1-\pi)) = \eta = \alpha + \beta_h + \gamma[f(I_B)] + \kappa d$$

Where α, β_h, γ, and κ are constants determined by regression, h denotes a bark hazard level and f(.) is a function of (either log or the identity function). Here, log refers to the natural logarithm (base e).

METHOD

The centroids of all houses up to 1 km away from the burnt vegetation boundaries were digitised along the appropriate wind direction for each case study. As part of the validation, the distance between houses and the vegetation boundary was plotted against the percentile of destroyed houses and compared to past studies (Ahern and Chladil 1999; Chen and McAneney 2010) (Figure 1). Bark hazard ratings were used from the Victorian fuel hazard GIS layer in conjunction with the Victorian fuel hazard assessment guide to determine the ember potential of vegetation.

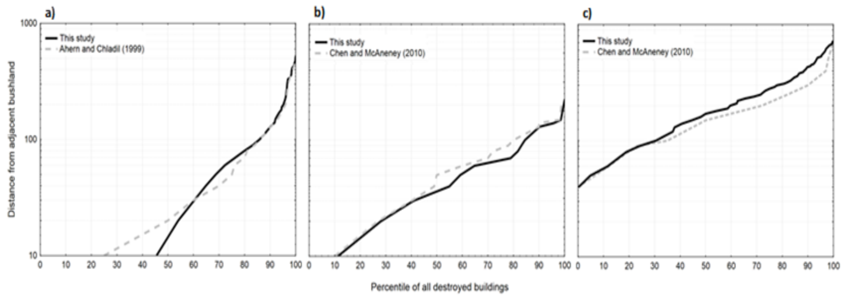

Figure 1. Some examples of the cumulative distribution of buildings destroyed in relation to distance from nearby bushland for a) Otways b) Como-Jannali c) Canberra. The solid lines are the distributions derived from this study, and the dashed grey lines represent those reported from previous studies. The number of samples from this study and previously reported values (in parentheses) for each of the sites are a) 684 (648) b) 71 (76) c) 312 (206).

RESULTS AND DISCUSSION

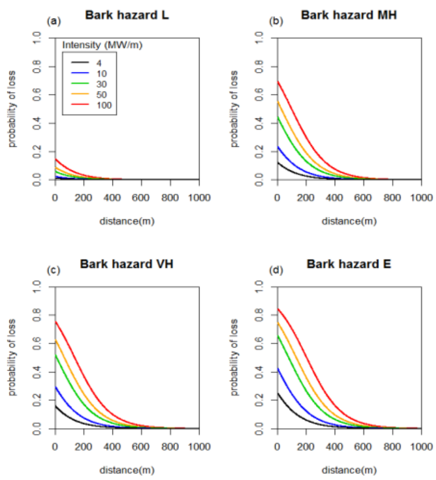

Figure 2. Plots of the probability of loss versus distance from forest for levels of intensity and at each bark hazard level (a) Low (b) Medium/High, (c) Very High, (d) Extreme.

Plots of the probability of loss versus distance from forest for different levels of intensity and at each bark hazard level are given in Figure 2. It can be seen that the probability of house loss increases with intensity and decreases with distance from the vegetation. The probability of house loss also increases with increasing bark hazard level. The bark hazard level of Low had large confidence intervals as a result of the small number of observations for this level (295) compared with the size of the data set (7265).

The model effectively incorporates localised and landscape scale bushfire attack processes of radiant heat and ember attack, providing a model to predict the risk of house loss when a fire does encroach on communities. Not surprisingly a number of studies have found that house loss decreases with distance from the vegetation (Gibbons *et al.* 2012; Price and Bradstock 2013). In addition, our results suggest that the dominant fuel type within 1 km of houses strongly influence the probability of house loss.

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