3.0 Rating the conditions of 7 February

3.1 Overview

The conditions of 7 February 2009 set new records for extremes in temperature and relative humidity (Karoly 2009). When combined with long-term rainfall deficits and drought conditions they created unique conditions for fire. Wildfire behaviour academics and researchers have developed methods for measuring fire danger, through the Fire Danger Index (FDI). This system rates the fire danger for a particular day, based on its temperature, relative humidity, wind velocity and the long-term drought conditions, often referred to as drought factor. The following section provides a background to this system.

3.2 Fire Danger Index

The Fire Danger Index system is used throughout eastern Australia. It was initially developed as the McArthur Fire Danger Rating System. It provides a means of estimating fire behaviour and the rate of spread in most of the common fuel types in eastern Australia (Luke and McArthur 1978).

Luke and McArthur (1978) say the Fire Danger Rating System consists of two meters: the forest fire danger meter and the grass fire danger meter. They integrate the combined effects of fuel moisture content and wind velocity to form a basic fire danger index. Each basic index can be related to fuel quantity and slope to give the head fire spread rates and other fire behaviour characteristics.

Luke and McArthur (1978) express the forest and grassland indices to the rate of forward spread on a scale of 1 to 100. They state that an index of 100 represented the near worst possible fire weather conditions that could be experienced in Australia. They claim an index of 1 would be virtually self-extinguishing, while an index of 100 (or greater) would burn so rapidly and intensively that control of these fires would be virtually impossible. Luke and McArthur (1978) divide the FDI rating into five categories:

- Low
- Moderate
- High
- Very high
- Extreme

The FDI takes account of long and short term drying. Luke and McArthur (1978) make use of a modified version of the Keetch-Byram drought index (KBDI). They take the short term rainfall to be based on the changes expected in the moisture content of surface litter, specifically in material less than 6mm in diameter. Wind speed is expressed in what Luke and McArthur (1978) refer to as "open station wind speed". The rate of spread and other fire behaviour characteristics given by the forest fire danger meter are based on typical single fires burning under commercial eucalypt forests. Luke and McArthur (1978) advise that the index should not be used to predict the behaviour of multiple fires burning in close proximity.

3.3 Grassland fire danger index

Luke and McArthur (1978) describe the grassland fire danger meter as a tool for use in relatively finely textured annual grasslands in the temperate regions of Australia. This meter integrates the variable fire danger factors of grass curing, air temperature, relative humidity and average wind speed in the open giving a fire danger index rating on a logarithmic scale from 1 to 100. Similar to the forest fire danger rating, the grassland fire danger rating threshold of 100 was significantly exceeded on 7 February 2009. Luke and McArthur (1978) note that the rate of spread of fire in a specific grass type is proportional to the fuel quantity, with a threshold loading at around 4-5 t/ha.

The grassland fire danger index is described by Lucas et al (2007) as being a relationship between fuel quantity in tonnes per hectare, curing factor, temperature, wind velocity and relative humidity. This is expressed in the formula:

$$GFDI = 10^{(-0.06615 + 1.2705\log_{10}Q - 0.004096(100-C)^{1.536} + 0.01201T + 0.2789\sqrt{V} - 0.09577\sqrt{RH})}$$

Q is the quantity of fuel in tonnes per hectare, C is the curing factor of the fuel, T is temperature in Celsius, V is wind velocity in km/h and RH is relative humidity as a percentage..

3.4 Forest Fire Danger Index

Lucas et al (2007) describe the Forest Fire Danger Index consists of a relationship between temperature, relative humidity, wind speed and the estimate of the fuel state, which is determined by the 'drought factor'. This relationship is expressed in the following formula:

$$FFDI = 1.2753 \times \exp^{(0.987\log DF + 0.0338T + 0.0234V - 0.0345RH)}$$

DF is drought factor, T is air temperature in Celsius, V is wind velocity in km/h and RH is relative humidity expressed as a per centage.

3.5 Fire danger indices of 7 February 2009

According to Karoly (2009) and Tolhurst (2009), the fire danger indices on 7 February 2009 significantly exceeded the previous records set on 13 January 1939 (Black Friday) (GFDI 87, FFDI 100) and 16 February 1983 (Ash Wednesday) (GFDI 196, FFDI 120). The 1939 event effectively set the benchmark Forest Fire Danger Index of 100 with conditions beyond 50 being described under the convention as 'extreme'. The unprecedented conditions which saw the Forest Fire Danger Index exceed 100 have prompted the need for a new description of 'catastrophic' to describe fire conditions beyond 100. These figures are detailed in the following sections.