CSIRO PyroPage
Putting science into practice

www.csiro.au

Number 38 | July 2024

Linking fire occurrence with landscape dryness metrics

Links between wildfire occurrence and the Keetch-Byram Drought Index (KBDI) and McArthur's Drought Factor (DF) were investigated using 17 years of Victorian fire incident data. Days with fires, particularly those with fires that escaped initial attack, were found to have higher DFs and KBDIs compared to all days in the dataset. Such differences varied geographically and were greatest in areas with moister climates.

Drought metrics

The Keetch Byram Drought Index (KBDI, Keetch and Byram 1968) and McArthur's Drought Factor (DF, McArthur 1967) are strongly ingrained in Australian fire management where they are used to estimate daily fuel dryness as inputs into fire danger and fire behaviour calculations.

The KBDI provides an indication of seasonal drying in the topsoil using a book-keeping method based on daily rainfall and typical evapotranspiration. Its value indicates the amount of rain required to bring the topsoil to saturation. The DF provides an estimation of the relative availability of fine fuels due to slowly varying long-term seasonal influences (typically calculated from KBDI) and short-term effects of wetting of fine forest fuels (calculated from the time since the last rainfall event and the rainfall amount). DF varies between 0 and 10 where all fine fuel is expected to be available.

Fire occurrence data

A dataset of all Victorian bushfires that occurred between July 2003 and June 2020 was compiled from incident records from the Country Fire Authority and Forest Fire Management Victoria and related observations from Bureau of Meteorology weather stations. Records included information on the location, timing and size class of each fire.

KBDI and DF values were compared for all days within the study period and for days with fires that did and did not escape initial attack, based on a 5-ha final area threshold. Comparisons were also made for areas with different climates, based on weather forecast districts across the state.

Results

Distributions of KBDI across the state (Fig 1a) show that most days tend to have low values, but days with fires, particularly with those with fires that escape initial attack (final area ≥ 5 ha), tend to have higher KBDI. Distributions of DF are more varied than KBDI, but also show that days with fires are more common at higher values (Fig 1b). This indicates that most days are affected by some short-term drying but are less influenced by longer-term drying.

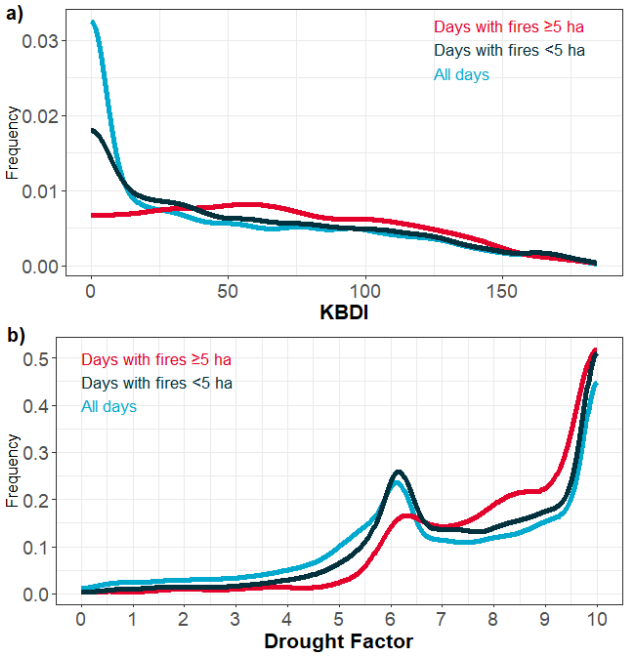

Figure 1. Smoothed frequency plots of the distributions of (a) KBDI and (b) Drought Factor associated with all days (blue) as well as days with small fires (< 5 ha, black) and large escaped fires (≥ 5 ha, red) across Victoria.

The DF plot also reveals a notable feature in the distribution of DF with a local peak around 6.2, which is a result of the method used to calculate it.

Differences in the distributions of KBDI and DF on days with fires and all days were greatest in districts with different climates. Figure 2 shows the distributions of DF in three weather districts with differing climates and fire loads—Mallee, Central and East Gippsland. Similar, but weaker, trends were found for KBDI.

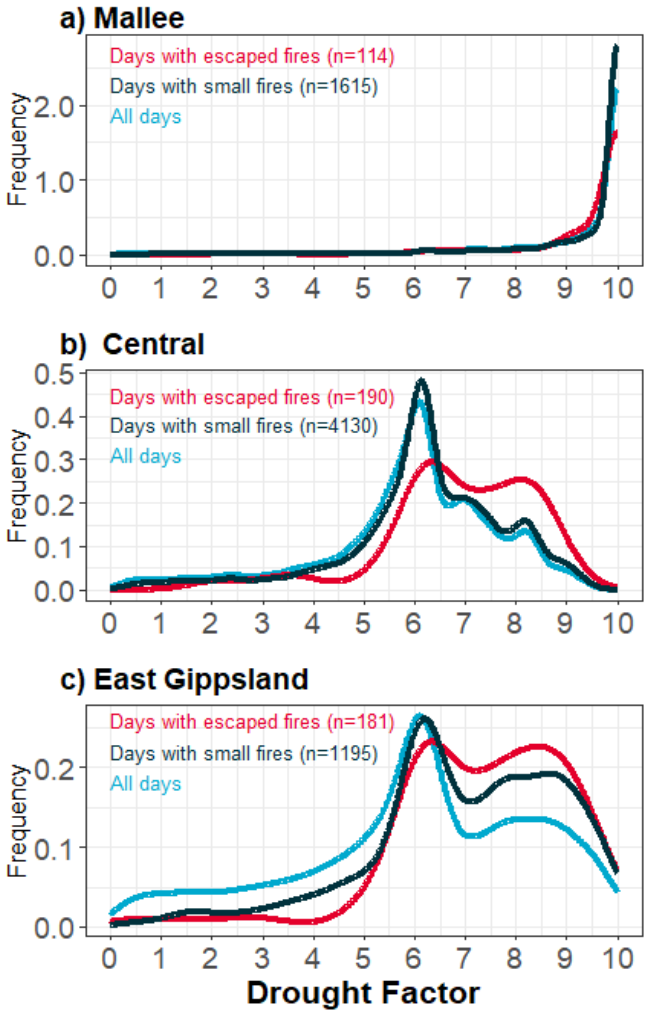

Figure 2. Smoothed frequency plots of Drought Factor in the (a) Mallee, (b) Central and (c) East Gippsland weather districts in Victoria.

The Mallee district (Fig. 2a) shows that in a drier climate DF is near its maximum on nearly all days and there are no real differences in the profiles for all days and days with fires. As a result, DF is of limited use for identifying days with greater fire potential in such regions.

The profile of DF is more varied in areas with wetter climates. The more populated Central weather district around Melbourne) (Fig. 2b) has small fires on most (66.5%) days and its DF profile differs little from that for all days. Days with escaped fires are few and concentrated towards the highest DF days. The DF profile in East Gippsland (Fig 2c) is similar, which has a similar climate but fewer fires.

Implications

The results show there is more difference between the distributions of DF on days with fires and all days than there is in KBDI for these day types. The implications of this are that it need only take a drying event of a few weeks during a fire season to lead to a spike in ignitions, including those that challenge initial suppression efforts. Regional differences in the influence of KBDI and DF indicate the importance of a local understanding in the interpretation of their value. Alternate metrics, or locally scaled versions of KBDI and DF, may present more spatially consistent estimates of the effects of drying on fire potential and should be considered in future.

Further reading

Plucinski M. P., Tartaglia E., Huston C., Stephenson A. G., Dunstall S., McCarthy N. F., Deutsch S. (2024) Exploring the influence of the Keetch–Byram Drought Index and McArthur's Drought Factor on wildfire incidence in Victoria, Australia. *International Journal of Wildland Fire* 33, WF23073.

References

Keetch JJ, Byram GM (1968) A Drought Index for Forest Fire Control. USDA Forest Service Southeastern Forest Experiment Station Research Paper SE-38, Asheville, North Carolina.

McArthur AG (1967) Fire behaviour in eucalypt forests. Commonwealth Department of National Development, Forestry and Timber Bureau Leaflet 107, Canberra, ACT.

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

FOR FURTHER INFORMATION
Environment
Dr Andrew Sullivan
t +61 2 6246 4051
e Andrew.Sullivan@csiro.au
w http://www.csiro.au

An archive of this and previous CSIRO PyroPages is available from: http://research.csiro.au/pyropage