

McArthur Mark 5 forest fire danger index

Description

The Mark 5 forest fire danger index (*FFDI*) was developed by [McArthur \(1967\)](#) in order to assess fire danger and behavior in eucalypt forest fuel types and has been widely used in Eastern Australia ([Noble et al. 1980](#), [Sharples et al. 2009a](#)). The *FFDI* requires temperature, relative humidity, wind speed and a fuel availability index (i.e. a drought factor) measured at 15:00 as input variables ([Matthews 2009](#)).

The drought factor is obtained based on soil moisture deficit (calculated using the *KBDI*), time since last rain and rainfall amount. It ranges from 1 to 10, with a value of 10 indicating that a maximal amount of fuel is available for combustion ([Matthews 2009](#), [Sharples et al. 2009a](#)).

Formula

The *FFDI* is defined as follows:

$$FFDI = 2 \cdot e^{-0.45 + 0.987 \ln(DF) - 0.0345 \cdot H_{15} + 0.0338 \cdot T_{15} + 0.0234 \cdot U_{15}}$$

where H_{15} is relative air humidity [%], T_{15} air temperature [°C], U_{15} windspeed [km/h] and *DF* a drought factor expressed as a function of the

$KBDI_{SI}$ (NB: in millimeters) and defined as follows ([Noble et al. 1980](#)):

$$DF = \min \left[10, \frac{0.191 \cdot (KBDI_{SI} + 104) \cdot (w + 1)^{1.5}}{3.52 \cdot (w + 1)^{1.5} + P - 1} \right]$$

where w is the number of days since last rain and P the last precipitation amount [mm] (measured over the entire period of rainfall).

[Griffith \(1999\)](#) improved the calculation of the drought factor (*DF*) with following formulation (in [Finkele et al. 2006](#)):

$$DF = \min \left[10, 10.5 \cdot \left(1 - e^{-\frac{KBDI_{SI} + 30}{40}} \right) \cdot \frac{41x^2 + x}{40x^2 + x + 1} \right]$$

where x is

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

where w is the event age (defined as the number of days since the day with the largest daily rainfall amount within the rain event, [Finkele 2006](#) referring to [Sullivan 2001](#)) and P is the rainfall event amount in mm (sum of rainfall within the event).

The rainfall event is defined as consecutive days with rainfall amount above 2 mm.
The calculation of w and P only the past 20 days' rainfall is considered.

Based on the experiences in operational use, the Bureau of Meteorology further improved this Griffith formulation, proposing following limitation of x (Finkele et al. 2006):

$$x_{tim} = \begin{cases} \frac{1}{1 + 0.1135 \cdot \frac{KBDI_{SI}}{75}} & \text{if } KBDI_{SI} < 20 \\ \frac{1}{270.525 - 1.267 \cdot KBDI_{SI}} & \text{if } KBDI_{SI} \geq 20 \end{cases}$$

The *FFDI* is supposed to be calculated on a daily basis. The meteorological data used for its calculation have to be recorded at 3 pm (Matthews 2009).

No particular values or conditions are stipulated for starting the *FFDI* calculation.

Index interpretation

Fire agencies to simplify the interpretation of the *FFDI* generally give following interpretation (Lucas 2005):

<i>FFDI</i> range	Fire danger class
0 - 5	low
5-12	moderate
12-25	high
25-50	very high
> 50	extreme

References

Original publication:

McArthur (1967)

Other publications:

Noble et al. (1980)

Griffith (1999)

Lucas (2005)

Matthews (2009)

Sharples et al. (2009a)