How do Tall Wet Eucalypt Forests Burn?

Modelling fuels and fire behaviour in one of the world's most complicated forests

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Tall Wet Eucalypt Forests (TWEF) are one of the world's most complex and unique forest types. A combination of eucalypts in the canopy, and rainforest and sclerophyllous vegetation in the understorey, results in a complex flammability profile. Hence fire behaviour in TWEF is poorly understood. This project seeks to characterise the fuels and fire regimes in Tasmanian TWEF and develop a conceptual framework for modelling fire behaviour in these forests.

TASMANIAN TWEF HAVE THE POTENTIAL TO EXHIBIT EXTREME FIRE INTENSITIES

We performed a simulation study of the Phoenix Rapidfire model under bad fire weather. It suggested that Tasmanian TWEF have the potential to exhibit the world's highest fire intensities.

Maximum Fire Intensity (kW/m)

0   100000

Figure 1: Maps of simulated fire intensity (left) and TWEF extent (right) in Tasmania
11,059 fires were simulated on a 99th percentile FFDI day using the Phoenix Rapidfire model assuming the most extensive planned burning regime theoretically possible

BUT OLD-GROWTH TWEF CAN ALSO EXPERIENCE LOW-SEVERITY FIRES

We measured fuels in old-growth TWEF across Australia and retrieved nearby historical climate data. We estimated potential fire severities and found that both low- and high-severity fires were likely. We concluded that old-growth TWEF support mixed-severity fire regimes

Figure 2: Probabilities of high-severity fires in TWEF across Australia[B]
We estimated flame heights using fuel load data and 90th percentile and above FFDI records with the McArthur model. We compared flame heights to canopy heights to estimate the probability of the following categories of high-severity fires occurring:
- ■ Coupled surface-understorey fire scorches canopy
- ■ Coupled surface-understorey fire consumes canopy
- ■ Surface fire scorches canopy
- ■ Surface fire consumes canopy

FURTHER, IN TASMANIA, HIGH-SEVERITY FIRES APPEAR MORE LIKELY IN REGROWTH STANDS

We similarly measured fuels across a variety of old-growth and regrowth stands in Tasmanian TWEF. We used this fuel load data and historical climate data to estimate fire severities and found that the potential for high-severity fires was higher in regrowth than in old-growth forest
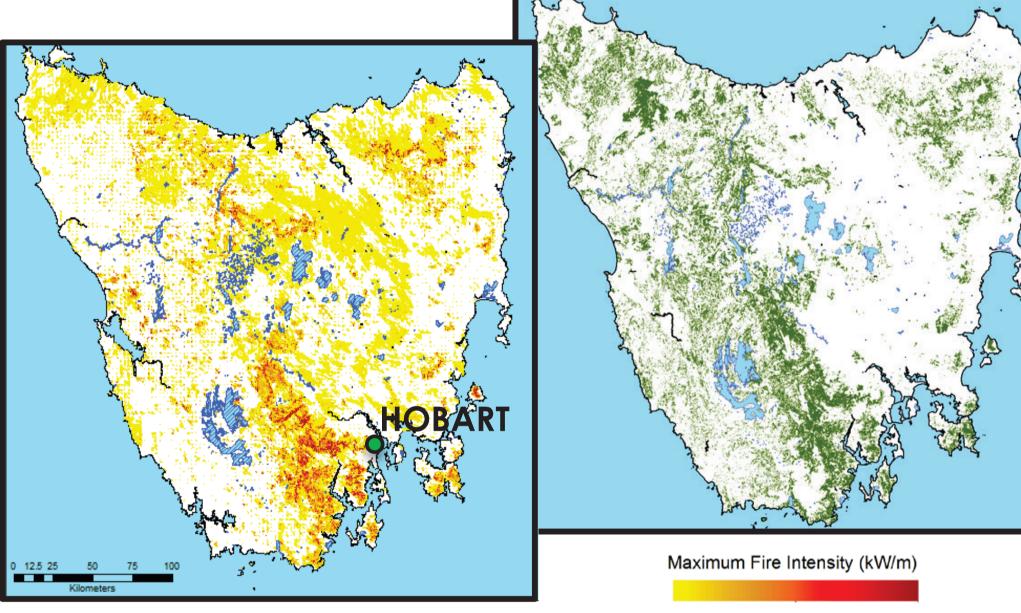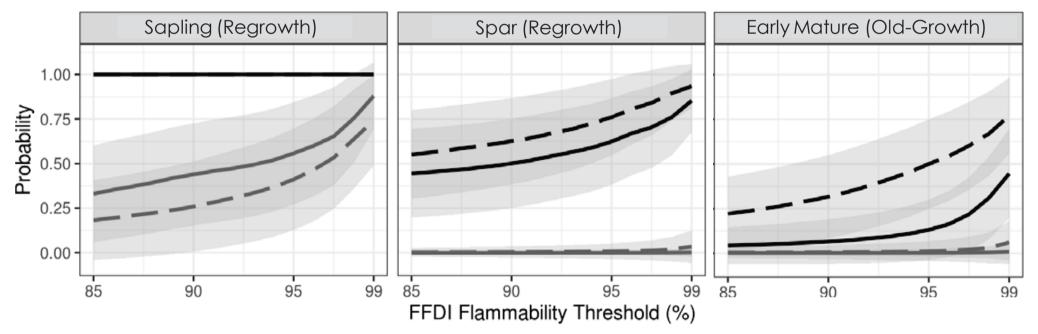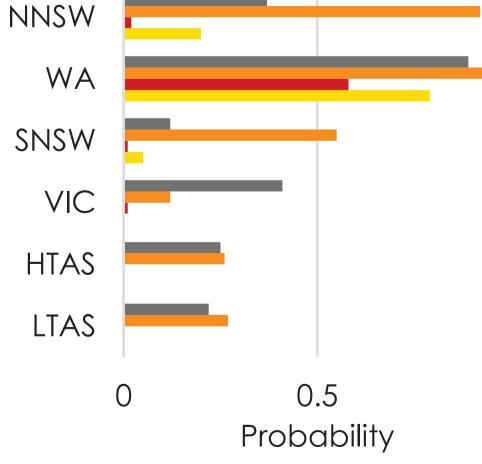

Figure 3: Probability of high-severity fires occurring in different stand-development stages across a range of flammability thresholds[C]
We estimated flame heights and fire severity using fuel load data and FFDI records above a given hypothetical flammability threshold. This threshold represented the assumed percentile FFDI at which wet eucalypt forests can burn for the following different categories of high-severity fires:

- – – Coupled surface-understorey fire scorches canopy
- —— Coupled surface-understorey fire consumes canopy
- – – Surface fire scorches canopy
- —— Surface fire consumes canopy

HENCE, FUEL DYNAMICS IN TWEF VIOLATE A MAJOR ASSUMPTION OF CURRENT FIRE BEHAVIOUR MODELS

Current models assume that fire hazard continuously accumulates over time, with the oldest stands exhibiting the highest fire danger. Our findings indicate that the standard fuel accumulation curves that underly fire behaviour models are incapable of representing the complexities of TWEF fuels.

SO HOW DO WE MODEL FIRE BEHAVIOUR IN TWEF?

We are currently performing a global review of different fire behaviour modelling approaches. We will use this, in combination with our understanding of fuels and fire regimes in TWEF to develop a conceptual framework for building and calibrating a fire behaviour model that can accurately represent tall wet eucalypt forests.

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