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A commentary on visual fuel assessment methods

Assessment of fuel in the form of fuel hazard has become the most common method of describing Australian forest fuel complexes, despite a lack of evidence supporting many of the underlying assumptions. Published studies of fuel assessments were analysed to evaluate the merits of fuel hazard ratings for representing measurable fuel characteristics such as fuel load and fire behaviour potential. No evidence of a functional relationship between fuel hazard rating and fuel quantity or fuel hazard rating and fire behaviour potential was found.

Visual fuel assessment methods

In Australia over the last 30 or so years, fuel assessment and inventory methods have shifted from direct measurement of physical fuel attributes, such as fuel load, cover and height, to the indirect assessment of 'fuel hazard' characteristics. Fuel hazard rating (FHR) (and the related fuel hazard score), visually appraise different fuel characteristics, such as mass, cover, height, continuity (vertical and horizontal), density and perceived flammability, to classify fuels into abstract fuel hazard categories.

Since the introduction of various visual assessment guides in the 1990s, they have been implemented in many fire management and research applications. This is despite a lack of evidence supporting the assumptions upon which the methods are based and the fact that the methods were not originally designed for such purpose. FHR assessments are based on three assumptions:

1) that the assessment method is objective and replicable;
2) that there is a relationship between the assessed rating and physical fuel properties driving fire behaviour, namely fine fuel load; and,
3) that the assessed overall fuel hazard rating is associated with fire behaviour potential.

Subjectivity and non-replicable nature of FHR assessment methods

As a largely visual method, FHR assessments are inherently subjective. Several studies pointed out a noticeable absence of objectivity in the methods due to the need for personal judgments when ranking the multidimensional nature of fuel characteristics and a lack of clarity in the definition of a number of fuel layers. The studies show that FHR results depend on the expertise and experience of the assessors. Lack of rigorous training with exposure to a wide range of fuel states is also known to increase subjectivity and biases in FHR data. The subjectivity of these visually-based assessment methods contributes to substantial uncertainty in predictions of fire behaviour and danger, either when (1) using the Vesta Mk 1 fire spread model that relies on surface and near-surface fuel layer hazard score as direct inputs, or (2) when converting FHRs into fuel load metrics for input to other fire behaviour models such as the McArthur Forest Fire Danger Meter.

Lack of a relationship between visually assessed ratings and fuel load

Currently one of the main uses of FHR data is the simple conversion of ratings into fuel load values. Two main issues arise from this conversion: firstly, the subjective nature of the FHR assessment causes a large uncertainty in estimated fuel loads, with studies suggesting variation of up to threefold from

different assessors. Secondly, and most importantly, there is no evidence that the relationships derived between FHR and fuel load hold true, with several studies showing no relationship between assigned FHR values and measured biomass for surface, near-surface or elevated fuel components.

FHR and fire behaviour potential

The Overall Fuel Hazard Rating (OFHR) aims to combine the hazard ratings for the individual fuel layers to represent "the effect that the fuel arrangement is likely to have on fire behaviour" and "the ability of suppression forces to control a fire in these fuels" under a defined set of fire weather conditions (McCarthy et al. 1999). The absence of a physical bases for combining individual FHRs or defining thresholds between rating classes contrasts starkly with the apparent high value Australian fire management agencies place on the FHRs as evidenced by the scale of investment in conducting thousands of such assessments every year. An analysis of simulated fire behaviour in Tasmanian open dry eucalypt forest fuel data using the Vesta Mk 2 fire spread model showed no effect of OFHR on fireline intensity (Fig 1). Variation within OFHR classes was larger than between classes with no statistically significant differences in fireline intensity between OFHR classes. These results question the validity of the OFHR in capturing the effect of fuel arrangement on fire behaviour.

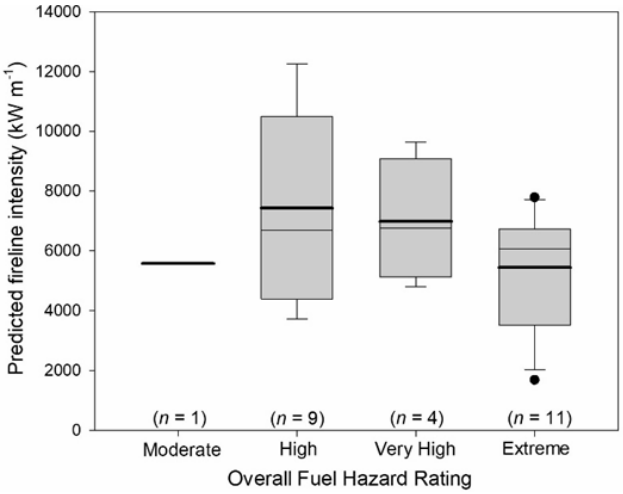

Figure 1. Distribution of predicted fireline intensity by Overall Fuel Hazard Rating found for Tasmanian open eucalypt forests.

The need for measurement and inventory of fuel physical characteristics

Despite the large investment in fuel hazard assessments over the last few decades in Australia, the value of the data collected is unclear. The evidence overwhelmingly shows that these data do not capture what the system creators envisioned or what the system users imagine.

Fuel attribute measurements based on well-established destructive sampling methods (e.g. objective, teachable, replicable, repeatable, representative, statistically sound), although much more onerous to carry out than visually based FHR assessments, provide reliable, accurate and meaningful data that can be used in a range of applications. These include supporting estimations of fire danger, risk and behaviour, modelling temporal variability in fuels, and quantifying effects of different fuel management and fire risk mitigation operations.

There is a critical need to establish consistent and robust national guidelines and scientifically valid methodologies for measuring the physical attributes of fuels that are essential inputs to widely used fire behaviour models employed for a variety of purposes. Such guidelines, agreed by the various agencies, are necessary before replicable fuel inventory schemes can be applied nationally.

Further reading

Cruz M (2024) A comment on the use of visually assessed Fuel Hazard Ratings and Scores for Australian fire management and research. *International Journal of Wildland Fire* **33**, WF23164. (Available as open-access for free download)

References

McCarthy GJ, Tolhurst KG, Chatto K (1999) Overall Fuel Hazard Guide, 3rd Edition. Victorian Department of Natural Resources and Environment, Fire Management Branch, Fire Management Research Report No. 47, East Melbourne, Vic.

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