HIGHFIRE RISK PROJECT

BUSHFIRE CRC Project B6.3

PROJECT PROGRESS REPORT FEBRUARY 2007

HighFire Risk Update - February 2007

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Summary

The following is a brief summary of activities undertaken by the HighFire Risk Project. More detail is provided in the following pages

- Understanding bushfire risk drivers in the high country – The work carried out so far has indicated that there are a number of key processes that contribute significantly to bushfire risk in the high country. Many of these processes are poorly understood and are now being investigated through a multidisciplinary approach that spans field data collection, physical modelling, analysis of fire data, fuel structure and risk methodologies.
- Fire weather analysis program – Two automatic weather station transects currently in the Brindabella Ranges are providing continuous monitoring of fire weather in the high country. Preliminary results indicate that terrain has a significant effect on fire weather in the high country.
- Terrain effects on fire – We are looking at various terrain characteristics. The capacity of these terrain features to predict fire behaviour is being investigated. Incorporation of these terrain features into risk models seems likely to lead to more efficient prescribed burning practices and resource allocation during major fires.
- Risk management frameworks – Collaborative work with researchers from Program A aimed at combining research findings promises to provide more detailed risk management methods for high country landscapes.
- Other activities
    - Collaborative work between HighFire Risk and the University of Coimbra on eruptive fire behaviour
    - Reanalysis of linescan data collected during 2003 fires
    - Combining data collection and modelling with U.S. Fire Labs Wind Wizard
    - Collaborative work with Ensis looking at positioning of anemometers on ridge-tops during large scale fire experiments
    - Discussions with Geosciences Australia about bushfire risk frameworks
    - Collaborative work with an international research group examining major atmospheric disruptive events
- Publications
    - 1 submitted journal article under review
    - 1 conference paper
    - 1 completed discussion paper for the ‘Are big fires inevitable?’ National Forum
    - 5 papers in preparation

Understanding bushfire risk drivers in the high country

The main approach to understanding bushfire risk in the high country, which has been adopted by the project, is a fire size class transition model that allows a particular fire to evolve through a series of bushfire size classes: small, medium, large, very large and extreme. The driving features of such a model are the probabilities of transition between the classes. The work carried out so far has indicated that there are a series of key processes that act to alter the size of a fire in the high country and, as a consequence, the risk it poses to a particular asset. While many of these drivers of bushfire risk apply elsewhere there are many unknowns, and the combination of factors that can occur in the high country is worthy of detailed study.

Items under study include:

- Fuel age spectrum as an indicator of the potential of major fire development
- The evolution of fuel distribution in the catastrophic fire cycle
- The role of ruggedness as an initiator of fire
- Nocturnal low-level jets, subsidence inversions and other dew point anomalies
- Dry slots
- Unusual combustion
- Violent pyro-cumulonimbus development
- Mountain wind waves
- Foehn winds
- Dynamic channelling
- Terrain chimneys
- Plume-driven fire
- The role of ruggedness as a fire limiter

Research indicates that some of these have played key roles in the 2003 and 2006/7 alpine fires.

Fire Weather Analysis Program

Portable automatic weather stations (PAWS) will be used to quantify the various aspects of high country sub-synoptic scale meteorology relevant to bushfire risk. Extensive research was conducted to obtain an optimal balance between the number of PAWS units and the quality of the sensors. This involved field assessment and consultation with members of various agencies including the Bureau of Meteorology, New Zealand Rural Fire Authority, ACT Rural Fire Service, Victorian CFA and Geosciences Australia.

Evidence collected from the 2003 fires has been carefully examined in order to determine the best areas for deploying the PAWS units. We have thus been concentrating on those areas that were severely fire affected but are still reasonably accessible by road. We have discussed these issues with Ian Knight from Ensis, who has a background in wind measurement and modelling connected with fire research.

We have also been in discussion with NSW National Parks and Wildlife Service and Environment ACT who have granted HighFire Risk scientific licences to conduct research in the parks.

As of January 2007, there are two transects of PAWS operating in Brindabella National Park and Tidbinbilla Nature Reserve. Initial data streams have been downloaded and preliminary analyses indicate that

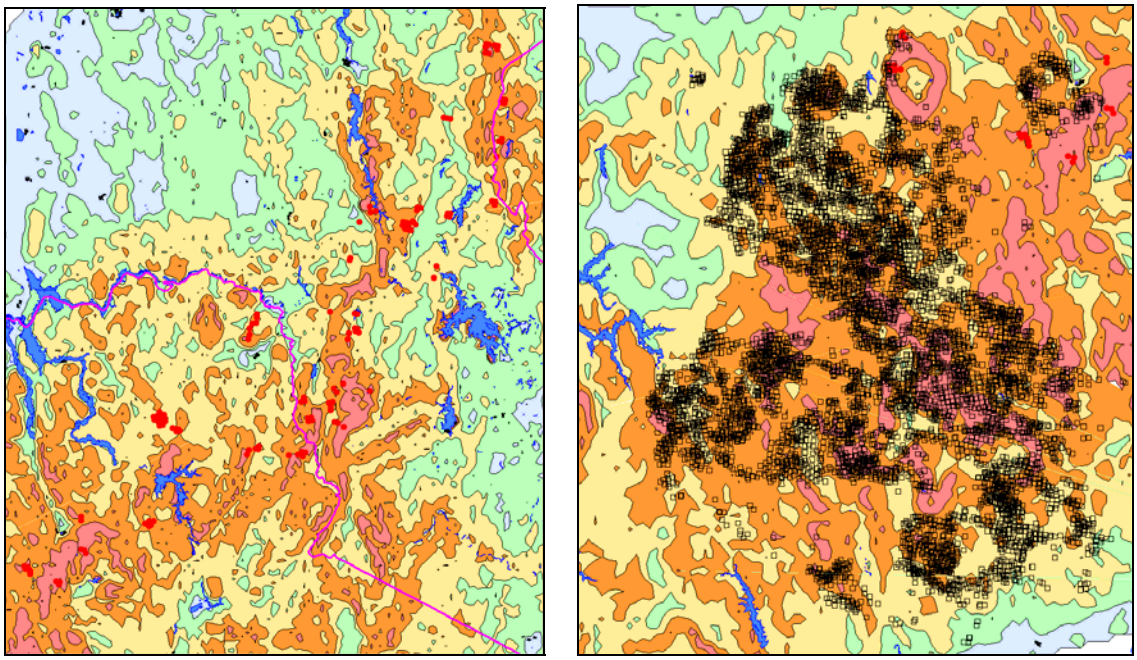
- The FFDI is elevated overnight on approximately 1 in 7 nights, primarily in response to a significant drop in the dew point. In about two thirds of these events there were some elevated overnight winds.
- There are some differences in diurnal temperature cycles between ridge-tops and nearby slopes.
- Ridge-top sites have 3 or 4 times the wind speed of upper slope sites.
- The ridge-top sites are locked into a very dominant bimodal wind distribution.

Figure 1. Installation of a portable automatic weather station on a very steep, fire-affected slope of the Tidbinbilla Range. This is one of a dozen stations, that carry sensors for a wide range of weather parameters, and which require no site disturbance to install.

Terrain Modelling

We are continuing to investigate the utility of various terrain indices derived from space shuttle data and digital elevation models. These terrain indices include measures of ruggedness and lightning ignition likelihood. Initial results suggest that there is a link between these terrain indices, fires caused by lightning ignition and historical fire scars. These may therefore prove useful in explaining actual lightning ignition and fire history patterns. To better test the relevant hypotheses we will seek collaboration with researchers from the Bushfire CRC's program B, such as Phil Zylstra who has recently completed a report that maps historical alpine fire scars. We will also be seeking

information on lightning climatologies from the relevant researchers and from the Sentinel fire detection system. Evidence arising from recent fires will also be analysed.



(a) (b)

Figure 2. (a) Indicative map of ignitions on 8/1/2003 (red dots) overlaid on map of terrain ruggedness index, (b) Terrain limiting of the December 2006 Victorian Alpine Fires. Rugged terrain is shown in yellow, orange or red. The southern margin made significant runs that produced some of the largest convection columns ever seen and yet failed to leave the rugged terrain.

The mesoscale elevation residual (MSER) is also being further investigated. The MSER is being used to provide look up tables for terrain correction of surface winds. Strong links with Kevin Tolhurst and Derek Chong have been fostered from early on in the HighFire Risk project and it thus hoped that collaboration with Program A's risk project will further improve risk management practices in complex terrain.

Risk management methodologies

The main tool adopted for understanding the risk posed by a bushfire is a fire size class transition model. A conceptual framework for the model can be seen in figure 3. It is a Markovian process model in which the transition probabilities have to be estimated through research into the key processes that cause escalation or decay of a fire. The weather monitoring program combined with physical modelling will provide information on the frequency and extent of the key process affecting these probabilities, as will analysis of fire data.

Methodologies allowing for the integration of various facets of knowledge to provide decision support for bushfire risk management will be an important component of the

HighFire Risk project. We have identified Bayesian Decision Networks (BDNs) as a viable option in this respect. Currently, however, the BDNs in use are of a form that doesn't allow the inclusion of spatially explicit models (eg. bushfire propagation model). Spatially explicit BDN's are under development and we have been discussing the possibilities with Carmel Pollino (iCAM, ANU), David Pullar (Uni. Queensland), David Ames (Utah) and Mark Burgman (ACERA, Uni. Melb.). Initial discussions were encouraging and suggest that spatially explicit BDNs for bushfire risk assessment are worth pursuing.

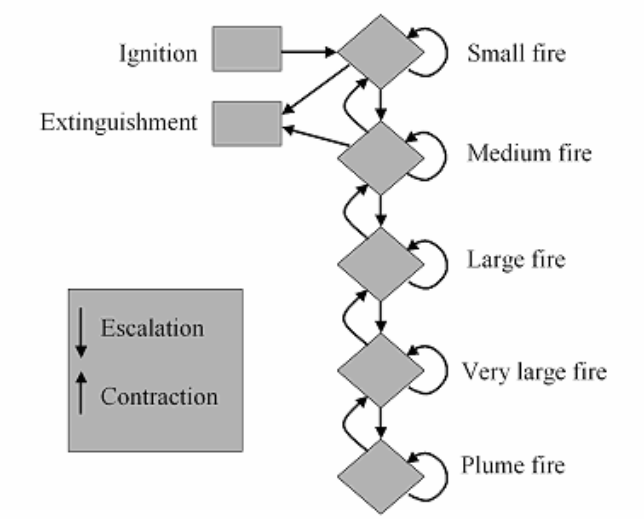


Figure 3. Summary of the fire size class transition model.

We also met with Kevin Tolhurst to discuss Phoenix at the ACT RFS on 7-8 September (see figure 2). The meeting involved a demonstration of the software and discussions about how Phoenix and HighFire Risk might combine research findings to deliver risk management tools relevant to high country landscapes. A member of HighFire Risk was present at the Phoenix training workshop in October 2006 and discussions have continued between Phoenix and HighFire Risk as to how best combine research findings.

Figure 4. Members of HighFire Risk, ACT RFS and Geosciences Australia meet with Kevin Tolhurst to discuss Phoenix at the ACT RFS Air Support Operations Centre.

Other activities

- A researcher from the HighFire Risk team recently attended the 5th International Conference on Forest Fire Research in Portugal. Contacts made with researchers at the conference have already led to some collaborative work between HighFire Risk and the University of Coimbra. We are investigating the applicability of some of their recent findings to the high country.
- We have recently obtained a version of the US Fire Labs "Wind Wizard" software to analyse wind-terrain interactions using computational fluid dynamics. Training in using the software continues. The software's outputs will be compared with actual measurements and with current operational models. This will lead to improvements in both the models and data collection methods.
- HighFire Risk has recently begun collaborative work with researchers from Ensis. This work involves wind measurements on ridge-tops to ascertain the most representative location for stationing anemometers during large scale fire experiments
- Members form HighFire Risk recently presented a series of talk at Geoscience Australia. Further discussions addressed the concepts of incorporating bushfire risk in the 'all-hazards' approach currently implemented by Geosciences Australia to deal with cyclones, floods and tsunami threats.
- HighFire Risk has recently begun working with Image Analysis and Mapping, Pty. Ltd. on reanalysis of infrared linescan data collected during the 2003 fires. These analyses have shown some unusual features in smoke plumes and the fire patterns on the ground. Joint publications seem likely.
- HighFire Risk is collaborating with an international research group examining major atmospheric disruptive events, which includes violent pyro-cumulonimbus development (as well as volcanic eruptions and atomic detonations).

Publications

1. Review of formal methodologies for wind-slope correction of wildfire rate of spread.

This paper reviews and compares the various formal methods (both vector and scalar) employed to correct rate and direction of bushfire spread in the presence of both wind and slope. These methods are critical for bushfire spread models employed in complex terrain. After discussions with Rob McAlpine (Ministry of Natural Resources, Canada), Jim Gould (Ensis), Kevin Tolhurst and Derek Chong (Uni. Melb.) the paper was revised and submitted to the International Journal of Wildland Fire in November 2006. It is currently under review.

2. Lessons from the January 2003 fires – advancing bushfire risk management in the high country.

This paper details some of the important information relevant to bushfire risk management that has arisen since the 2003 alpine fires. It outlines some of the shortcomings of current risk management practices and presents evidence of some of the

significant additional drivers of bushfire risk that operate in high country landscapes. This paper was presented at the July 2006 Bushfire Conference in Brisbane and appears in the proceedings.

3. Review of mountain meteorology relevant to fire behaviour and bushfire risk.

This paper draws together and explains those elements of mountain meteorology that have the potential to severely effect fire behaviour and hence contribute significantly to overall bushfire risk in regions of complex terrain. The mountain meteorological literature has been extensively consulted and condensed into an easily readable form that is relevant to Bushfire CRC stakeholders and researchers. Preparation of the paper has involved consultation with the Bureau of Meteorology Research Centre and other fire weather experts such as David Packham (Monash Uni.) and Alen Slipjcevic (CFA). The paper will be completed and submitted to the International Journal of Wildland Fire near the end of February 2007.

4. Incorporating terrain geometry in an eruptive fire behaviour model.

This paper details collaborative work with D.X. Viegas and C. Rossa from the University of Coimbra, Portugal. In builds on the eruptive fire behaviour models developed by Viegas, specifically dealing with the problem of how to combine terrain information with these models. These approaches are important for understanding the dynamic fire behaviour that can occur in complex terrain and that can often lead to dangerous conditions.

5. Are big fires inevitable? – Perspectives from the HighFire Risk project.

This paper deals with the problem of understanding how large fires evolve in high country landscapes. The problem is discussed with reference to a fire size class transition model and the factors that affect the probability of a particular transition occurring. The paper is intended to be a discussion paper for the upcoming National Forum.

6. Fire channelling.

This paper discusses the phenomenon of dynamic channelling of airflow by rugged terrain and how it affects fire behaviour. Evidence arising from the January 2003 fires is presented and analysed. The analysis sheds light on the role that channelling events play in the escalation of a fire. Comparisons are made with some noteworthy international fire events such as the Storm King Mountain blow-up. The first draft of this paper is currently under preparation and should be completed by mid 2007.

7. A simple method for calculating fire danger.

This paper introduces a simple algorithm for computing fire danger. This novel approach is compared and contrasted with existing fire danger indices. The first draft of this paper is under preparation and should be completed by mid 2007.

8. The role of terrain ruggedness in bushfire risk management.

This paper discusses the part that terrain ruggedness plays in the overall bushfire risk framework. The effects of ruggedness on lightning ignition likelihood and the implications for risk management practices are discussed. The role that ruggedness plays on controlling large fires in the high country is also discussed in light of evidence arising from recent fires. The first draft of this paper is currently under preparation and will be completed by mid to late 2007.