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Comparing daily fire danger metrics with fire activity

Fire danger indices integrate weather and fuel variables to indicate the potential for bushfires to ignite, spread, resist suppression and cause damage. There are a range of ways that these can be summarised at the daily scale. Different daily summary statistics of the Forest Fire Danger Index (FFDI) were compared with fire occurrence data in six forested areas in southern Australia. Maximum hourly FFDI performed the best overall, although no statistically significant differences between variants were detected, including between those calculated using different drought indices.

Fire danger

The Forest Fire Danger Index (FFDI, McArthur 1967) is applied across much of Australia, with the daily maximum value calculated using forecast weather. It is used to guide public warnings, fire-use restrictions, prescribed burning and suppression resourcing. The advent of weather forecasts at hourly intervals enables other summarising methods to be applied to estimate daily fire danger.

This study compared a variety of daily FFDI summary statistics with fire occurrence records to determine if any of these are suitable for estimating likely fire activity on a given day.

Summarising daily fire danger

Twelve metrics for summarising daily FFDI were calculated using observations from a centrally located weather station in each study area and compared to the fire activity classifications of the area. The maximum FFDI calculated using observations from each hour (M1) was used as the standard for comparing all other metrics. There were six other variants of the daily maximum FFDI (M2-M7), including the FFDI calculated from the observed hourly extremes of input variables, FFDI calculated with a lagged moisture input and FFDI observed at 15:00 local time. The sum of hourly FFDI observations were considered for five different periods (S1-S5) including all 24 hours, daylight hours and afternoon hours.

The use of daily maximum and summed hourly metrics allowed the influence of daily profile shape to be investigated (Fig. 1). The influence of the choice of drought index in the drought factor calculation (i.e., Keetch-Byram Drought Index (KBDI) or Soil Dryness Index (SDI)) was also investigated.

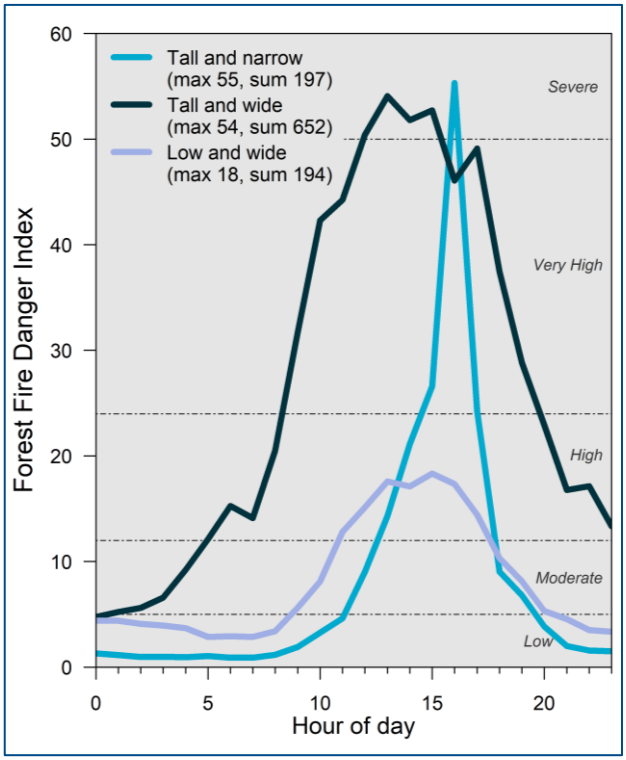

Figure 1. Example days from the same weather station with different FFDI profiles summarised using maximum values and values observed at each hour summed for a 24-hour period.

Comparison with fire activity

Fire activity data were obtained for a 14-year period from three case study areas across south-west Western Australia and three in Victoria. These were used to determine five different binary daily fire activity classifications based on the daily occurrence of one or more fires, two or more fires, and fires that burned more than 5, 50 and 500 hectares in each study area.

The analysis applied the rank percentile method (Eastaugh 2012) to determine the best metric for each fire activity classification in each study area.

Differences in fire activity on days with wide and narrow FFDI profiles were examined for days with above median FFDI. Days with wide profiles were those with high summed hourly FFDI and lower maximum FFDI and those with narrow profiles had high maximum FFDI and a lower summed FFDI across the day (Fig. 1).

Findings

The analysis found that most daily FFDI summary metrics performed similarly in relation to predicting observed fire occurrence. The standard maximum hourly FFDI performed better than other metrics for most fire activity day types, however this difference was not statistically significant (Figure 2).

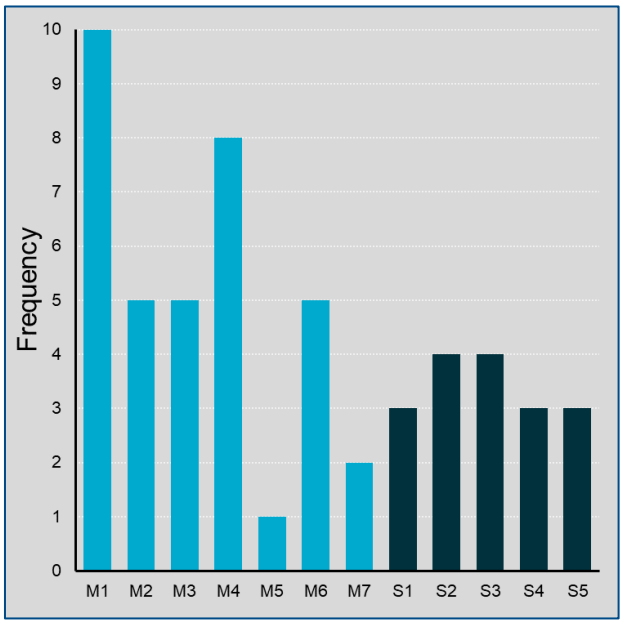

Figure 2. Histogram showing the frequency that each of the metrics tested performed best for each combination of fire activity classification and case study area. Light blue columns show the daily maximum metrics (M) and dark blue columns show summed hourly metrics (S). M1, the maximum FFDI for the day determined from hourly observations during the day was found to most often be the best performing metric.

Days with wide and narrow FFDI profiles were found to have similar fire occurrence rates in all but one case study area (Perth Hills), where more fires occurred on days with wide profiles.

There was no clear preference for FFDI summary metrics derived using KBDI or SDI determined inputs. This finding is not surprising as both indices aim to quantify the longer-term moisture deficit in soils.

Conclusions and implications

The results justify the current use of the forecast hourly maximum FFDI and indicate that the use of alternative methods to determine Drought Factor offers little benefit.

Daily maximum metrics are easier to forecast than the summed period metrics, as they generally occur during a similar time period each day and do not need to account for conditions across a broader time window. The forecasting of summed period metrics would be more prone to error as the effect of fine temporal inaccuracies across the day can accumulate.

The evaluation of the performance of fire danger rating systems is challenging because they are applied at broad spatial scales and for multiple purposes. The selection of suitable metrics for evaluating their performance is subjective, depending on purpose, and thus they cannot be evaluated for all possible applications (e.g. fire occurrence, fire behaviour, suppression difficulty, community impact) simultaneously. Fire activity metrics for evaluating fire danger indices are not independent as feedbacks between the forecast metric and outcomes can exist, such as the impact of fire-use restrictions.

Further reading

Plucinski, MP, Sullivan, AL, McCaw, WL (2020) Comparing the performance of daily forest fire danger summary metrics for estimating fire activity in southern Australian forests. *International Journal of Wildland Fire* 29(10), 926-938.

References

Eastaugh, CS, Arpaci, A, Vacik, H (2012) A cautionary note regarding comparisons of fire danger indices. *Natural Hazards and Earth System Sciences* 12, 927-934.

McArthur AG (1967) Fire Behaviour in Eucalypt Forests. Forestry and Timber Bureau Leaflet 107, Commonwealth Department of National Development (Canberra).

CONTACT US
t 1300 363 400
+61 3 9545 2176
e enquiries@csiro.au
w www.csiro.au

FOR FURTHER INFORMATION
CSIRO Land and Water
Dr Andrew Sullivan
t +61 2 6246 4051
e Andrew.Sullivan@csiro.au
w www.csiro.au/en/Research/LWF

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