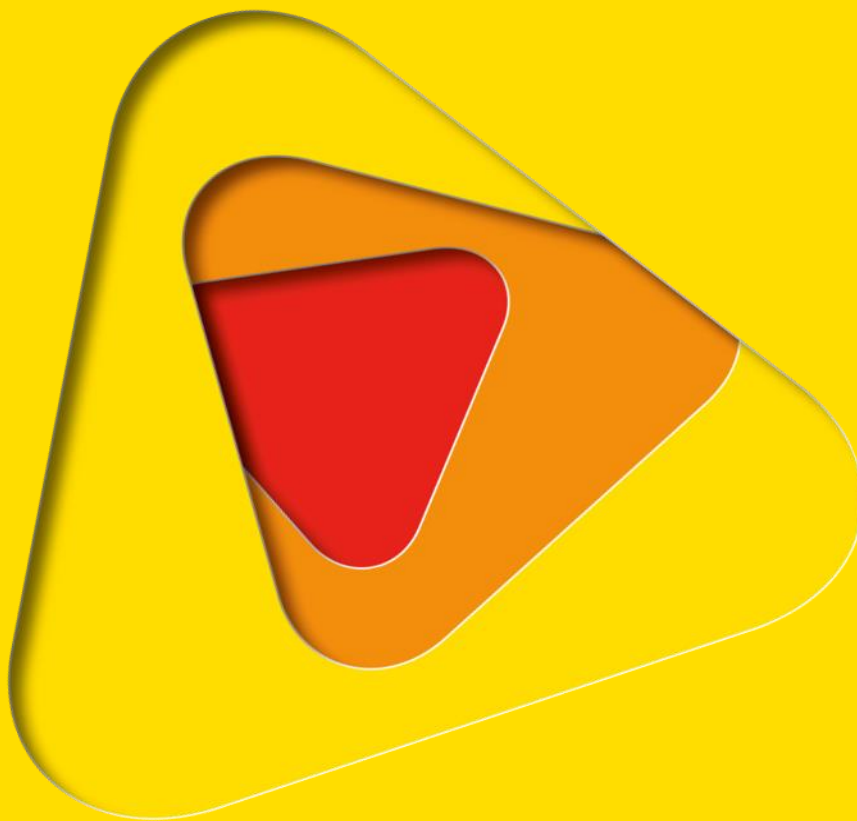# NSW RFS BUSH FIRE HOUSEHOLD ASSESSMENT TOOL

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M. O'Halloran
NSW Rural Fire Service

Corresponding author: melissa.ohalloran@rfs.nsw.gov.au

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ABSTRACT

The web based NSW Rural Fire Service Bush Fire Household Assessment Tool provides advice to the community to assist with making an informed decision on whether it is safe to stay and defend their property. The new website is based on an extensive body of scientific knowledge and has been developed via a successful partnership between NSW Rural Fire Service and the Centre for Environmental Risk Management of Bushfires at University of Wollongong.

A Bayesian Network has been implemented as the modelling framework to underpin the tool. The first step of the model calculates the Radiant Heat Flux to determine if the location and the structure are adequate to protect people to safely shelter in place. A Bayesian Network is used to assess responses for critical elements of preparedness developed from published expert knowledge. The model also assists NSW Rural Fire Service staff in assessing development applications and adequacy of existing controls for community protection plans.

The complexity of the model is not visible to people using the website. A member of the public will access the website and enter their property address triggering a series of spatial queries to determine the direction of greatest bush fire risk and the characteristics of the risk posed. A series of questions relating to the construction of their house, their personal capacity to defend, the available equipment and the conditions of the grounds of the property are then used to determine their capacity to defend their property. The automated calculations and interactive graphics provide visual assistance with answering critical but often poorly understood questions.

INTRODUCTION

A resident's decision to leave early or stay and defend a well prepared home is complex and may be difficult for an individual to decide without expert advice. The web based NSW Rural Fire Service (NSW RFS) Bush Fire Household Assessment Tool provides specific advice to the community about whether their personal circumstances are adequate for them to safely stay and defend their well-prepared home in the event of a bush fire.

The website provides support to the resident to undertake a self-assessment and determine whether they can satisfy the many criteria required to be able to safely defend their home. The website provides guidance throughout the assessment, and the questions demonstrate the variety of physical as well as personal aspects that need to be considered to defend a home from a bush fire.

The first iteration of a self-assessment website was developed in response to the recommendations from the Victorian Bushfire Royal Commission in 2009. NSW RFS built an initial assessment tool however it was quite simplistic and only considered some of the elements important in preparedness. The informal feedback received suggested it was difficult for the community to interpret and understand. The website statistics indicated that many people that commenced the assessment did not continue to the final page of the assessment. The focus of this project has been to incorporate a wider range of considerations based on contemporary research and expert opinion.

In many cases people do not leave early but wait until a severe threat is realised (McLennan 2012) and those that stay are not adequately prepared. One of the aims of this tool is to demonstrate to the public the many aspects required to preparing your home. The model requires all of the key

areas to meet the criteria to be safe to stay and defend a home, achieving most of the criteria is not an acceptable outcome. House survivability can be increased when residents are present to defend a home (Blanchi 2008) but this should only be considered when the resident is adequately prepared and understands the risk.

METHOD

The assessment in the Bush Fire Household Assessment Tool has three initial models to determine if a resident is adequately prepared to defend their home. The calculations for the bush fire exposure of the property, the vulnerability of the house construction and the preparedness of the household are then combined for the final outcome. The initial premise of staying to defend a home is that the property needs to be of suitable construction for the bush fire exposure to provide protection for the resident to shelter in place as the fire front passes. The model intentionally prioritises the safety of the resident over the survival of the home.

FIGURE 1 - CONCEPTUAL MODEL FOR DETERMINING WHETHER IT IS SAFE TO STAY AND ATTEMPT TO DEFEND FROM PENMAN ET AL. 2013

The bush fire exposure is determined by calculating the radiant heat flux the property could be exposed to in the event of a bush fire. The calculations for have been redeveloped for this model from AS3959:2009 Construction of Buildings in Bushfire Prone Areas. These calculations are also used by NSW RFS to assess the Bush Fire Attack Level (BAL) for development applications in bush fire prone areas and the Bush Fire Threat areas for the Survival Map of a Community Protection Plan. Any tools developed in the future to support these business processes will use the same model for calculating radiant heat.

The radiant heat flux model is based on a 1 in 50 year fire scenario as defined in Planning for Bushfire Protection 2006. This identifies the relevant fire danger index (FDI) value to input to the model that represents the weather scenario that would be expected in a fire of this scale. The values for the Sydney Region are an FDI of 100, whereas other areas of the State such as the North Coast of NSW have a lower FDI value of 80. On days with a catastrophic fire danger rating (an FDI of over 100) leaving early is the only recommended action for all residents regardless of house construction or

preparation. The site condition inputs to the radiant heat flux model include the distance between the structure and the vegetation, the type of vegetation and the slope under the vegetation. The type of vegetation is used to depict the fuels that may be present in close proximity to the property and provides a description of the fire behaviour that may be experienced.

The Radiant Heat Flux model uses the site specific inputs to determine the bush fire exposure in four categories relating to type of bush fire conditions the house could potentially incur. These are:

- Flame contact
- Radiant heat exposure
- Ember impact
- No fire

To determine if the property is appropriate for the resident to shelter in place as the fire front passes the model requires the bush fire protection construction standard of the house to determine if it is adequate for the bush fire exposure. In NSW, the construction standard AS3959: Construction of Buildings in Bushfire Prone Areas has applied to all new houses been built since 2003 in bush fire prone areas. All houses built prior to 2003 and outside of bush fire prone land are assessed in the model as being built to a low construction standard for bush fire protection and may only provide adequate shelter if the property is exposed to ember impact.

If the property exposure is assessed as being within the flame zone (as described in AS3959-2009) the resident is unable to continue with the online assessment due to unacceptable risk and is only able to access the leave early reporting materials. This trigger is in place to ensure the resident is aware that there are no circumstances where it would be recommended for a resident choose to stay and defend a home.

For areas potentially exposed only to ember impact, the risk of exposure reduces with increased distance from vegetation. A low risk calculation has been applied to the model where the property is at a distance greater than 350m from bush fire prone vegetation. Beyond this distance, the risk to a resident is considered to be sufficiently low that they would are unlikely to experience the impacts of fire. This distance accounts for 99% of all reported historical house losses (Ahern and Chladil 1999, Chen and MacAneney 2010). If a resident in a low fire risk area enters an assessment a message will appear highlighting that the risk is sufficiently low that there are no circumstances where the resident is recommended to leave their property early due to the risk of fire impact. The resident can still continue the assessment to consider elements of preparedness where fire protection can be improved. The model does not consider other reasons why a resident may leave an area impacted by a bush fire early such as concern for health impacts from smoke or risk to travel routes for isolated communities.

Where the model has determined that the property and the bush fire exposure is adequate for the resident to safely stay and defend, the preparedness level is tested. The elements of preparedness were determined by an expert panel selected for their knowledge in specific areas of bush fire preparedness. The elements identified by the panel were based on published and grey literature. The results of the expert workshop that underpins the preparedness model of the Bush Fire Household Assessment Tool have been published in the International Journal of Disaster Risk Reduction (Penman *et al.* 2013).

The model divides the capacity to defend into three categories of preparedness these are personal capacity, equipment required for firefighting and the conditions around the grounds. Each preparedness element within the model were analysed to determine if it was required for all of the bush fire exposure categories. For example personal protective clothing is required for all residents attempting to defend a home from bush fire regardless of the exposure, however having access to multiple water points around a property is only required by the model where the exposure is flame contact or radiant heat. When the bush fire exposure is from embers only the movement around the property to access water points should not be restricted.

Within the model the personal capacity component includes mental and physical capability of the resident, criteria addressing dependents that may influence capacity to defend and elements relating to the planning elements of preparedness.

Equipment required for defending a home includes items of personal protective clothing for each person that would be defending the property, tools to put our fires and a range of items associated with the access and distribution of water. While these items are of primary importance if the resident is likely to stay and defend a property, they may also assist fire fighters or neighbours to defend the home in the absence of the resident.

The landscape conditions immediately around the house are a significant predictor of house loss (Gibbons 2012). The vegetation and other items that may act as fuels are an essential component in considering how fire may transfer from the main fire to vulnerable elements of the house. Heavy fuels adjacent to the house may increase the fire intensity beyond the construction standard the property has been designed for. The potential sources of fuels considered in this model are classified into property maintenance such as clearing gutters of leaves and twigs, landscape elements such as combustible fencing in close proximity to the house and the presence of heavy fuels such as woodpiles or outdoor furniture.

The assessment questions provide defined distances for items relating to the condition of the grounds that pose potential fire risk exposure. These figures have been defined in this research and are not provided in existing NSW RFS community engagement material such as the Bush Fire Survival Plan. The preparedness model treats all elements with equal weighting as there is insufficient evidence to provide accurate probabilities.

DISCUSSION

The Bush Fire Household Assessment Tool website packages the model components into a user friendly site with automated spatial calculations and graphical depiction of all elements of the model. This provides guidance to the resident throughout the assessment process.

The spatial calculation determines the direction and extent of the greatest fire risk by calculating the distance to vegetation, the vegetation type and the slope. These features are often difficult for a resident to quantify therefore the initial spatial calculation provides a valuable starting point. The automated calculation will translate the input values to determine the fuel and topographic features in all directions and distances. The greatest risk may not be posed by the closest vegetation or the direction the resident is most commonly concerned about. The values can be updated by the resident if they are able to provide more accurate property level data. Many of the underlying

datasets have variable spatial accuracy or are not sufficiently detailed to account for small scale variation in data, so it is essential that the calculated figure be reviewed.

Throughout the site, meters reminiscent of the highly recognisable fire danger meter are used to indicate the status of each section of the assessment. The meters identify which elements have a significant effect on the assessment outcome, each step needs to meet the criteria for the final assessment to recommend that a resident can safely stay and defend their home.

All preparedness questions are presented independent of the initial bush fire exposure calculation except where the bush fire exposure has been calculated as flame zone. The results of the assessment questions may not affect the assessment outcome in lower fire exposure areas, however all the elements are triggers for positive actions of preparedness and may provide opportunities for improved preparedness. The assessment process can be used to provide guidance on achievable actions to reduce bush fire exposure and increase the survivability of a home regardless of the intention to stay and attempt to defend a property or leave early.

The household assessment identifies the existing elements of preparedness and can be used to identify areas of weakness in preparedness. Throughout the assessment all questions with achievable preparedness actions ask a follow up question if the resident indicates that the conditions are not currently met. Items such as mental preparedness or access to reliable mains water are elements that are unlikely to be modified prior to the fire season. From the follow up questions, the resident is able to develop an action plan to assist with improving their preparedness regardless of their decision to leave early or stay and defend their property. The list is presented as a 'to do' list for all actions the resident indicated they are willing and able to undertake prior to the fire season such as ensuring there are fresh batteries for the portable radio or activities that need to occur on all high fire danger days such as move combustible outdoor furniture away from the house.

The resident can return to the site via an email link to complete or update existing assessments. The email link or the printed reports can be shared with family members, neighbours or friends as the starting point for developing Bush Fire Survival Plans. The final assessment links to relevant NSW RFS literature on the public website and provides a summary report of responses.

The Bayesian model allows for individual components of the model to be updated and modified as new research and data becomes available. Future enhancements may incorporate data from the post fire Building Impact Assessment programme to provide weightings for the elements of grounds conditions that are most often present when homes are destroyed. The flexible model design will be incorporated into a range of NSW RFS planning functions, the present website interface has been specifically designed to support current NSW RFS community messaging. Residents will be encouraged to revisit the website on an annual basis to ensure the assessment outcomes are still relevant. The model could be modified to provide advice using forecast weather conditions for a specific location, this advice could provide detailed information on the potential fire conditions for that day.

The model will be used by NSW RFS staff and volunteers while undertaking community engagement activities with individuals or groups within the community. The graphics throughout the website can be used to visually demonstrate a bush fire risk scenario. The Bush Fire Danger Assessment can be used iteratively with the Household Construction page to show the relative effect of slope, vegetation type, set back distance and construction standards on the bush fire risk. The online site

assessment process will generate discussion and allow NSW RFS members to provide site specific advice.

CONCLUSION

The self assessment tool provides many prompts for preparedness that highlight to the community the many aspects to being adequately prepared. This tool is best used to start a conversation with family, neighbours, community and NSW RFS members on how best to prepare and what triggers to use for decision making.

The assessment tool reflects evidence from past fires that it often only takes one point of failure for a house to be lost in a bush fire. The relatively small proportion of properties constructed to comply with the Australian Standard 3959-2009 compared with number of properties in bush fire prone area will be the trigger for many well prepared residents to be advised that the only option is to leave early in the event of a bush fire. The outcome of the self assessment is based on a theoretical one in fifty year event, therefore it is potentially a conservative answer and may recommend some people leave early when the actual conditions on the day of a fire in their area may be adequate for them to safely stay and defend.

The Bush Fire Household Assessment tool is presented as part of a range of tools available to the community on the NSW RFS public website. The results of the household assessment will assist the community when completing their Bush Fire Survival Plan and hopefully support better decision making on what actions to take in the event of a fire.

ACKNOWLEDGEMENTS

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