HighFire Risk: The role of rugged landscapes

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Introduction

Analyses of very large fire events in the high-country have revealed a number of recurrent themes. One such theme is the role of terrain ruggedness, which is defined in terms of the local relief of the topography. Analysing fire and lightning histories in combination with ruggedness data has revealed some interesting emergent patterns. A better understanding of these patterns is required to fully appreciate the inherent bushfire risk in the high-country.
The two main themes investigated were
(1) The relationship between lightning ignition swarms and terrain ruggedness
(2) The relationship between the extent of very large fires and rugged landscapes.

Lightning Ignition Swarms

To explore the relationship between occurrence of lightning ignitions and terrain ruggedness, we collected data on the most significant recent lightning ignition swarms: January 8, 2003 and December 1, 2006. These are plotted in Figures 1a and 1b, respectively. Statistical analyses indicated that these lightning ignitions occurred preferentially in the more rugged parts of the terrain. The most rugged lands are the most difficult for initial attack, clearly indicating a challenge for fire agencies, air operations and land managers.

Topographically Constrained Fires

The mapping of historical fire data clearly showed a constraining effect of terrain ruggedness on the extent of very large fires. These fires tended to stop in parts of the landscape that coincided with a threshold ruggedness value, with perhaps 5 km of over run, especially where there is in excess of 5 t/ha of fine fuel. Possible explanations were: changes in the weather as the terrain changes; changes in fuel as the terrain changes; and changes in access and suppression effectiveness as terrain changes. The Victorian Alpine fire complex, which arose from an ignition swarm at around 4pm on 1st December 2006 provided further opportunity to test the relationship between large fire extent and ruggedness. Figure 3 shows hotspot satellite data overlayed on a map showing terrain ruggedness; the complex was strongly limited to rugged terrain. Figure 2 shows that violent pyro-convection was underway at 4:30pm on 14 December, when the fires were reaching the flat lands of Gippsland. This was some of the most intense fire activity recorded in Australia and offers strong support for a terrain-interaction that limits larger fires.

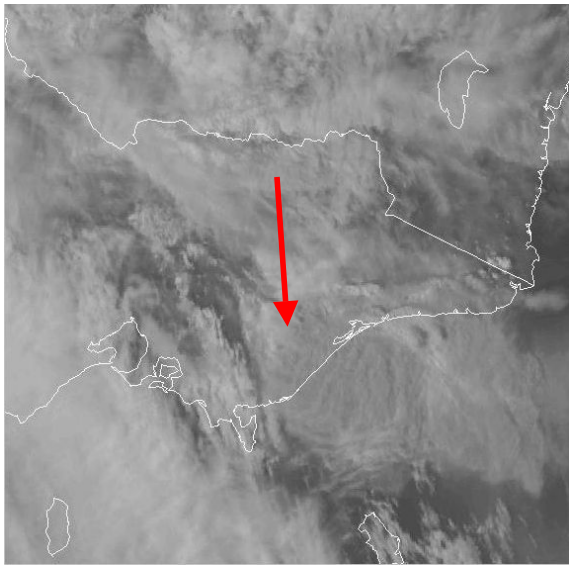

***Figure 2**. Visible satellite photo of violent pyro-convection [arrow] over Maffra at 16:33, 14 Dec 06.*

Conclusions

Analyses of fire, lightning and ruggedness data have yielded results that are significant for fire authorities.
(1) Lightning ignition swarms are concentrated along the “backbone” of the most rugged parts of the landscape; and
(2) Very large fires tend to be constrained within the rugged parts of the landscape.

The results also suggest that certain incident objectives may not be achievable in rugged landscapes once a fire has escalated to a very large scale. Consideration of changes in terrain type is important in judging where such a fire might be containable.

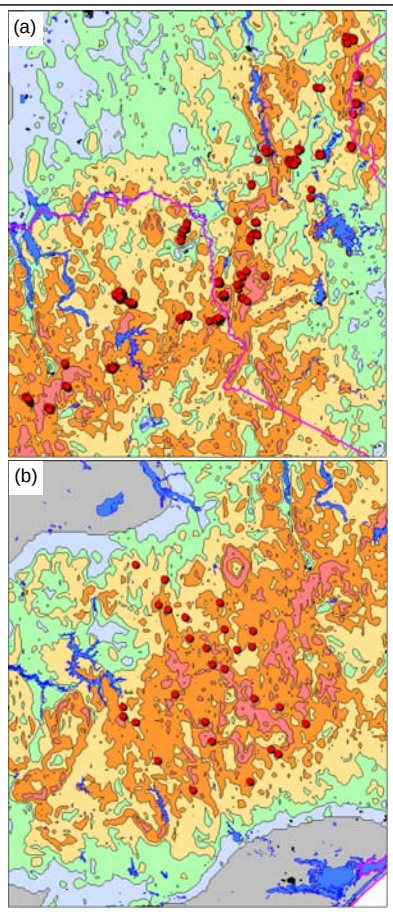

***Figure 1.** Maps showing lightning ignition swarm data over terrain ruggedness – for (a) 08 Jan 03 and (b) 01 Dec 06.*

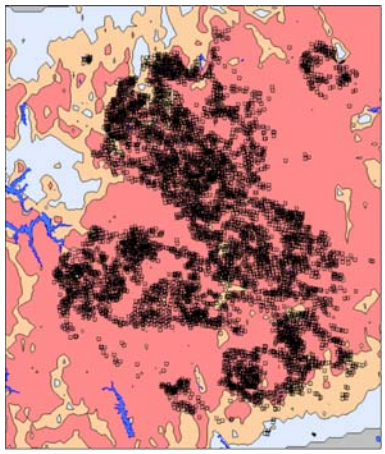

***Figure 3**. Map showing partial satellite hotspot data for 2006 Alpine fires over rugged landscape class (red).*