LESSONS FROM THE JANUARY 2003 FIRES – ADVANCING BUSHFIRE RISK MANAGEMENT IN THE HIGH COUNTRY

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ABSTRACT

The alpine fires of January 2003 burnt vast tracts of forested country in Victoria, New South Wales and the ACT. Much of the prior basis for bushfire risk management was found insufficient for understanding this event. Lessons must be learnt from the event to ensure future safety of threatened communities. The BushfireCRC HighFire Risk Project will use Federal Government funds to address this.
Initially using the bushfire risk framework used across the ACT, we will address all aspects and methodically analyse shortfalls in understanding. Some of these are already evident from material collected during the fires, some will need to be researched. A multi-disciplinary approach will be applied, spanning field data collection, modelling, analysis of fire data and risk methodologies. While much of the initial effort will of necessity be meteorological, many aspects of fire management will be integrated.
So far the approach has revealed significant risk drivers that have been poorly recognised to date. Nocturnal low-level jets frequently produce peak FFDIs between midnight and sunrise. These produce unexpectedly intense fire behaviour and require rethinking of objectives and strategies, and put crew safety at risk. Dynamic channelling was the key factor that produced the catastrophic fire behaviour seen around the ACT on 18/1/2003. Future mitigation effort will need to reflect these findings.
Significant improvements in bushfire risk management in the ACT have already emerged from initial efforts. Benefits are expected for the entire alpine region, and elsewhere in Australia.

INTRODUCTION

The alpine fires of January 2003 burnt vast tracts of forested country in Victoria, New South Wales and the ACT. Much of the prior basis for bushfire risk management was found insufficient for understanding this event. (Esplin *et al*. 2003; House of Representatives Select Committee on the Recent Australian Bushfires 2003) Lessons must be learnt from the event to ensure future safety of threatened communities and assets.

Many inquiries were held, or indeed still are being held, into the event. The House of Representatives held one of these. Arising from it, the Federal Government has given the BushfireCRC funding for the HighFire Project. One of the research projects within HighFire is a bushfire risk study. Developed in co-operation with land- and fire-managers, its research outputs will provide a scientific evidence-base to support decisions made regarding policy and practical issues for land- and fire-management (BushfireCRC 2006)

Bushfire risk studies began in earnest in Australia in the early ‘90s with projects in Western Australia, the Victorian Country Fire Authority and the ACT Bush Fire Council. Many elements of these were common, and were also taken up by later projects, such as that in New Zealand (NRFA 2002). All studies have recognised the complexity of the problems faced. The development of spatial tools has greatly facilitated the application of processes to risk modelling.

However, there were always “To Do” lists in these projects, aimed at filling-in gaps in knowledge of processes or in the fundamental datasets that drive such modelling. When the extreme events of January 2003 came along, many of the knowledge gaps were still real. The intense collection of real-time data during the fires has proven both how complex the processes can be and how real the knowledge gaps were.

One of the key goals of HighFire is that of evidence-based policy setting. Thus the only way that we can achieve validated policies for bushfire risk mitigation is to address the knowledge gaps. In many ways the restriction of HighFire to “the high country” will facilitate the goal, by allowing an intense focus on specific issues.

METHODS

A decision has been made to initially use the bushfire risk framework used across the ACT. This is a foundation of the ACT Government's Strategic Bushfire Management Plan (ACT ESA 2005), and has been designed in a modular fashion to cover both scale-dependent issues and all aspects of the fire problem.

The latest revisions of the model address the transitions between scales as fires escalate or decay (see Figure 1). This gives valuable insights into setting operational strategies and to prior mitigation measures. It is a process model, and will in future examine transition probabilities.

The project will address all aspects of the process model and methodically analyse shortfalls in the understanding that should underpin it. Some of these are already evident from material collected during the 2003 fires, while some will need to be researched. A multi-disciplinary approach will be applied, spanning field data collection, modelling, analysis of fire data and risk methodologies. While much of the initial effort will of necessity be meteorological, many aspects of fire management will be integrated.

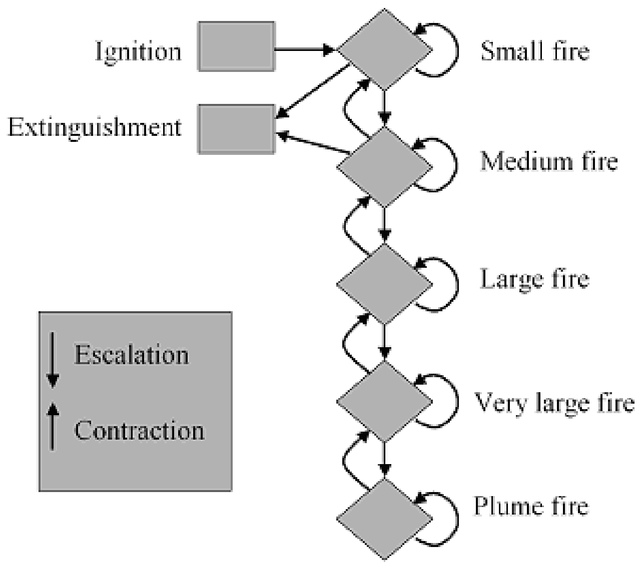

Figure 1. Summary of the risk transition model.

RESULTS

To date the approach of examining data collected during and after the fires has revealed significant risk drivers that have been poorly recognised. Among these are:

- What are believed to be "nocturnal low-level jets", which frequently produce peak FFDIs between midnight and sunrise. These have been discerned in automatic weather station data from alpine sites (see Figure 2). While noticed during January '03, no valid explanation or understanding was then available. They produced unexpectedly intense fire behaviour, and, for the future, require rethinking of objectives and strategies if fire crews are to operate safely in high areas.
- Dynamic channelling (Kossmann, *et al.* 2001; McRae 2004) was the key factor that produced the catastrophic fire behaviour seen around the ACT on 18/1/2003. It was recognised only after detailed examination of linescans flown during the fires. Their occurrence appears at present to be fuel-load independent. Mitigation of the risks arising from channelling is not being achieved using current risk analyses, and future mitigation effort will need to address some difficult questions.
- Unusual fire behaviour, in the form of non-stoichiometric combustion (Dold *et al*. 2005). There is strong evidence of this playing a role in the catastrophic fire behaviour upwind of Canberra. There may be links with channelling and with the formation of ember storms. These need to be investigated.
- The formation of plume-driven fires and the associated violent pyro-cumulonimbus storms (Fromm *et al* 2006). Satellite data have shown through these the Canberra fire event had a global impact, by raising stratospheric particulates. The formation of massive, three-dimensional atmospheric circulations clearly played a role in the formation of catastrophic fire behaviour. This also needs further investigation.

Other phenomena have been indicated by observations, and are being investigated. As an example a series of photographs were taken of a decaying and collapsing convection column, allowing a current estimate of its downward velocity of between 150 and 250 km/hr.
The tables below are examples of the detail behind the transition model.

Table 1. Description of Very Large Fire from transition model.

VERY LARGE FIRE [LANDSCAPE FIRE]

ORIGIN:

Escalation of Large Fire before suppression.

BEHAVIOUR

CODE	EVENT	CONDITIONS	MITIGATION
VA	Decay of Very Large Fire into one or more Medium or Large Fires	Loss of coherence in convection. OR Diurnal cycle drops FDI. Rain.	Burn-out pattern to form mosaic to drop coherence. Containment [indirect]
VB	Persist as Very Large Fire	Most likely path.	Containment [indirect] Spotfire patrols Fuel-age mosaic at landscape level Strategic broadacre fuel reduction
VC	Escalate to Plume-driven Fire	Massive flaming zone causes coherent plume to form,	Avoid fire convergence. Prioritise keeping fire out of areas prone to channelling.

STRATEGIC GUIDANCE FOR INCIDENT MANAGEMENT TEAMS

- Containment on or around **each** key landform element – generally, requiring multiple shifts. A goal should be to break the fire up.
- Prevent spotfires taking fire outside of containment.
- Avoid arrangements conducive to development of coherent plume.
- Control might be difficult in rugged terrain, due to weather interactions, or in flat areas, where there are no downhill runs to allow crews to catch-up. Other areas may provide fallback options.

DEFINITION

Coherent plumes occur when the size of the flaming zone allows the convection column to avoid mixing with surrounding air for some considerable vertical distance. The column, and the fire products that it contains, may then be pushed along by upper air. At this point the fire's behaviour is driven by that rather than by fuel, weather and terrain. Requires extreme fire intensity, atmospheric instability and escalation of flaming zone dimensions, usually by channelling or fire convergence.
Channelling is a process where air flow is diverted by terrain arrangements such as to expand the fire laterally as well as ahead.
Fire convergence occurs when two flaming zones come close together, creating a much larger effective flaming zone.

Table 1 reviews, for a very large fire, the origin, transition drivers, the resulting incident objectives and provides some definitions.
Table 2 summarises the transition options for a very large fire.
Table 3 gives complete transition chain for emergence of a plume-driven fire. As mentioned earlier, there are elements in this chain, especially later on, that are currently poorly understood. If we are to estimate that likelihood of severe events, then we need to understand the likelihoods of all elements of the chain. It is also likely that some elements are not independent – in other words it may eventuate that the occurrence of channelling implies a situation in which a drying event is also likely.

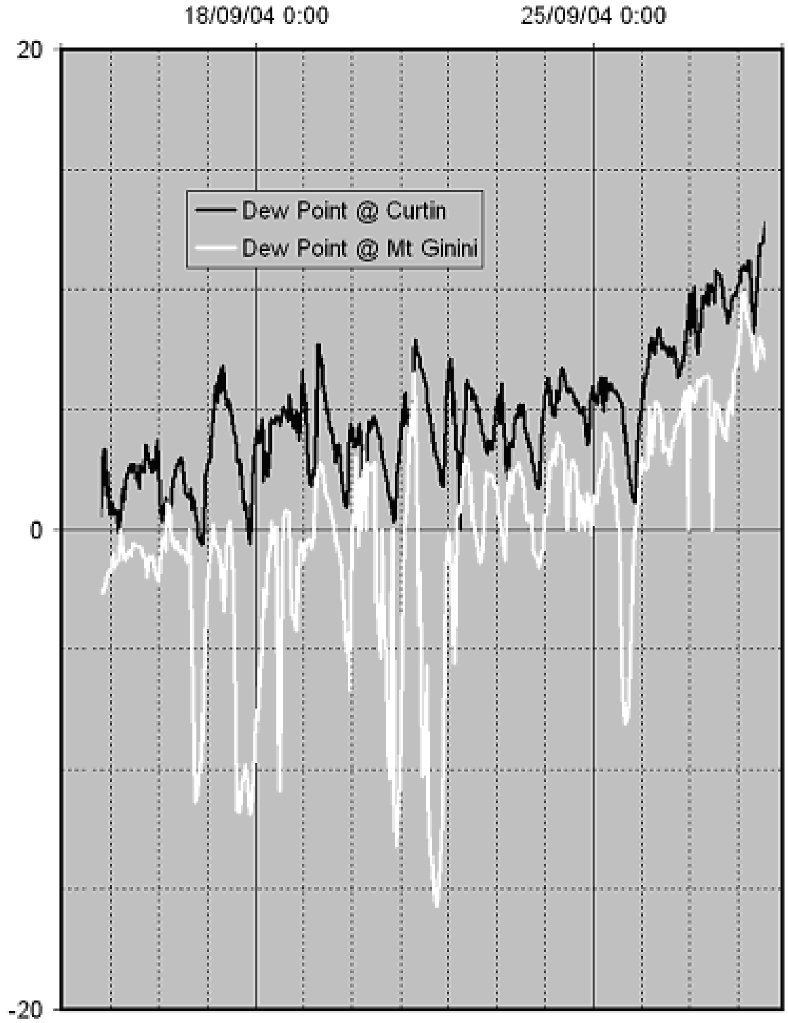

Figure 2. Dew Point traces from Curtin Automatic Weather Station (ACT ESA, at 580 m ASL), upper line, and Mt Ginini AWS (Bureau of Meteorology and ACT ESA, at 1760 m ASL), lower line.

DISCUSSION

The policies that drive the management of government lands and assets in the high country (if not those in private ownership) are, in part, in conflict. These conflicts arise most sharply in matters such as fire fuel management. In many ways these policies are driven by overly-simplistic assumptions about how fires behave. The basis for this arises from the existence of a set of different fire size classes, each reflecting different processes. Further, each size class produces a different risk exposure to threatened assets.

While small fires are common and rarely cause damage, large ones are less common but do cause damage. When applied to a risk matrix, such as defined in the Australian Standard for Risk Management (Standards Australia 2004), the resulting risks may or may not be different.

Most fire managers have very little experience with catastrophic fires, and are required to extrapolate upwards from their experiences with the smaller size classes. The result of this may be an erroneous perception of risk.

By methodically studying the bushfire risk process in the high country, we seek to:

- Formalise the basis of risk assessment for the largest fires
- Allow better understanding of the relative risks from each fire size class in the high country
- Identify options for risk mitigation and for incident management.
- Develop and provide material to pass these findings on across the industry.

The work must be multi-disciplinary, and must use all available linkage to other projects. As the HighFire project has a three-year life span, it may provide valuable findings and feedback to other, longer-term projects within the CRC.

Table 2. Transition factors for a very large fire.

Transition	Probability increases if…			
	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**
VA	ROS drops	Coherence dissipates		
VB	{NOT VA and NOT VC}			
VC	Instability	Dry upper air mixing down	Channelling	Convergence
VD	In very large firepath			

NOTES

- In general, each factor generates a probability for that transition. The greatest probability for the set of factors listed in the table row determines the likelihood of the transition occurring.
- ROS must be calculated at the appropriate scale (correcting slope for scale, etc).
- Suppression is a sequence of detection, response and achieving objectives.
- Fuel is a complex set of descriptors, covering size, layering and availability.
- Firepaths are zones within which fire behaviour, at that scale, would present a direct and immediate threat to an asset.

Table 3. Transition chain for development of a plume-driven fire.

The recipe for a plume-driven fire is:

A small fire that…	Travels, and is not suppressed and has suitable fuel, and so is able to escalate into a…
Medium fire that…	Travels, and is not suppressed, and is not rained on and has suitable fuel, and so is able to escalate into a…
Large fire that…	Travels (or spots ahead) onto multiple landform elements, and is not effectively suppressed, and does not break up into a series of smaller fires, and has suitable fuel, and so is able to escalate into a…
Very large fire that…	Travels and maintains coherent convection, or experiences instability, or mixing of dry upper air, or channelling, or convergence, and so is able to escalate into a…
Plume-driven fire.	

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