The hydro-geomorphic sensitivity of forested water catchments to wildfire

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Introduction

Wildfire changes the hydro-geomorphology of a landscape through altered hydrological flow and erosion rates[1]. When fire occurs in a forested catchment area, this change can result in negative impacts on soil and water resources, infrastructure and lives[2] (Figure 1).

Landscape response to fire can vary depending on fire intensity, rainfall after the fire and the hydro-geomorphic sensitivity of the landscape. The greatest risk following wildfire is when these factors intersect.

Landscape sensitivity studies investigate reaction to a disturbance (such as wildfire), by measuring landscape properties that enable an area to resist, adapt to, or bounce back from change[3] .

In this project I will be using sensitivity and fire research concepts to create a method of predicting potentially sensitive post-fire landscapes.

Figure 1: Fire leads to erosion and water quality impacts.

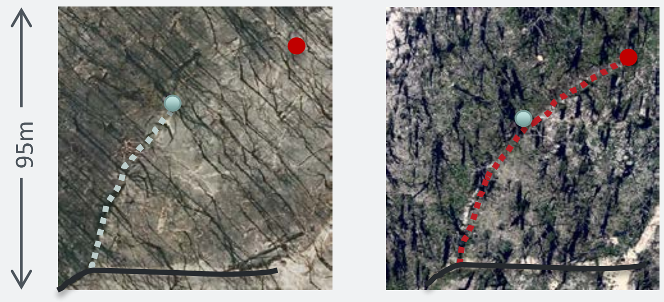
How is sensitivity measured?

Hydro-geomorphic sensitivity can be measured by investigating the degree of change in water flow and erosion processes following fire. These processes require energy input to react a certain threshold before initiating. Due to changes in vegetation and soil after fire, erosion processes can be initiated with less rainfall energy input, thus, the thresholds are lowered by fire.

This response – the lowering of a threshold – will be affected by the landscapes resistance, resilience and feedback mechanisms. Exploring these concepts can help explain the degree of the response i.e. the sensitivity.

For my project I am using two aerial photo sets of the 2009 Black Saturday Victorian fire, the first was taken two weeks after the fire and the second taken 10 months later. I will compare these two sets for changes in hydro-geomorphic processes.

Figure 2: Change in channel head position.



2 weeks after fire | 10 months after fire

What can be used as a visual identification of threshold change?

Movement in the position of channels is visible in the aerial photos. Figure 2 shows changes in the channel length over time.

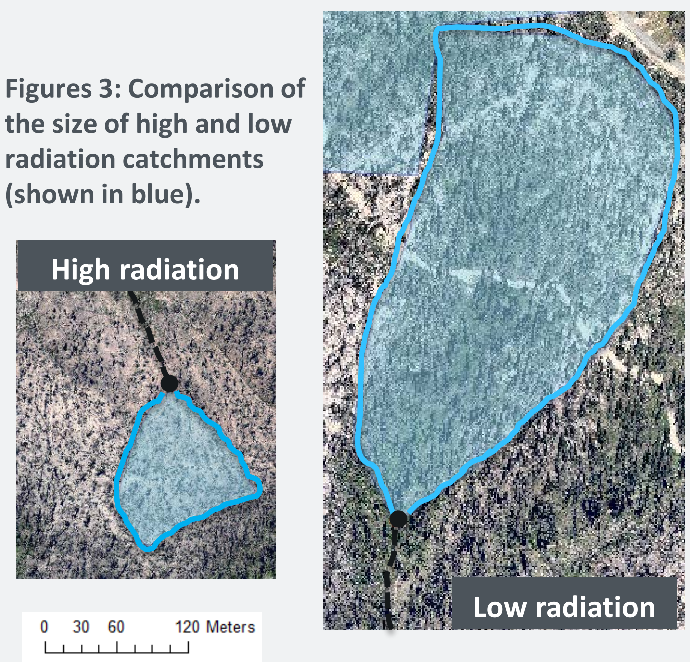
Channels form when sediment transport processes change from diffuse to active. This project focuses on whether runoff energy (as measured through contributing drainage area and slope) is sufficient to overcome the erosional resistance of the ground surface and form a channel[4].

After fire, the threshold for channelization is lowered causing channels to form higher in the catchment. The greater the change in channel observed, the greater the shift in thresholds, and hence the greater the sensitivity.

The identification of channel initiation in this manner has not been attempted in previous research. A new method therefore had to be developed in order to utilise aerial images for quantifying shifts in channel heads post-fire .

The degree/magnitude of channel shift will be linked with landscape variables to determine the drivers of variability in sensitivity.

Figures 3: Comparison of the size of high and low radiation catchments (shown in blue).



What could be an important factor in determining sensitivity levels?

Preliminary field investigations suggest dryness (a measure of radiation and precipitation balance[5]) may be an important variable in predicting sensitivity. Results show a difference in the morphology of headwaters with different radiation inputs or dryness. Drier channels are characterised by smaller, steeper contributing catchments than wetter ones. Figures 3 and 4 illustrate this difference.

Drier headwater catchments generally have poorly developed soils that are more likely to generate runoff and erosion, resulting in steeper slopes and channel heads that extend further upslope, than sites with more structured and permeable soils.

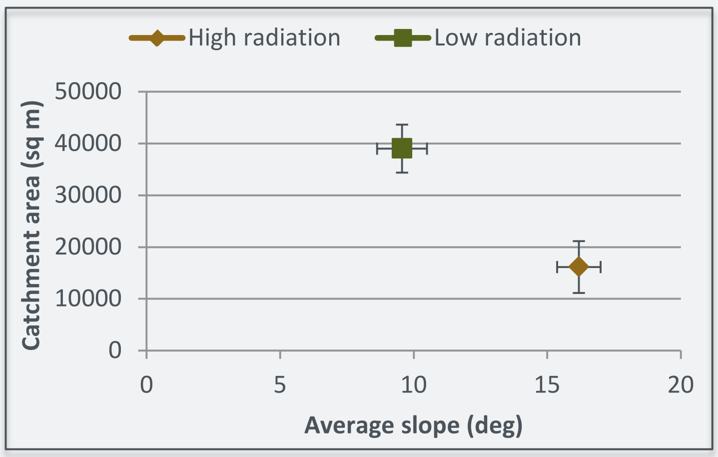


Figure 4: Catchment area and slope contributing to channels in high and low radiation catchments.

Future Directions

Initial observations suggest dry areas may display higher sensitivity to fire than wetter areas, making dryness an important variable in determining hydro-geomorphic sensitivity to fire.

If the research can link a measure of dryness to post fire hydro-geomorphic sensitivity, then land and fire managers can use this to better predict potential post-fire risks.

Sensitivity prediction will provide important information to aid in three levels of decision making:

Before a fire: Where is fire mitigation best placed? Where should we put resources into fire breaks or fuel reduction?

During a fire: What is the value of protecting a particular asset (eg. water supply)? What is the real risk to an asset if burnt?

After a fire: Is remediation (eg. building log dams) needed? Where will it be most effective?

References

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