Impact of the drought on forest fires

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The recent experience of drought in southeastern Australia reinforces the observation that droughts are associated with an increase in forest fire activity. There is also scope to speculate about the impact of a longer-term rainfall deficit. This paper attempts to briefly explain how drought impacts on forest fires in Victoria and what was known about climate and environmental indicators in the drought leading up to the summer of 2002/03.

An outline of the impact or leverage of drought on the general incidence and extent of forest fires in the 2002/2003 fire season is shown on the following map (Figure 1). In addition there was also damage to private property and additional consequences from the fires in the terms of extensive disruption to communities, local business, tourism and widespread smoke haze.

Fires are obviously strongly influenced by moisture content of the fuel. In forests most of the fuel consists of dead material, so once this dead material becomes dry the risk of fires increases. Therefore forests are predisposed to ignitions that give rise to actively spreading fires earlier in a fire season during a drought. Abnormal forest fire activity is in itself one indicator of the severity of drought. In addition to an increase in the number of days when forest fuel is dry enough to ignite, drought stress can increase the amount of fuel that is available to burn. Therefore forest fire activity for an entire fire season is primed to increase during a drought.

The abnormally high incidence of forest fires in the 2002/2003 fire season compared to a 20 year average, as shown in Figure 2, is an example of

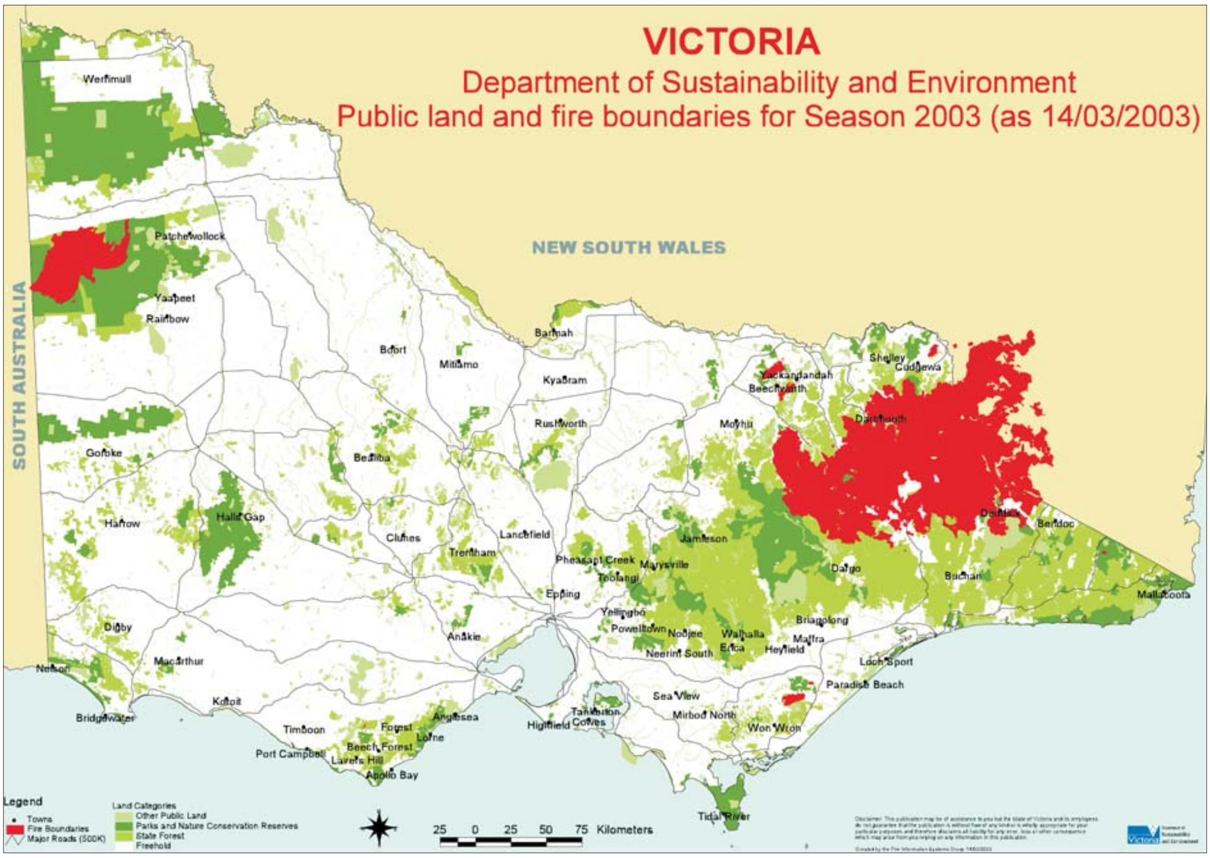


Figure 1. Impacts of the Drought

the impact of drought – more fires starting early in the season and more fires in general.

Looking more widely at fire seasons with periods of drought - such as 1982/1983, 1997/1998 as well as 2002/2003 – shows that there is a large increase in the number of forest fires (Table 1). These fire seasons also generally show an increase in the damaging or spreading fires, as reflected in the total area burnt.

Forest fires are mainly found to originate from human activity and lightning is usually a much smaller source contributor. Drought has a tendency to increase lightning caused fires (Table 1). Perhaps this is due to drier fuels (greater receptivity to ignition) or perhaps there is less rainfall in thunderstorms to immediately quell the heat from a lightning strike?

When the impact of drought is very severe, such as for the seasons 1982/83 and 2002/03, the total area burnt increases dramatically - by a factor of roughly 9 to15 (Table 1). The reasons for this are complex. For example, the 1997/98 fire season is out of step; there was a drought effect in forests in eastern Victoria (winter and spring rainfall was decile 3 or lower for 6mths), a very high number of fires occurred, particularly from lightning; so why was the total area burnt for that season less than the long-term average? One climate factor is that fire control is always assisted by fortuitous rainfall. Soon after a fire starts even light rainfall of just a few millimetres from thunderstorms or with cold fronts can be a very significant factor in gaining the upper hand in fire control. But this has no effect on the drought situation.

While drought is an irregular influence on the Australian landscape, an extreme drought can bring about significant changes in fire behaviour

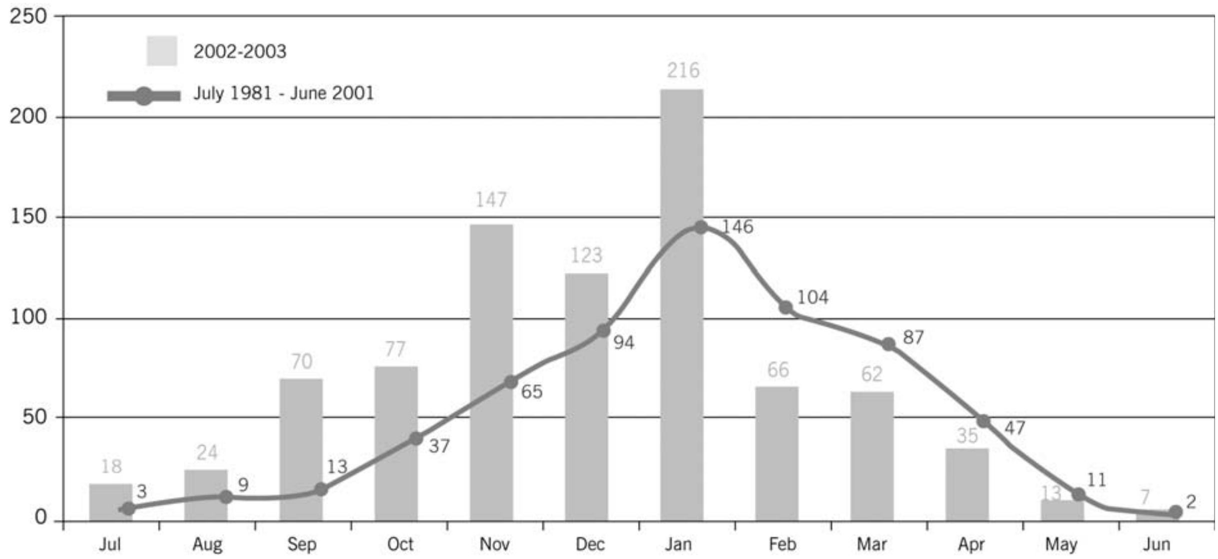


Figure 2. Count of forest fires in Victoria

Table 1. Forest Fire Statistics and Drought

Fire season	**2002/03**	**1997/98**	**1982/83**	**Long-term average (20 years)**
Total Number of Fires	855	1070	878	618
Lightning caused Number Percentage	259 30%	450 42%	237 27%	166 27%

that increase the probability of larger fires. Where the rainfall is relatively high, such as in mountain forests, the damper areas such as southerly aspects and lower slopes near streams act as natural barriers to fire spread. These natural moisture barriers carry through summer except in a prolonged drought. These areas also contain a lot of vegetation. Only in a severe drought does this become dry enough to burn, setting up the potential to accelerate fire spread and add to spotting.

Long distance spotting is a rare fire behaviour characteristic that starts new fires many kilometres ahead of the original fire. In dry mountain forests, long distance spotting makes fire control almost impossible. During the 2002/2003 fire season fires easily spread through stream buffers and southerly aspects, resulting in many days of violent fire behaviour when long distance spotting defeated all fire control attempts. This fire behaviour a consequence of extreme drought as well as short-term fire weather.

Ash Wednesday in February 1983 is a reminder that just one day with extreme fire danger during a severe drought can be the primer for catastrophic fires.

In the lead up to the 2002/2003 fire season, what was known about the drought and the potential impact and how was climate information used? Each fire season is different, just as every drought is different. The number of fires or the area burnt or areas of greatest fire activity cannot be accurately predicted, but the general trends and potential for fires can be assessed.

One of the earliest indicators is to examine the number of fires starting early in the fire season. Abnormally high numbers of fires in spring is a strong indicator of a potentially severe fire season ahead. For example, analysis of historical data in mid November 2002 focused on the previous fire seasons with a similar early start. All show a distinctive profile - continuing well above the average number of fires for the entire season, and these seasons all run to well above average numbers of fires in total (more than 800 fires c/f long term average of 618). Adding a climate filter (El Niño years) to data is the analysis shown in Figure 3 – in an attempt to compare similar fire seasons with a strong climate indicator. It was concluded that the remainder of the 2002/2003 fire season was highly likely to run midway through this historical data and total more than 800 fires.

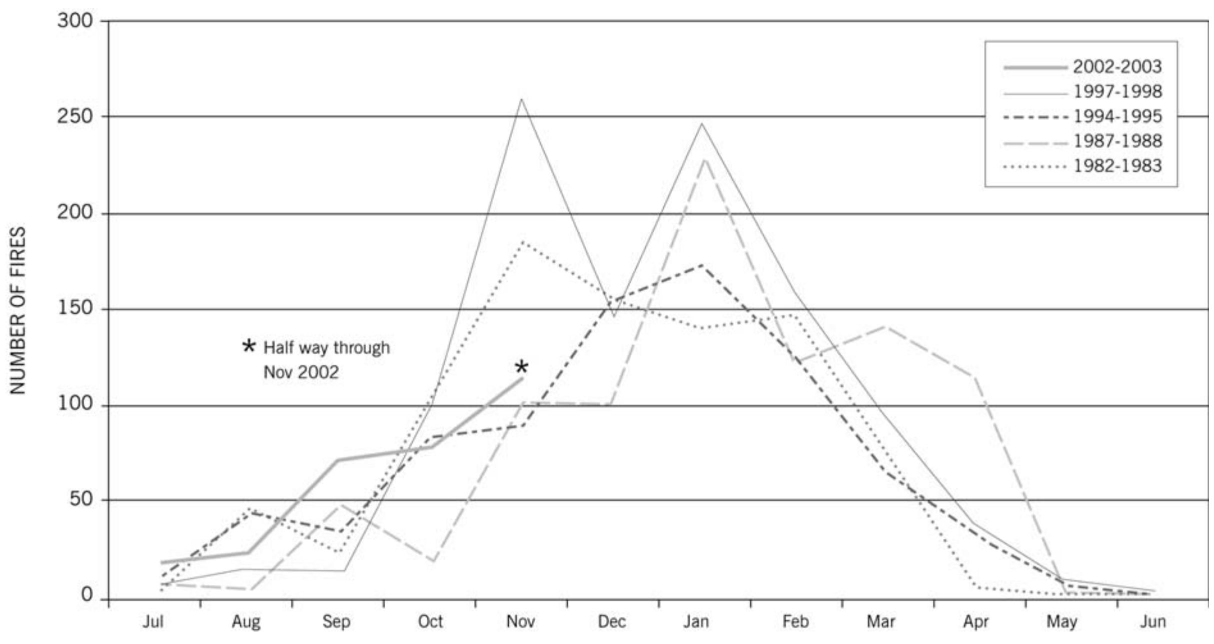


Figure 3. Seasons with 800+ Forest fires and El Niño (climate filter)

This hypothesis was reasonably valid, apart from the large deviation during February 2003 below the historical data set and long term average (Figure 2).

How the forests are wetting and drying, and therefore how the fire risk is likely to change, is analysed through a number of environmental or climate indicators. There are a range of rainfall and temperature maps. There are also other ways to look at the long-term moisture balance. For example the monthly rainfall deficit (amount below long-term average) plus increased evaporation (above the long-term average) was monitored at the Melbourne Airport site (Figure 4). This shows a combined indicator of moisture deficit rising to 259.6mm by October 2002. While this is just one point source of data and it does not account for forest canopy interception, this suggested that the moisture balance was very abnormal.

Keetch and Byrams' Drought Index is also another indicator of the general dryness of forest fuels and is monitored closely at approximately 130 locations. It is a theoretical value derived from point sources of rainfall and maximum temperature and cannot be directly measured. Trends in this showed widespread abnormally high levels over winter and into summer, but interestingly some locations did not show any abnormality until December 2002.

Another way to gauge drought in forests is to look at catchment yield or stream flow. However this is measured as a daily flow at the end of each month, not a monthly average of stream conditions and the values could be distorted by recent intense rainfall. Apart from these limitations, this information is useful because it is directly measurable and it represents a coarse indicator of the total catchment condition, accounting for rainfall, evaporation and forest canopy interception. It is easily compared against historical records. Figure 5 shows an example of quite alarming falls in stream flows seen in spring 2002. Longer trends showed stream flows at or near record low flows over a very wide area.

Lastly the Climate Outlook guidance products for rainfall and temperature issued by the Bureau of Meteorology are closely examined together with recent and historical maps of rainfall and temperature (Figure 6).

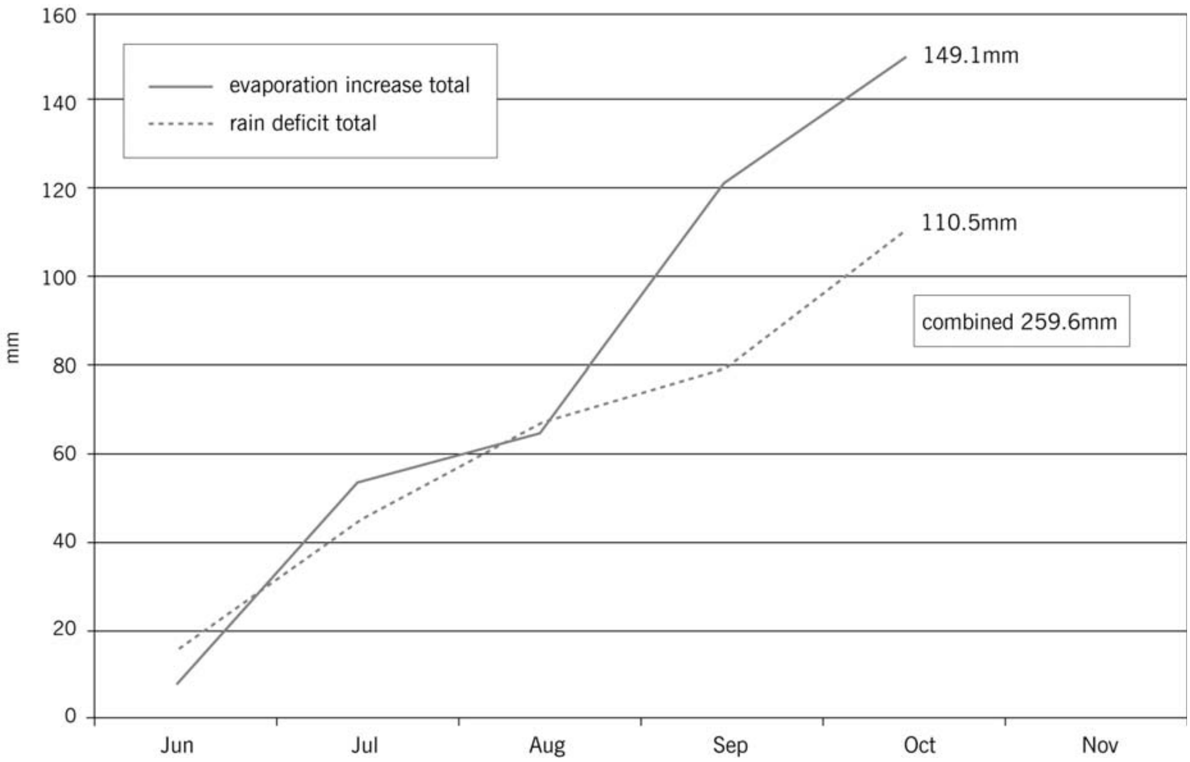
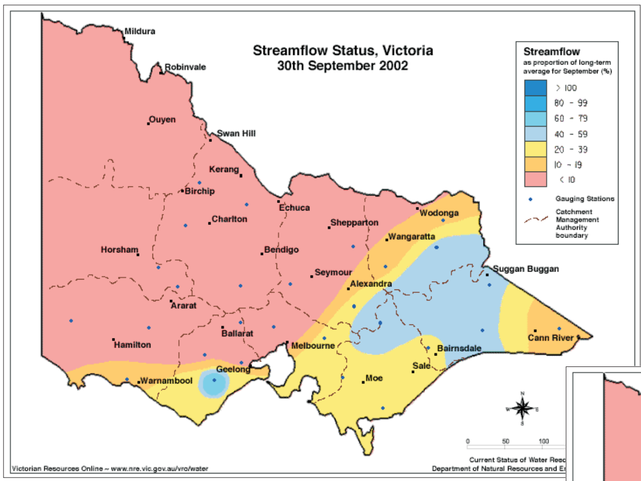


Figure 4. Melbourne Airport - Rainfall deficit/increased evaporation



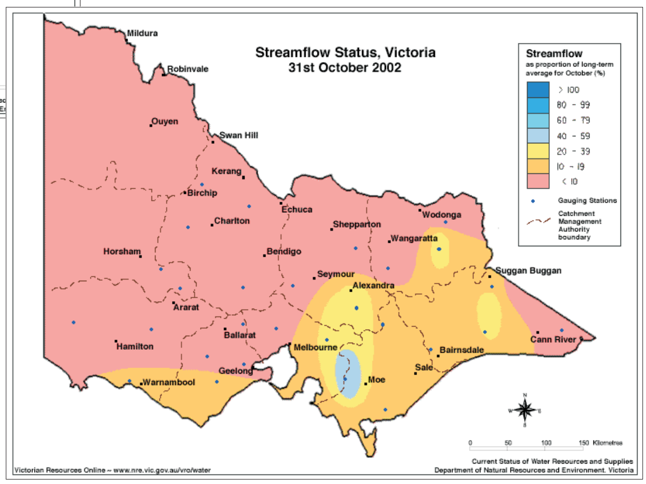


Figure 5. Stream flow changes Sept - Oct 2002

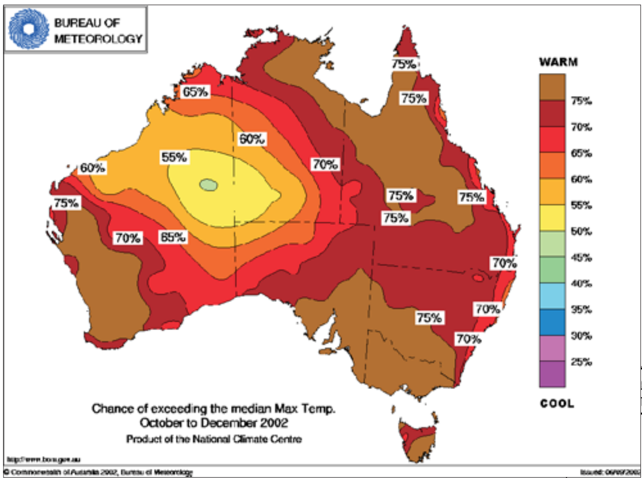
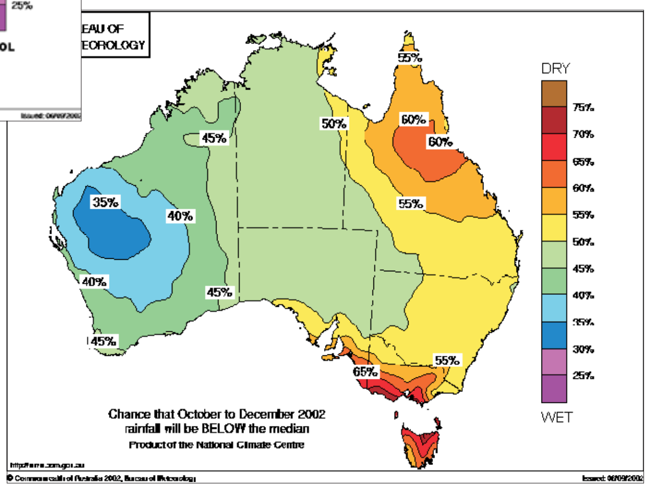


Figure 6. Rainfall & Max Temperature probabilities



Comparisons were made between this guidance, actual conditions and historical patterns. Special briefings by Bureau staff coinciding with the monthly public release of the climate outlook products were also useful in interpreting the significance of trends and probabilities. Products were widely circulated. Fire season information was also shared with the Bureau.

From a forest fire perspective it is important to examine climate outlook guidance each month, not just when a drought appears to be looming. Climate guidance is an essential information source that helps drive fire preparedness, and assists in synchronising broad resource strategies, including seasonal firefighters, equipment and aircraft that have may long lead times. This guidance is recognised in terms of its probabilities. A wide range of information in addition to the probabilities needs to be considered, often in a time series.

Climatic cycles and conditions need to be examined closely. Normally these factors mature or bring a forest fire season to a climax in Victoria a month or so later than say the comparable peak in the broad acre agricultural sector – such as the peak in grass or crop production. Similarly but on a broader scale, climate causes the forest fire season to mature several months earlier in NSW and migrate south. If the NSW forest fire season escalates earlier than normal in some situations this is a significant indicator.

In 2002/2003 the fire situation in NSW was monitored very closely – it was widespread and severe. This brought about changes to resourcing in Victoria. When firefighting resources from Victoria provided assistance to NSW late in spring 2002 climate guidance was important to plan a long term support strategy, based on how fire activity might increase in Victoria and where to draw resources.

Outside of the existing climate guidance there is scope to add some more products. One example is to better understand short-term seasonal changes, such as the potential for a very rapid drying cycle in late spring or a strong wetting cycle in autumn. These are a very short but crucial periods and they have a significant community safety focus related to fire. One focus is that in spring fuel reduction burning in forests has the greatest immediate protection benefit but also is exposed to the greatest risk of escape. In autumn the main fuel reduction burning program is undertaken and how much gets done is highly weather dependant. A severe short-term drying cycle or a wetting cycle is a concern every year. There is a demand for a short-term guidance product spanning a month, compared to the current 3 monthly guidance.