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The 20% wind speed rule of thumb for quickly estimating a grassfire's forward spread rate

Wildfires propagating over grasslands under heightened fire danger conditions can sustain very fast rates of forward spread, at times exceeding 10–15 km/h. Under these conditions there is often little time to conduct a detailed prediction of a fire's spread potential. A simple rule of thumb was developed to predict the forward spread rate of a grassfire when driven by dry and windy conditions. This simple rule is evaluated against existing grassfire spread models and its main assumptions discussed.

The need for a rapid assessment of grassfire spread potential

A grassfire under the influence of low relative humidity (<20%) and strong winds (>30 km/h) can spread rapidly and burn a large area in a single day (Figure 1). Such a fire can severely impact unwary rural communities many kilometres from the origin. The ability to quickly assess the propagation potential of such a fire is critical to issuing of timely warnings of potential threat. In such situations, traditional fire spread prediction tools may not be capable of providing timely predictions for issuing warnings to the general public or firefighters.

New research to address the need

Existing rate of spread data of wildfires in Australian grasslands was analysed to extract data typical of wildfire runs under critical burning conditions. Of the more than 200 wildfire runs available in several datasets, 58 cases were found to meet the following conditions: curing more than 90%; wind speed higher than 20 km/h; dead fuel moisture less than 10%; and run duration greater than one hour. Rate of fire spread in the final dataset ranged between 1.6 and 17.0 km/h. The Grassland Fire Danger Index (*GFDI*) averaged 101, with 49 of the 58 observations above a *GFDI* of 50.

Statistical analysis assumed that under such heightened fire danger conditions, wind speed is the dominant variable driving wildfire spread rate (Cruz et al. 2022). The results found that grassland wildfire spread rates are approximately 16% of the 10-m open wind speed. This value is twice that found for fires in forest and shrublands (Cruz and Alexander 2019), suggesting that under extreme burning conditions a grassfire will spread at about twice the speed of a high-intensity crown fire in forest or shrublands.

Figure 1. The Cascades fire in Western Australia on 17 November 2015 during its 94 km run as viewed from an airliner (photo courtesy of Australian Broadcast Corporation). This fire averaged 15 km/h for a period of 4–5 hours over its main afternoon run.

In the interest of creating a simple relationship, we tested the adequacy of using a 0.2 wind speed multiplier to predict wildfire propagation in grasslands; that is, the forward spread rate of a grassfire is approximately 20% of the average 10-m open wind speed. The analysis of error showed other

variables, such as relative humidity or dead fuel moisture content, to not have any additional explanatory power.

How well does the rule of thumb work?

The rule of thumb was found to predict the wildfire data with an average relative error of 66%. The application of the Cheney et al. (1998) grassfire spread models to the same dataset yielded an average error of 60%. The rule of thumb best predicted wildfires spreading over grasslands assumed to be grazed (i.e., normal summer condition), with an average error of 51%, less than that of the Cheney et al. (1998) grazed model. Wildfires characterised in the dataset as spreading in eaten-out pastures were over-predicted by the rule of thumb, with the error twice as large as that obtained by the Cheney et al. (1998) eaten-out model.

Operational implications

Predictions based on the 20% rule of thumb are likely to represent the near-worst case scenario for grassfire spread where the landscape is essentially fully cured, fine dead fuel moisture contents are low (<6%), open winds are strong (>30 km/h) and gusty, and topography is flat or gently undulating. Furthermore, the rule of thumb assumes there are no appreciable barriers that would hinder fire propagation, and that fire suppression efforts are not successful in constraining fire spread and size thus restricting the overall propagation rate.

The rule of thumb aims to produce an approximation of the average rate of fire spread over periods of an hour or more, with the best accuracy likely to occur when the prediction period extends over several hours. The rule of thumb does not capture smaller temporal variations in rate of spread which occur in response to wind gusts or lulls which can cause surges and pauses in fire propagation. The rate of fire spread during a surge can be several times faster than the average speed observed over periods of an hour or more but will be very short lived.

Graphical representation of the applicability of the rule of thumb in terms of ambient air temperature and relative humidity is given in Figure 2.

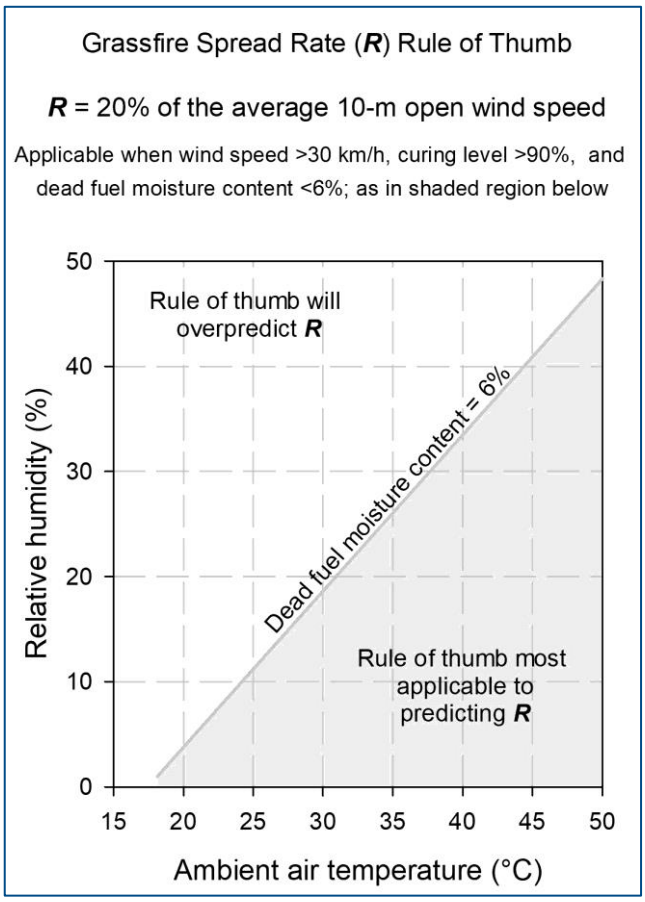

Figure 2. Graphical aid for determining from ambient air temperature and relative humidity the suitability of the 20% grassfire rule of thumb.

Further reading

Cruz, M.G; Alexander, M.E.; Kilinc, M. (2022) Wildfire rates of spread in grasslands under critical burning conditions. *Fire* 5, 55. (Free open access publication)

References

Cheney NP, Gould JS, Catchpole WR (1998) Prediction of fire spread in grasslands. *International Journal of Wildland Fire* 8, 1-13.

Cruz MG, Alexander ME (2019) The 10% wind speed rule of thumb for estimating a wildfire's forward rate of spread in forests and shrublands. *Annals of Forest Science* 76, 44.

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