QUANTIFYING WATER QUALITY RISKS FOLLOWING BUSHFIRE

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Background

Fire fighters and incident controllers must make resource allocation decisions based on the value of assets at risk and the costs associated with the loss of these assets. "Water supply catchments" are one such asset. Catchments are clearly assigned a value in the decision making process – both the 2007 and the 2009 fires in Victoria were stopped on the boundary of the catchments that supply 80% of Melbourne's water. In addition, more than 600km of new, wider, firebreaks have been constructed or upgraded to protect Melbourne's catchments. Similar "catchment protection" efforts can be identified in other parts of Australia.

Given these substantial efforts and resources assigned to the protection of catchments, it is important that fire managers have a clear understanding of what is at risk.

Erosion and water quality impacts of bushfire; *Top*, A post-fire debris flow blocking a road near Licola, Victoria, 2007. *Bottom*, High sediment loads and flooding of the Macalister River at Lake Glenmaggie, Victoria, 2007.

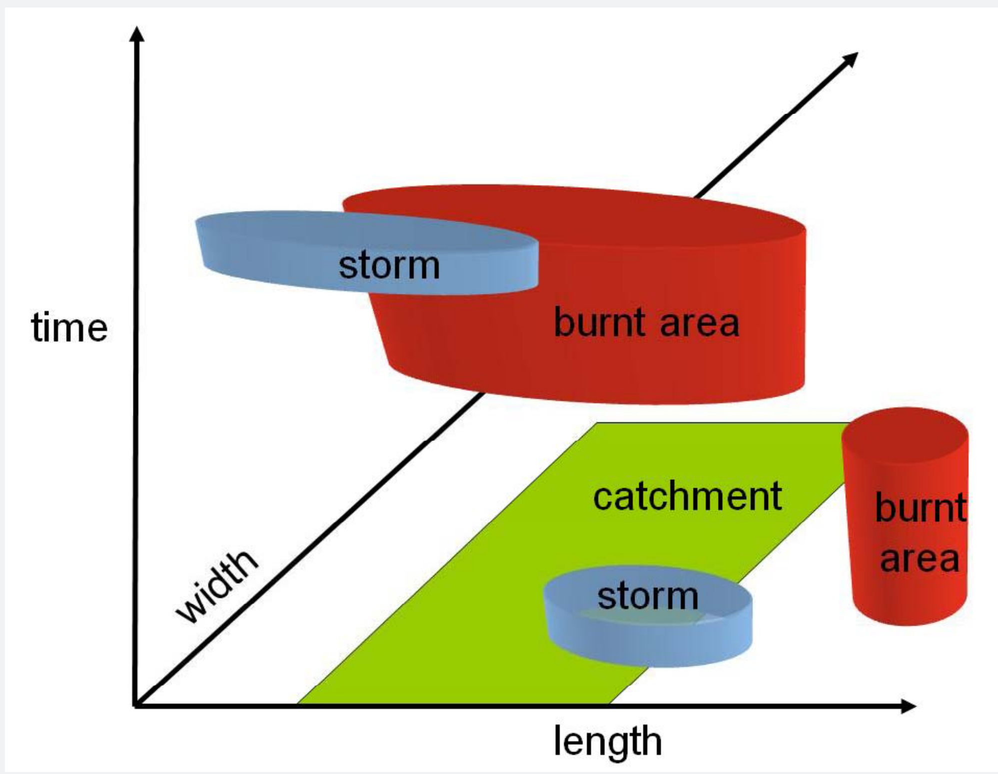
Aim

The aim of this project is to help fire managers answer the question; "What are the risks to water supplies if this catchment is burnt by bushfire, and can the risk be reduced with prescribed fire?".

The conceptual model

The occurrence of fires, followed by erosive-storms in the window-of-risk after the fire, is a complex stochastic process in space and time. An appropriate mathematical model to represent the dominant elements of this interaction does not currently exist. In this project we aim to develop and parameterise a simplified analytic model to quantify the mean annual area of extreme erosion events as a function of the temporal and spatial distributions (ie. frequency and size respectively) of both fires and erosive storms.

This simplification is illustrated in the conceptual diagram below.



Conceptual representation of the stochastic coverage model proposed for this project. Fires and storms are assumed to occur randomly in time and space. We are interested in quantifying the long-term average rate of intersection between the burned areas, the storm cells, and the catchments of interest.

Methods

The project includes 4 key steps;

1. Determining the frequency and magnitude of extreme erosion events (leading to water quality impacts) following the 2009, 2007 and 2003 Victorian fires from analysis of areal photography and radar imagery.
2. Establishing the quantitative relationship between burn severity and hillslope hydrology, vegetation recovery, and erosion and water quality impacts for a dry *Eucalyptus* forest using field experiments.
3. Developing and parameterising a risk-based *coverage* model, that quantifies the probability of the intersection, or overlap, (in time and space) of the burn area at risk of extreme erosion events, and; a) convective storm cells responsible for localised extreme erosion events, and b) widespread east coast low pressure systems commonly resulting in flood events.
4. Using the new model to predict how the probability of an extreme water quality impact may be modified by landscape scale prescribed fire.

The coverage model

The proposed model (below) will quantify the average annual area A of fires and erosive storms "overlapping" in space and time within a given area Ω, where X and Y represent the sizes of the fires and erosive-storms respectively, and λ_ξ and λ_ζ represent the average time-rates of fires and erosive-storms, respectively;

$$\mathrm{E}\|A\| = \|\Omega\|(1 - e^{-\lambda_\xi \mathrm{E}\|X\|})(1 - e^{-\lambda_\zeta \mathrm{E}\|Y\|}).$$

Further development of this stochastic model will form part of this project.