USING LANDSCAPE ARIDITY TO ASSESS POTENTIAL RISK OF EXTREME POST-FIRE EROSION EVENTS

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Introduction

Extreme erosion events pose a significant risk to soil and water resources following wildfire[1]. In particular, post-fire debris flows have been observed in regions of North and east Victoria following recent fires[2]. Within a burnt area debris flows occurrence is variable and evaluation of post-fire risks depends on knowing what areas are sensitive. This research project investigates landscape properties and processes which could be linked to hydro-geomorphic sensitivity, and how sensitive areas can be identified.

Landscape aridity

Aspect and topography are landscape properties which are important to post-fire erosion response (Figure 1). We propose that the observed difference in response between aspects may be due to a difference in aridity. Aridity is a measure of the balance between solar radiation and precipitation, it influences water availability which is important for soil development[3,4].

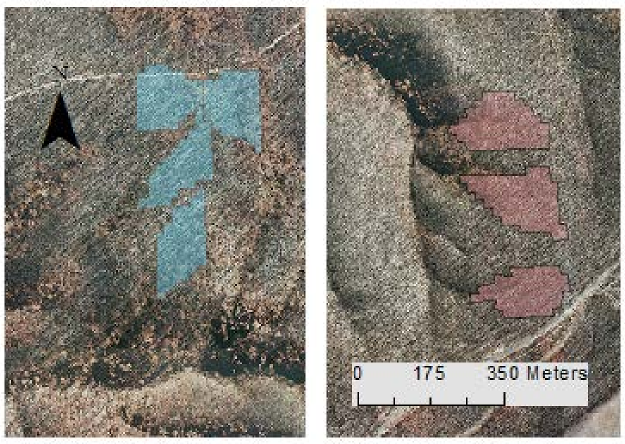

Figure 1: Non debris flow (blue) and debris flow (red) producing catchments have different orientations

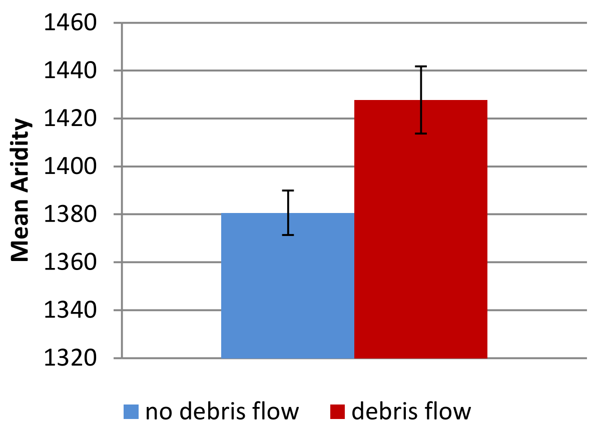

Figure 2: Mean aridity of debris flow (red) and non debris flow (blue) producing catchments.

Predictor variables	B	se	Wald	Sig.	exp(B)
Aridity	0.003	0.001	7.170	0.007	1.003
Constant	-5.697	1.815	9.854	0.002	0.003
Burn severity	0.001			0.980	
EVC	0.118			0.732	
Geology type	0.690			0.406	
Soil type	1.011			0.315	
Maximum Slope	3.164			0.075	
Mean Slope	7.551			0.273	

Overall model evaluation		χ²	df	Sig.
Omnibus test of model Coefficients		7.393	1	0.007
Hosmer and Lemeshow goodness of fit		7.451	8	0.489
Cox & Snell R square	0.033			
Nagelkerke R square	0.047	n=222		

Figure 3: Regression analysis table shows Aridity is the only significant variable (at 95% level). Other variables tested did not significantly improve the prediction of debris flows.

Methods

Single headwater catchments (~2ha) within the 2009 Kilmore-Murrindindi fire complex were identified using GIS (Figure 1). Information on aridity, slope, EVC, geology and burn severity were obtained for these headwaters using spatial data sets.

Using a stepwise binary logistic regression analysis these landscape variables were related to the presence/absence of debris flows.

$$Aridity = \frac{Radiation}{Precipitation}$$

Discussion and Future direction

A strong empirical relationship between aridity and debris flows is evident in the results. However, the exact cause of this relationship is not known. We hypothesise that this relationship is a result of underlying system properties and processes which the aridity value represents, as outlined in Figure 4. The next stage in the research project is therefore to conduct field experiments to investigate how soil infiltration and runoff varies with aridity. Additionally, work is ongoing to determine more accurate measures of aridity.

Results of the study have important implications for the prediction of post-fire erosion. If aridity can be used to assess debris flow risk, then this measure and other readily available data could be used to determine highly sensitive catchments to plan management strategies, protection and mitigation measures.

Results

The occurrence of extreme erosion across the burnt landscape was strongly related to landscape aridity (Figure 2). As illustrated in Figure 2, the results showed a significant difference ($p < 0.01$) between the average aridity of headwater catchments which produced debris flows (n=65) and those which did not (n=157).

Regression analysis of data also suggested inclusion of landscape aridity is important in the prediction of debris flow producing catchments (Figure 3).

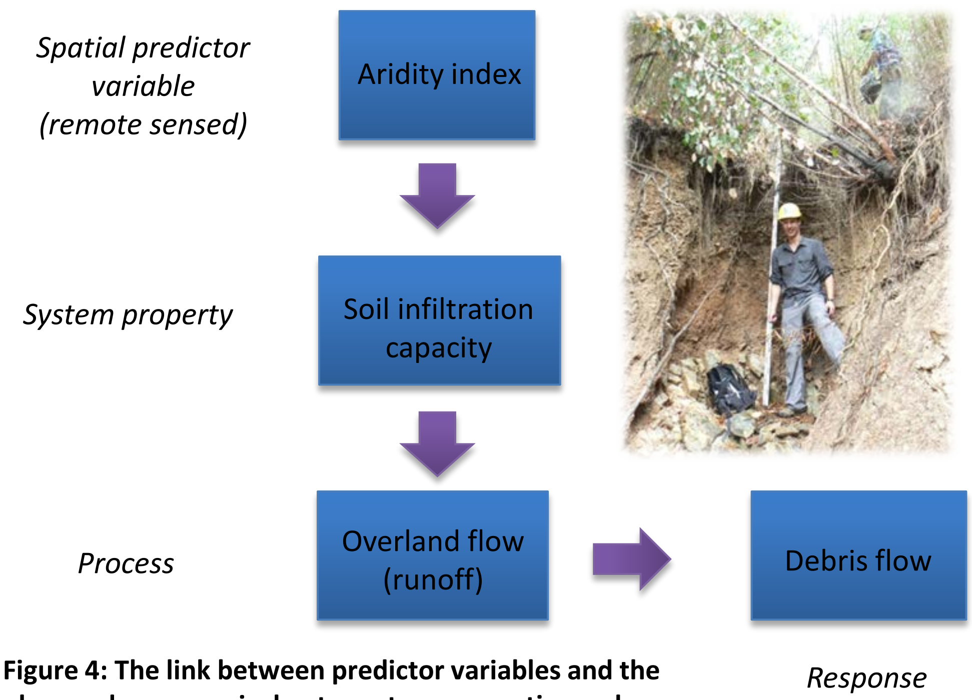

Figure 4: The link between predictor variables and the observed response is due to system properties and processes.

References
Aerial photography supplied by DSE
[1] Smith *et al.* (2011). *Journal of Hydrology*, 396, p170-192 . [2]Nyman *et al.* (2011). *Geomorphology*, 125, p383-401. [3] Jenny, H. (1941). Factors of soil formation : a system of quantitative pedology. [4]Budyko, M. I. (1958). The Heat Balance of the Earth's Surface.