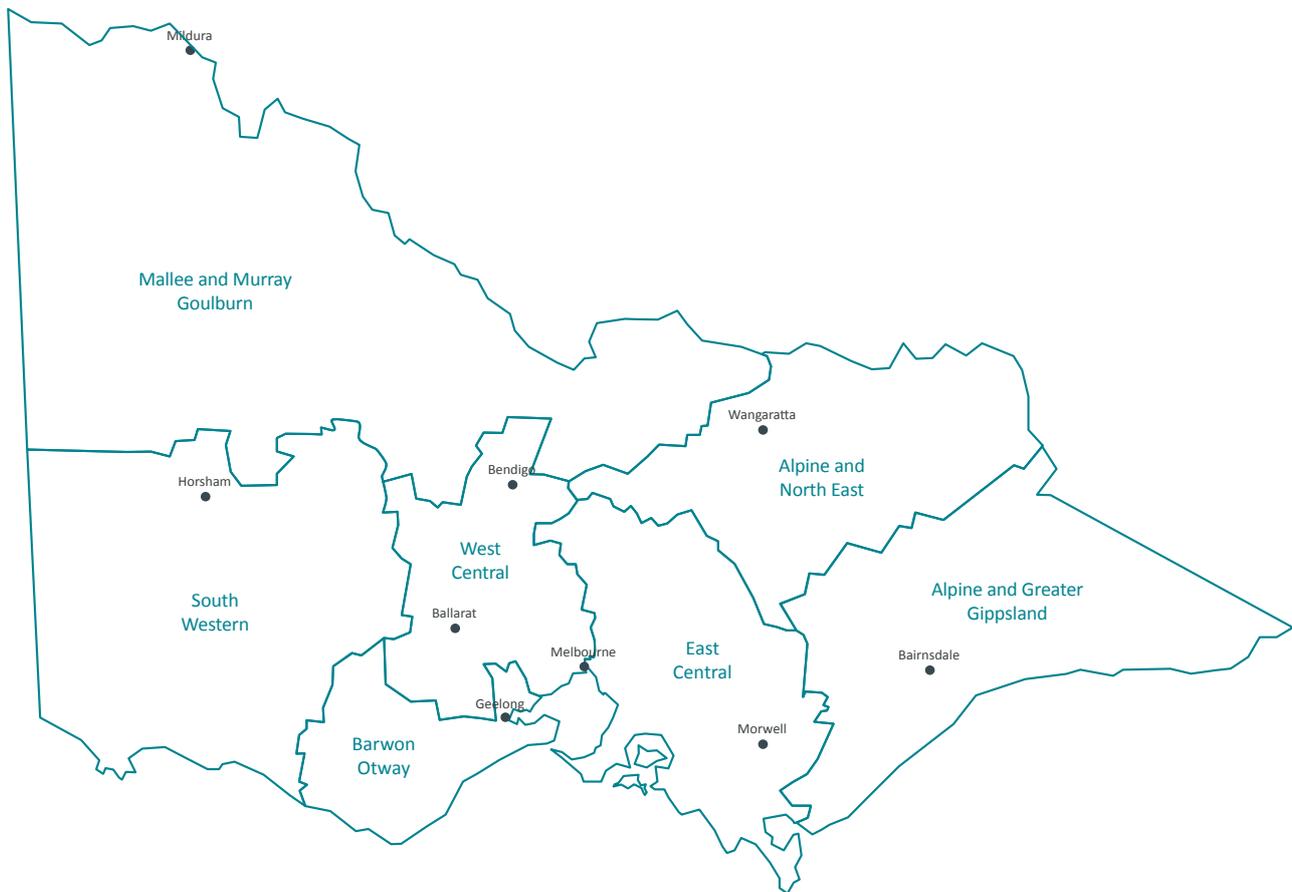


Measuring Bushfire Risk in Victoria





Victoria Government, Department of Environment, Land, Water and Planning, Melbourne, November 2015



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Introduction

In Victoria, catastrophic losses to life and property from bushfires over the past two decades have emphasised the need for a more strategic approach to managing fire. A key requirement of such an approach is a means of quantifying bushfire risk and its response to changing conditions, including changes that result from management actions.

The Department of Environment, Land, Water & Planning (DELWP) has developed a system that integrates bushfire modelling and analysis to quantify bushfire risk across Victoria. The system can be used to generate profiles of statewide and regional risk as it has changed historically and as it is projected to change as a result of future planned burning on public land.

This document provides an overview of the methodology used in the modelling and analysis system, along with a description of its assumptions and limitations.

Figure 1.

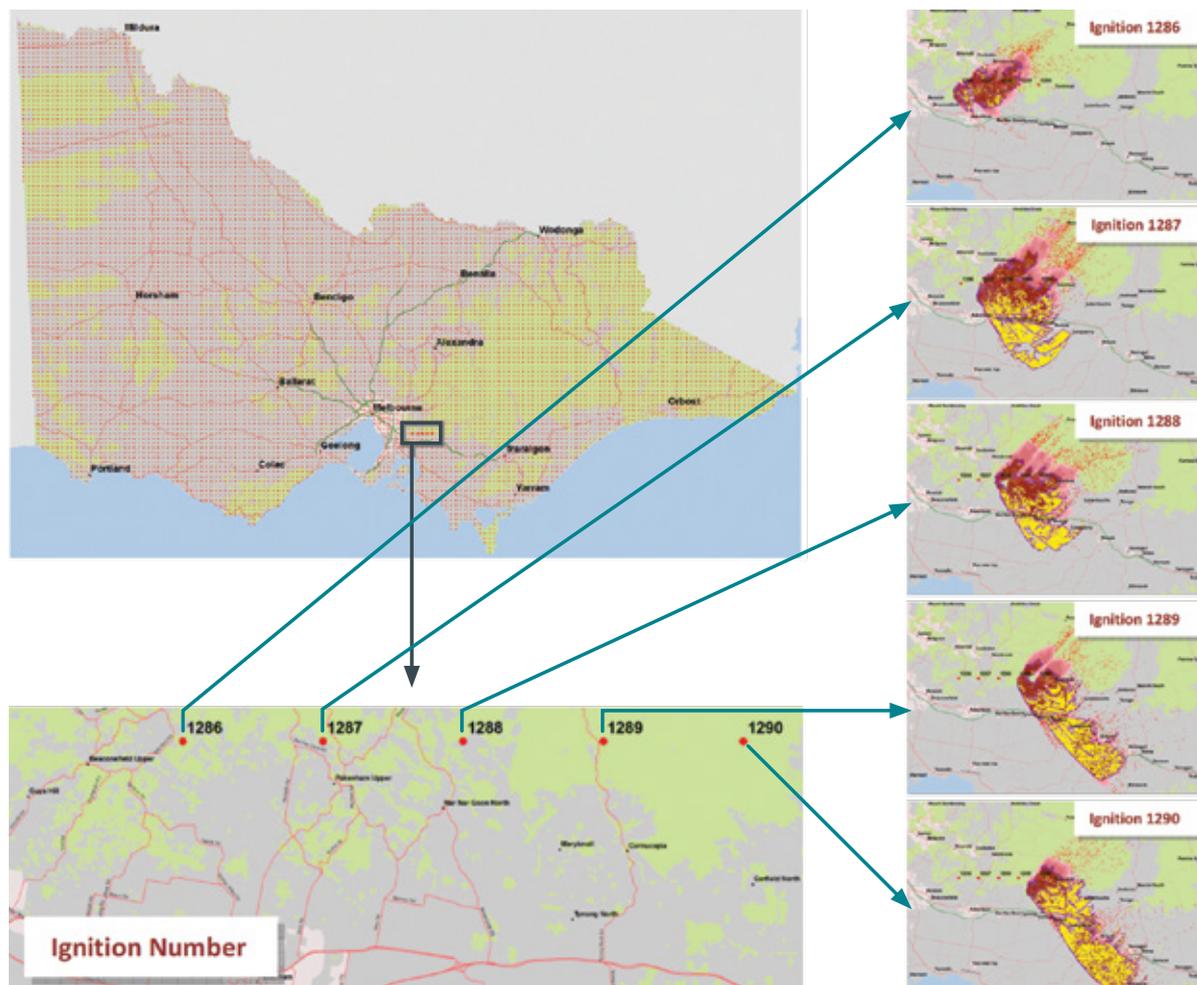


Figure 1: Systematic 5 km grid of ignitions across all of Victoria (9088 fires in total). Each fire is simulated individually, as can be seen in the subset of fires 1286–1290. Fires in this example use the fuel as at June 2009 with a grass load of 2 tonnes per hectare and are simulated on 16 February 2010 using simulated weather that represents a Forest Fire Danger Index of 130.

Measurement of landscape risk

The system that DELWP uses to measure landscape bushfire risk is based on simulating a set of severe bushfires across the landscape using PHOENIX Rapidfire. The simulated bushfires are ignited at points on a 5 km systematic grid across Victoria. Fires are ignited and simulated individually, that is, they are not modelled as if they are burning simultaneously. An example of this process is shown in Figure 1. The measure of landscape bushfire risk for a particular set of bushfires is then produced by calculating the average modelled property impact of all fires in that set.

An initial set of bushfire simulations is used to create a “maximum risk scenario”. The maximum risk scenario model shows the average impact fire would have on properties if the fuel in the landscape was at the highest possible level. Because higher fuel loads equate to higher bushfire risk, DELWP can use this model to set the benchmark for maximum bushfire risk in the Victorian landscape.

A second set of bushfire simulations is then used to establish a “modified risk scenario”. The modified risk scenario shows the average impact fire would have on properties if the amount of fuel in the landscape had been reduced by a particular combination of bushfires and/or planned burning. The modified risk scenario draws on records of past fires and planned burns.

Many different modified risk scenario models can be produced, each representing a different combination of bushfires and planned burning. These modified risk scenarios may be based on past records of fire occurrence, or predicted occurrence of fire such as future planned burning related to a fuel reduction strategy, or a hypothetical occurrence of fire that may be used to investigate the effectiveness of particular management options.

By comparing the impact on properties in the benchmark maximum risk scenario with the impact on properties in the modified risk scenario, DELWP can investigate how different fuel reduction regimes affect the impact of severe bushfires. The difference between the maximum risk and modified risk scenarios is referred to as residual risk: the ratio of the average property impact of the modified risk scenario to the average property impact of the maximum risk scenario, reported as a percentage. In other words, residual risk represents the percentage of maximum bushfire risk that remains in the landscape following fuel reduction due to a particular planned burning and bushfire history.

Figure 2.

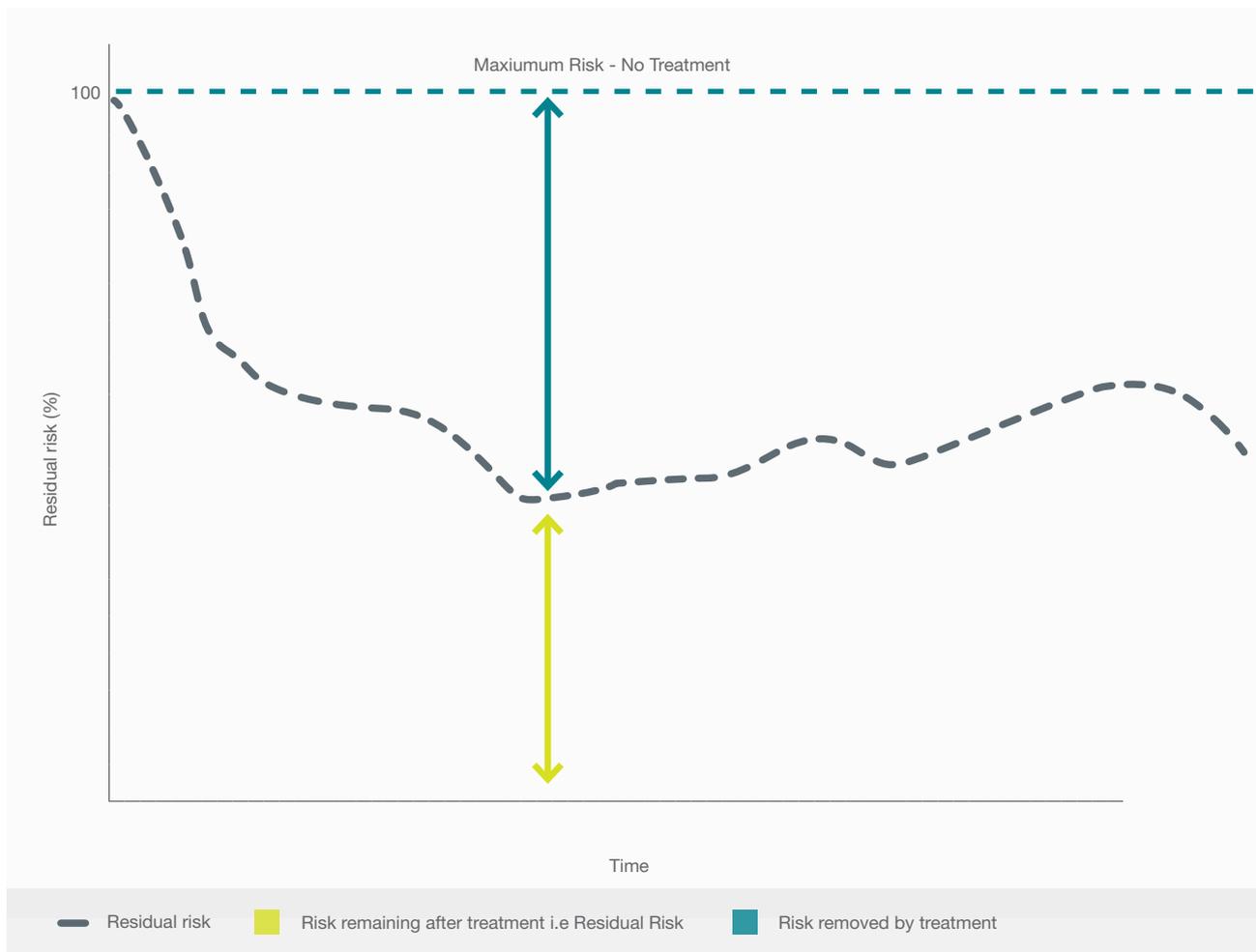


Figure 2: Measure of changing residual risk through time. The maximum risk level of 100% represents the “no treatment”, including no bushfires, or maximum risk scenario landscape, with all fuels at maximum load. The residual risk profile for a particular treatment represents the changing level of risk as a particular fuel reduction treatment is applied through time.

Residual risk profiles

By producing modified risk scenario models for each year of the recorded fire history back to 1980, DELWP is able to construct a chart of residual risk as it changes through time. This is referred to as a residual risk profile. This trend shows how the potential consequences of bushfires across the landscape have changed over time according to whatever mosaic of fuel-reduced patches existed each year (from both bushfires and planned burns). This is illustrated conceptually in Figure 2.

DELWP can project future levels of residual risk, by modelling the impact of planned burn activities which have been scheduled for the next three years. These projected risk trends do not, however, include the effects of any bushfires that may occur during those three years, and so they show only the effect that planned burning on public land may have in reducing bushfire risk.

The residual risk profiles allow DELWP to start tracking how bushfire risk has changed in the past and how it is changing as a result of current bushfire management activities. Therefore, DELWP can compare the effectiveness of different bushfire management regimes.

Analysis database and scalability

The results of the PHOENIX RapidFire runs are loaded into a spatially-enabled database management system (DBMS) to facilitate data organisation and analysis. The DBMS enables DELWP to access and use many millions of data points, and to generate analysis products in a consistent and repeatable fashion. Importantly, the DBMS also provides the capability to easily “slice and dice” the data along many dimensions, and in particular to summarise it according to different geographic boundaries. This allows DELWP to produce residual risk profiles at multiple scales, from statewide down through bushfire risk landscapes and DELWP regions to municipal localities.

Figure 3.

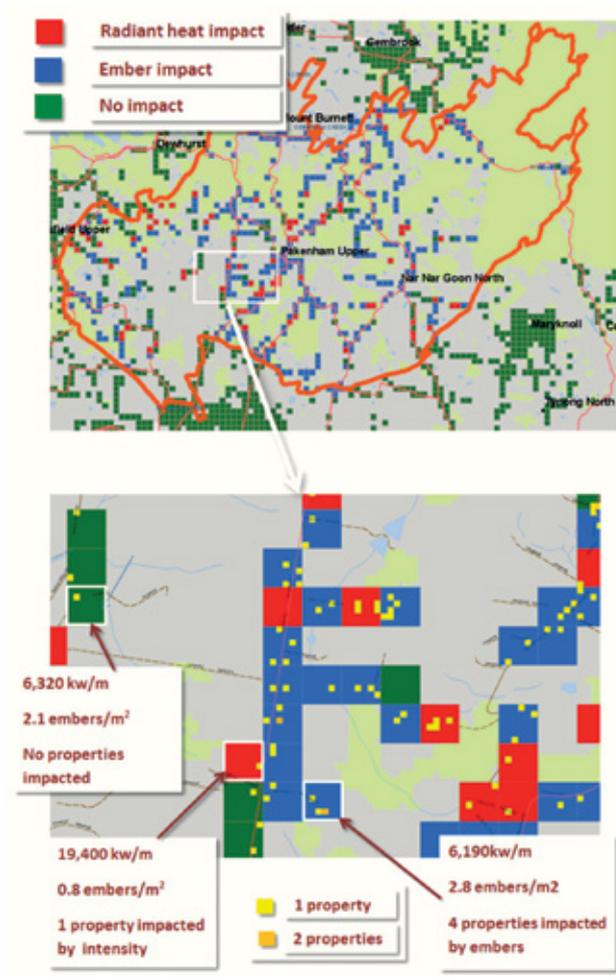


Figure 3: Potential property impact can be measured by relating address points (properties) to PHOENIX RapidFire grid cell outputs containing modelled fire behaviour information (such as fire intensity and ember density).

Modelling bushfire impact

Bushfire impact on human life and property is estimated using modelled property loss. DELWP models property loss by comparing Victorian property addresses with the potential severe bushfires modelled by PHOENIX. DELWP has assumed that properties will be affected when fire intensity or ember density reach particular thresholds (intensity > 10,000 kW/m or ember density > 2.5 embers/m² (see Figure 3)).

These thresholds have been developed by analysing statistics of house losses against the fire characteristics of the 1983 Ash Wednesday bushfires (Tolhurst, Shields and Chong 2008), and have subsequently been refined using data from other events, including the 2009 Black Saturday bushfires.

Assumptions and limitations

Due to the unpredictable occurrence of bushfires, it is difficult to quantify the risks that they represent. DELWP has adopted a system that allows the simulation and assessment of many thousands of potential bushfires, without having to wait for real bushfires to occur. While this is useful, it is important to understand the assumptions and limitations of such a system. These are described below:

- **All bushfires have been simulated using the same weather scenario**, which has been designed to represent a typical “worst case” fire day in Victoria. In future, a much greater variety of weather scenarios may be modelled. Until this is possible, DELWP will assume the weather scenario that represents the conditions under which, to date, the greatest losses of life and property have occurred in Victorian bushfires. The typical features of such weather are:
 - a forest fire danger index of well over 100
 - severe drought conditions
 - strong to gale-force north-westerly winds
 - temperatures above 40°C
 - relative humidity below 10% and
 - a strong to gale-force west-south-westerly wind change that turns the eastern flank of a running bushfire into a wide new fire front.
- Because of the chosen weather scenario, **modelled bushfires are restricted to those that do their most damaging runs in a single day**. The risk posed by multi-day bushfires (“campaign fires”) is explicitly excluded from the current analysis. The greatest losses of life and property in Victorian bushfires have historically been caused by severe single-day bushfires.
- Under the primary objectives of the *Code of Practice for Bushfire Management on Public Land* (DSE, 2012), DELWP is required to manage bushfire risk for values including human life, industry, the economy and the environment. However, **the analysis presented here considers only the risk that bushfires pose to human life and property**. In future, as the system is developed, ecological values will be incorporated as technical capabilities and value-impact models are refined.
- Bushfire impact on human life is not modelled directly. Instead, the spread and impact of bushfires on property (built assets) is modelled, and this impact is considered to be a proxy for the impact of bushfire on human life. In other words, there is an assumption in the modelling that the loss of property due to bushfire is correlated with the loss of human life due to bushfire.
- Bushfire impact on property is modelled using the latest version of the authoritative dataset of Victorian address points (Vicmap Address). Risk is always estimated using the same address point dataset.
- A full understanding of bushfire risk requires consideration of both the **likelihood** and **consequence** of bushfire impacts on human life, property and other values. The approach presented here mainly considers the consequence element of bushfire risk. While the approach does include some consideration of the likelihood of bushfire arriving at individual assets, the likelihood of particular ignitions is explicitly ignored. In other words, **all ignitions are considered to be equally likely in the present analysis**.
- All of the analysis presented here depends on simulations of bushfire by PHOENIX RapidFire, a computerised bushfire model developed by the University of Melbourne in collaboration with the Bushfire Cooperative Research Centre and DELWP. PHOENIX is one of several bushfire models currently available, each with its own strengths and weaknesses. Like all models, **PHOENIX gives only an approximation of reality**. PHOENIX is considered the most appropriate tool for bushfire modelling and analysis in Victoria.
- The accuracy of any model depends greatly on the quality of its inputs. PHOENIX uses a range of data inputs to model bushfire behaviour, including fuel types, ignition locations, weather variables, topography and previous fire history. Further analysis that is carried out on PHOENIX model results makes use of other datasets (such as the address point dataset already mentioned). While DELWP strives to use the most accurate data possible, it is acknowledged that **these datasets vary in accuracy and there is need for continuous improvement**.

References

DSE (2012) Code of Practice for Bushfire Management on Public Land. Department of Sustainability and Environment, East Melbourne, Victoria, Australia.

Tolhurst, KG, Shields, BJ and Chong, DM (2008) Phoenix: development and application of a bushfire risk management tool. *The Australian Journal of Emergency Management*, vol. 23, no. 4, 47–54.

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