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Supplementary Material

Exploring the influence of the Keetch–Byram Drought Index and McArthur's Drought Factor on wildfire incidence in Victoria, Australia

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Calculation of KBDI and DF

The calculation of KBDI and DF used for this study use the method of Finkele et al (2006a, 2006b) and are consistent with those applied within the Bureau of Meteorology and used operationally by Australian fire agenies.

The KBDI for a given day ($KBDI_n$) is calculated with a book keeping function that uses the KBDI from the previous day ($KBDI_{n-1}$) and estimates of effective precipitation (P_{eff}) and daily evapotranspiraion (ET) from the previous day (Equation S1).

$$KBDI_n = KBDI_{n-1} - \ P_{eff} + ET \qquad \text{S1}$$

The effective precipitation is estimated as the difference between the daily rainfall total (collected at 9 am local time) and the estimated quantities that have been intercepted by vegetation and/ or run off the soil. The quantity intercepted or run off is approximated as the first 5 mm within consecutive days with non-zero rainfall and does not account for differences in vegetation, soil type or terrain. Daily evapotranspiration for the previous day is estimated from the KBDI and maximum temperature (T_{max}) of the previous day and the annual rainfall (R_{ann}) for the site using equation S2.

$$ET = \frac{(203.2-\mathrm{KBDI}_{n-1})(0.968e^{0.0875Tmax+1.5552-8.3})}{1+10.88e^{-0.00173R_{ann}}}10^{-3} \qquad \text{S2}$$

KBDI assumes that the rate of moisture loss from the soil is a function of vegetation cover, reflected by the annual rainfall and that the estimated evapotransipriation approximates the rate of moisture loss from the soil. It also assumes that the soil depth has a field capacity of 200 mm, and is capped at this value (Sullivan 2001).

Drought factor (DF) is calculated using the soil moisture deficit estimated by KBDI and rainfall over the previous 20 days (Griffiths 1999; Finkele *et al.* 2006a, 2006b).

$$DF = 10.5(1 - \mathrm{e}^{-(KBDI+30)/40})\frac{41\mathrm{x}^2+x}{40\mathrm{x}^2+x+1} \qquad \text{S3}$$

Where *x* is the influence of the past rainfall amount (*P*) and the number of days (*N*) since it fell.

$$x = \begin{cases} \frac{N^{1.3}}{N^{1.3}+P-2} & N \geq 1 \; and \; P > 2 \; mm \\ \frac{0.8^{1.3}}{0.8^{1.3}+P-2} & N = 0 \; and \; P > 2 \; mm \\ 1 & P < 2mm \end{cases} \quad \text{S4}$$

According to Finkele et al (2006a, 2006b) operation use found these equations to result in DF increasing too quickly during prolonged dry periods after large rain events, so they presented two adjustments to these results. The first of these limit DF outputs within KBDI values in a similar manner to the original Forest Fire Danger Meter (McArthur 1967) circular slide rules where DF estimates were limited to four KBDI range categories. The second adjustment, uses equation S5, and was applied here as it is the version used by the Bureau of Meteorology and applied operationally by Australian fire agencies.

$$x_{lim} = \begin{cases} \frac{1}{1+0.1135 \; KBDI} & KBDI < 20 \\ \frac{75}{270.525-1.267KBDI} & KBDI \geq 20 \end{cases} \quad \text{S5}$$

This equation results in the maximum value of 6.2 when the KBDI is less than 20, which causes the local peak observed in Figures 2b and 2d.

References

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