Department of Environment and Conservation (NSW)

Can weather indices on ignition day predict the probability of large fires in the Sydney region?

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Figure 1. FFDI values

Equation 1 (Noble *et al.* 1980)

$$FFDI=2*\exp(-0.450+0.987*\ln(DF)-0.0345*H+0.0338*T+0.0234*V)$$

H=Relative humidity
T=Air temperature
V=Wind velocity
DF=Drought factor

Background and Aims

Weather has a major impact on fire spread (Gill & Moore 1996, Keeley 2004). Few studies have examined the relationship between large areas burned and weather (Preisler *et al.* 2004). Indices can act as surrogates for weather variables.

The forest fire danger index (FFDI) was developed by McArthur in 1967 to predict fire spread rates and indicate fire danger (Figure 1). FFDI (Equation 1) is determined by both drought (drought factor (DF)) and ambient (relative humidity, air temperature, wind velocity (FFDI(DF=1)) indices.

Using historical information, this study examined the probability of large fire ($\geq$1000 ha) ignition days in relation to drought and ambient indices on ignition day. Predictions under both current and future climatic conditions are important for nature conservation and the protection of life and property. The Sydney region was chosen for its long-term weather data and reliable information on unplanned fire occurrences.

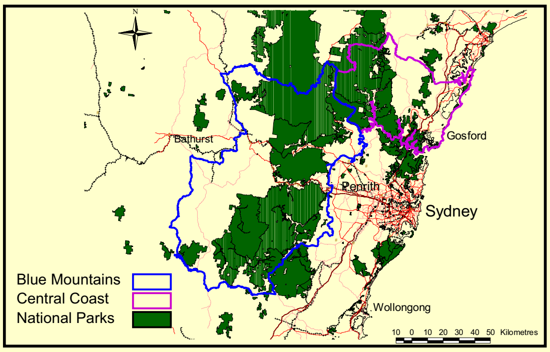


Figure 2. Study areas

Methods

Historical data on unplanned fire occurrence and size within Blue Mountains (1960-2003) and Central Coast (1988-2003) districts were collected. The combined study areas covered approximately 1.5 million ha (Figure 2).

On each day of ignition, weather indices and the resulting area burned were calculated. Weather data for the Blue Mountains and Central Coast districts were taken from respectively, Sydney and Williamtown stations (Australian Bureau of Meteorology).

Logistic regression was used to relate the probability of large fire ignition days and explanatory variables (FFDI, DF, FFDI(DF=1)) on the days of ignition (Blue Mountains n=15705 (51 large fire ignition days); Central Coast n=5455 (23 large fire ignition days. Interaction terms were considered. Models were fitted with WinBUGS (Spiegelhalter *et al.* 2000).

Results

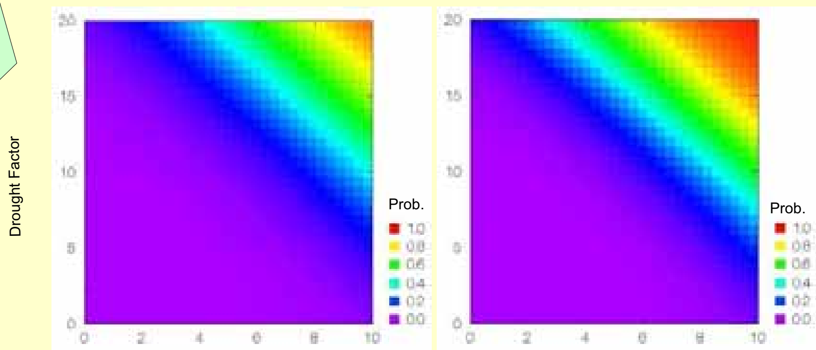
The best model for both study areas was the additive effects of the ambient (FFDI(DF=1)) and drought (DF) components of FFDI. As each increased there was a corresponding increase in the predicted probability of large fire ignition days (Figures 3a,b).

Figures 3a,b indicate a $\geq$50% chance of a large fire ignition day on the Central Coast when DF$\geq$9 and FFDI(DF=1) $\geq$4, and in the Blue Mountains when DF$\geq$12 and FFDI(DF=1) $\geq$5. Over the respective study periods these ranges in conditions were met on 1.43% days (5 days/year) on the Central Coast and on 0.13% days (0.5 days/year) in the Blue Mountains.

The higher predicted probabilities at lower values of FFDI(DF=1) and DF on the Central Coast indicate spatial and temporal variations, beyond the scope of this study. Further work is needed to examine other days in the fire cycle, which may also be used as indicators.

Climatic modelling (Hennessy *et al.* 2005) indicates an increase in the frequency of high and extreme FFDI days. Our work infers a coincident increase in the occurrence of large fires. This will be especially critical for the more fire sensitive native biota in reserves adjacent to major urban areas, where arson is more likely and there are other management imperatives such as life/property protection.

3a. Blue Mountains **3b. Central Coast**



Forest Fire Danger Index (Drought Factor =1)

Figures 3a,b. Contour plots showing the mean predicted probabilities (0-1) of occurrence of large fire ($\geq$ 1000 ha) ignition days in relation to ambient (FFDI(DF=1)) and drought (DF) indices on ignition day.

Summary

- *Weather indices on ignition day were used to predict the probability of large fire ignition days- higher ambient and drought indices lead to higher probabilities.*
- *There is $\geq$50% chance of a large fire ignition day on the Central Coast when DF$\geq$9 and FFDI(DF=1) $\geq$4, and in the Blue Mountains when DF$\geq$12 and FFDI(DF=1) $\geq$5.*
- *With climate change, a predicted increase in FFDI, may lead to a coincident increase in the probability of large fires.*
- *With an increase in the probability of large fires, nature conservation may be especially difficult in reserves adjacent to major urban areas where arson is more likely and there are other management imperatives such as life/property protection.*

References

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