EVALUATION OF OPERATIONAL MODELS FOR WIND VARIABILITY OVER COMPLEX TERRAIN

bushfire&natural HAZARDSCRC

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UNDERSTANDING THE VARIABILITY OF WIND SPEED AND DIRECTION ACROSS COMPLEX TERRAIN IS A VITAL PART OF UNDERSTANDING VOLATILE FIRE BEHAVIOUR. A PROBABILISTIC CHARACTERISATION OF WIND FIELDS CAN COMPLEMENT THE CURRENT DETERMINISTIC APPROACHES TO ENHANCE DISCUSSION OF UNCERTAINTIES IN THE MODELLING PROCESS.

INTRODUCTION

Wind characteristics over complex terrain are highly variable and modelling them comes with inherent uncertainties. These uncertainties are often not captured in the current operational wind models used for fire prediction. It is shown here that these deterministic models can grossly underestimate the variability of wind direction across complex terrain.

Case Study: Flea Creek Valley in the Brindabella Ranges was heavily burnt by the 2003 Canberra bushfires. Across this region, fires were shown to travel in directions different (and sometimes perpendicular) to that of the prevailing winds.

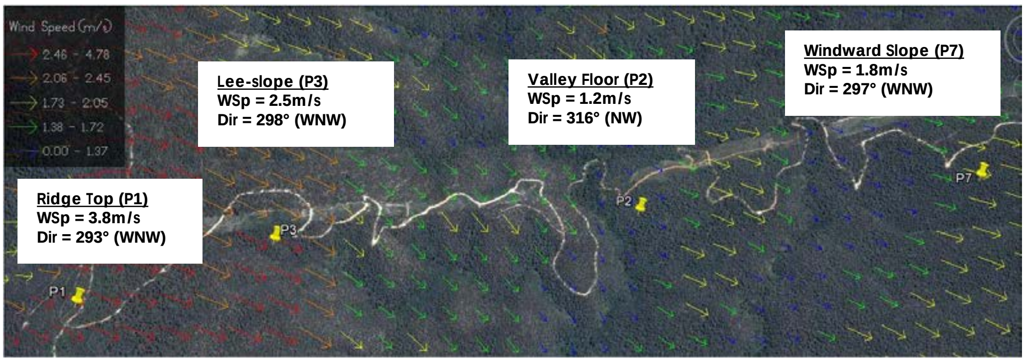

Figure 1: WindNinja 2.5.2 wind speed and direction output for Flea Creek Valley (WindNinja and Google Earth).

Table 1: Probabilities of valley winds being as predicted by WindNinja, given a prevailing WNW wind direction and increasing wind speed thresholds.

	≥ 0m/s	≥ 2m/s	≥ 4m/s
Leeward: P(P3=WNW|P1=WNW)	0.0239	0.0083	0
Valley Floor: P(P2=NW|P1=WNW)	0.0732	0.0387	0.0499
Windward: P(P7=WNW|P1=WNW)	0.0356	0.0092	0.0001

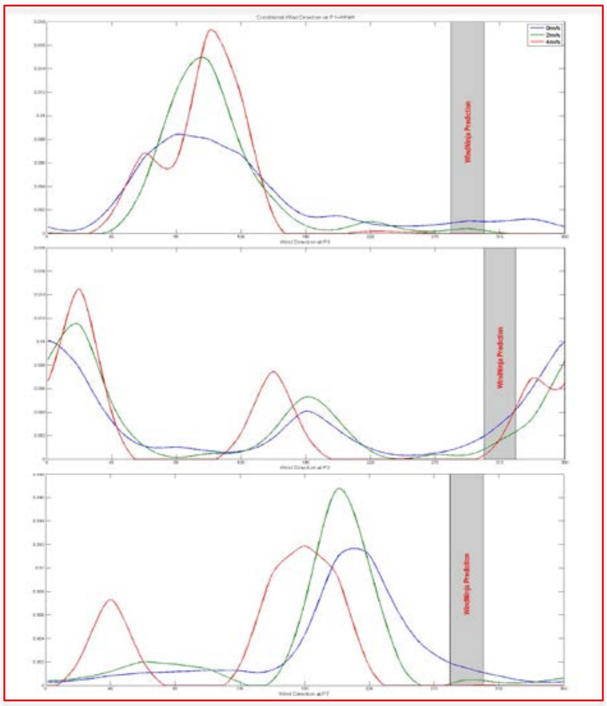

Figure 2: Wind direction distributions for the lee-slope (P3; top), valley floor(P2; middle) and windward slope (P7; bottom) in Flea Creek Valley. Grey regions represent the compass point (22.5° interval) predicted by WindNinja.

MODELLED WIND FIELD

WindNinja (Version 2.5.2) was used to model wind speed and direction across Flea Creek Valley (Figure 1). The input vegetation was set to "trees", while the domain averaged winds at 5m were set to 2m/s from 300° (WNW-NW). No diurnal effects were included. The model provided predictions for 5m winds at medium (104m) resolution.

OBSERVED WIND FIELD

Wind direction distributions were constructed using data observed at four points in the valley between April and July 2014. Figure 2 shows the conditional distributions of the wind directions on the lee-slope (P3), valley floor (P2) and windward slope (P7), given a WNW (293°) prevailing wind measured on the western ridge line (P1). Three prevailing wind speed thresholds are shown (0m/s, 2m/s and 4m/s) to highlight the changing directional behaviour as wind speeds increase across the valley.

RESULTS

The peaks observed in each of the conditional wind direction distributions from Flea Creek Valley do not agree with the wind direction predicted by WindNinja. Even on the windward slope (P7), only 3.6% of observations were aligned with the predicted wind direction, or in fact the observed prevailing WNW direction.

The most obvious disagreement is on the leeward slope (P3), where only 2.4% agree. The dominant mode on the leeward slope is that representing a wind reversal (i.e. observing ESE). The probability of observing this reversal increases from 19% up to 37.3% as the wind speed threshold increases.

The closest agreement is found on the valley floor, where 7.3% of all winds observed agree with the predicted NW direction. However, the distinct bimodal flow up and down the valley is not captured by the single prediction given in this study.

CONCLUSIONS AND FURTHER WORK

Preliminary analysis clearly highlights the variability in wind direction that is not captured in current deterministic wind modelling approaches. Future investigations will continue this analysis by considering further operational models.

There is potential for significant improvement in wind modelling for fire prediction by developing a probabilistic characterisation of wind fields. The next step towards this is to develop statistical models incorporating physical parameters which can be extrapolated across the landscape.

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WindNinja

WindNinja 2.5.2 http://www.firelab.org/project/windninja

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