Lessons from the Burning Bush - The Influence of Live Fuels on Fire Behaviour

Philip Zylstra

Project: Fire regimes and Sustainable Risk Management (B.1.2)

Program: Ensuring Sustainable, Safe Prescribed Burning

Introduction

This study examines the role of the shrub *Daviesia mimosoides* in low to moderate intensity experimental fires and uses a rudimentary semi-physical model to predict the contribution of the species to fire intensity with changing weather conditions, terrain,leaf moisture, plant size and plant density.

Methods

Data was collected from video and other records of 8 experimental burns, examining the broad changes in flammability of the species with variations in leaf moisture and plant height.

The semi-physical model used empirical data (Table 1) collected from the burns coupled with existing theory on the factors affecting ignition delay time (ignitability of fuels), flame merging, and plume angle. Convective heat transfer only was considered, and the flame geometry and temperature gradient in the plumes were simplified.

Predicted results were compared with those of an existing empirical model (A.G. McArthur's Leaflet 80) that does not consider differences in live fuels. Results were tested against 37 flame height measurements taken during the experimental burns:

a) when isolated plants were burning, and

b) when groups of plants were burning and flame merging occurred

TABLE 1. Field Data Used in the model

Live Fuel Descriptors

Plant height, plant base height, plant diameter, leaf thickness, leaf moisture, plant spacing, percent cover of plants.

Other Factors

Change in flame height and duration with moisture content and plant size, mean surface flame height away from burning plants, surface fuel moisture, mean 30 second wind speed, slope

Results

D. mimosoides plants had a negligible effect on mean flame height when the separation between plants was 0.63m or greater, but when the mean separation was 0.49m or less, the effect was to multiply the flame height by a factor of 3.57 (figure 1).

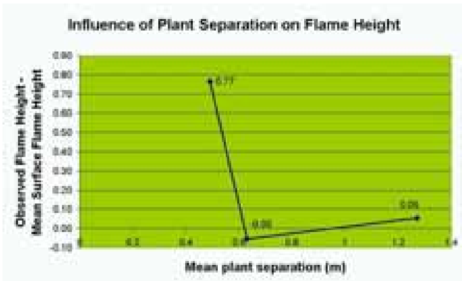

Figure 1. The Influence of plant separation on flame height

Flame height in the study was poorly represented by the empyrical approach of leaflet 80 (figure 2), which significantly over-predicted when surface fuels were heavy (15t/Ha) and live fuels sparce.

The semi-physical model was able to more closely follow the change in flame height, giving a consistent slight over-prediction but with a correlation coefficient of 0.87.

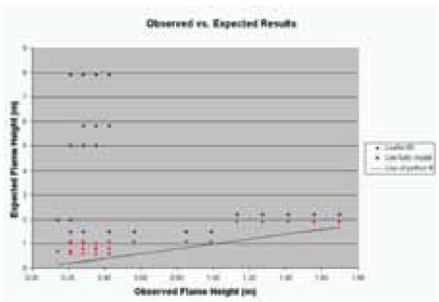

Figure 2. Observed vs. expected results for both models

Discussion

Although only in its early stages, this study suggests that the contribution to flame height by burning live fuels (Figures 3 & 4) can be significant, and beyond the capacity of a generic empyrical model to encapsulate. In contrast, the semi-physical model was able to more closely model the contribution made by this species through consideration of the combined effects of flame angle and ignitability on plant density, to facilitate the phenomenon of flame merging.

Figure 3. Merging of flame from 3 plants producing a flame height of 1.4m

*Figure 4.*Surface fuels burning at the same site as figure 3 with a flame height of 0.3m.

Acknowledgements

Much valuable advice has been provided for this work by Prof. Rodney Weber, Dr Malcolm Gill, Dr. Matt Plucinski and Mr Brendan Pippin. All burns were carried out with the generous assistance of the NSW NPWS staff at Jindabyne and the Rocky Plains Fire Brigade.