

AIR QUALITY DURING VICTORIAN BUSHFIRES OF 2002-03

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1. INTRODUCTION

Between December 2002 and April 2003 severe bushfires struck several areas of south-east Australia. Among the many impacts of these fires were high levels of air pollution in many areas of Victoria. This report documents the impacts of the bushfires on air quality in Victoria and suggests simple actions to take to minimise the health effects.

2. MAJOR FIRES IN VICTORIA

Over the past 100 years Victoria has experienced a number of major fires. There are records of such fires in 1926, 1932, 1939 (Black Friday), 1942-44, 1952, 1962, 1965, 1968-69, 1972, 1977, 1980-81, 1983 (Ash Wednesday), 1985, 1997-98, and 2002-03.

Generally the worst fires have occurred during drought periods, often associated with *el Niño* events, when a disturbance of the temperature in the Pacific Ocean has a direct effect on Australia's rainfall.

This report covers the bushfires observed between 17 December 2002 and 30 April 2003 and their impacts on air quality in Victoria. Both satellite images and 'on the ground' measurements are used

to assess the impact on Victorian residents. During this period there were also severe bushfires in Sydney and Canberra.

3. NORTH-WEST FIRES

Fires were ignited by lightning on 17 December 2002 in the Big Desert Wilderness Park and continued to burn until 31 December. The area burnt reached 181,400 hectares.

Very little of the smoke from these fires reached EPA monitoring equipment simply because of the way the wind was blowing at the time. However, air quality impacts in some areas would have been substantial, particularly in towns such as Mildura, which is 170 km to the north.

Some idea of the impacts can be obtained from NASA satellite images during this period. The satellite images do not indicate what level of smoke is actually on the ground, but they do give an idea of how widespread the fire plume is. In Figure 1 we can see satellite images of fine particles from smoke between 17 and 21 December 2002. Although the resolution is coarse, the images show that a large area in the north-west of Victoria was affected, particularly on 21 December.

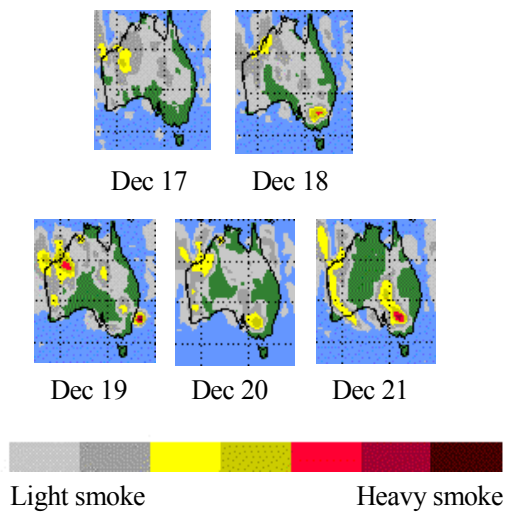


Figure 1: NASA Aerosol Index (north-west Victorian fires)

Smoke may transport a long way in a single day. For example, from Figure 1 we can see that, between 18 and 19 December, the centre of the smoke plume has moved from mid-south NSW to an area off the eastern coast of Australia.

4. NORTH-EAST FIRES

On 7 and 8 January 2003, thunderstorms resulted in lightning strikes that ignited more than 80 fires in eastern Victoria. Over the next two months, a major fire fighting effort was undertaken, with the fires declared contained on 7 March. A total of 1.12 million hectares was burnt (Figure 2)

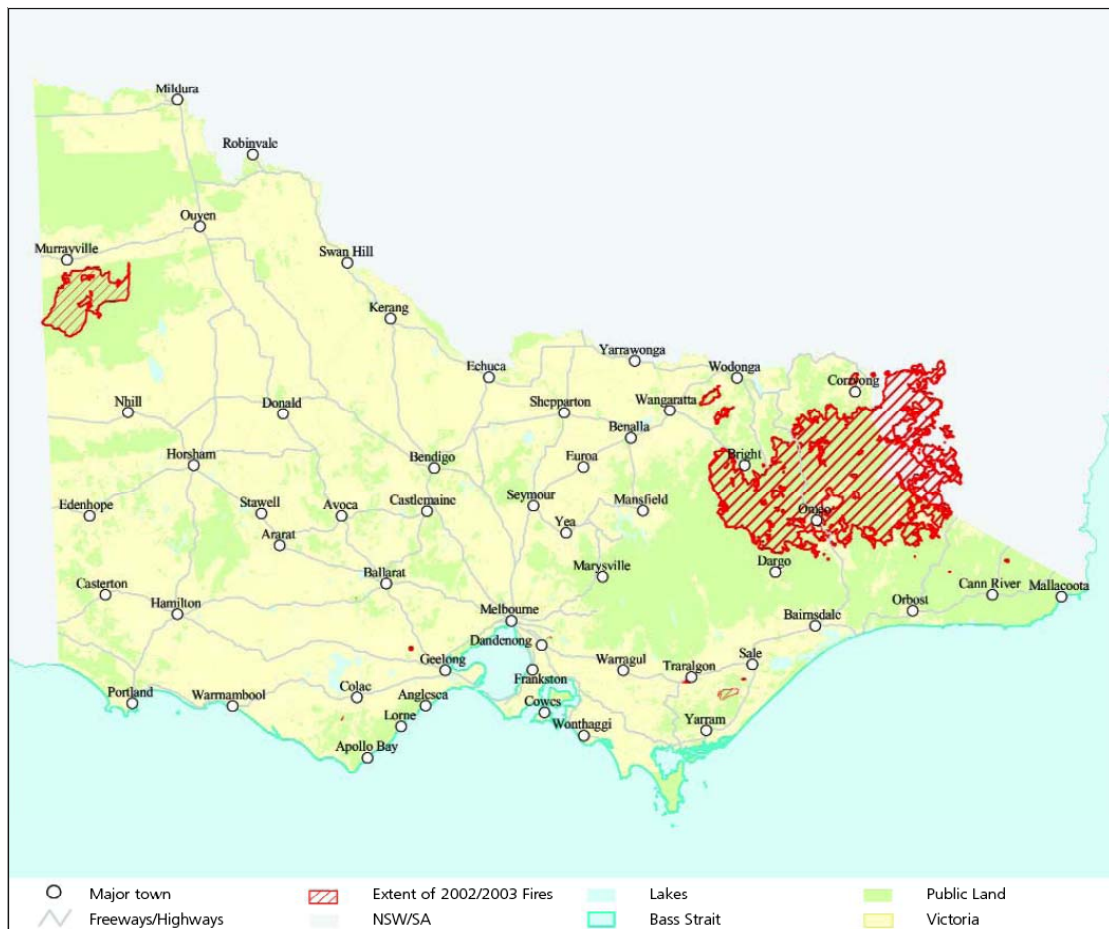
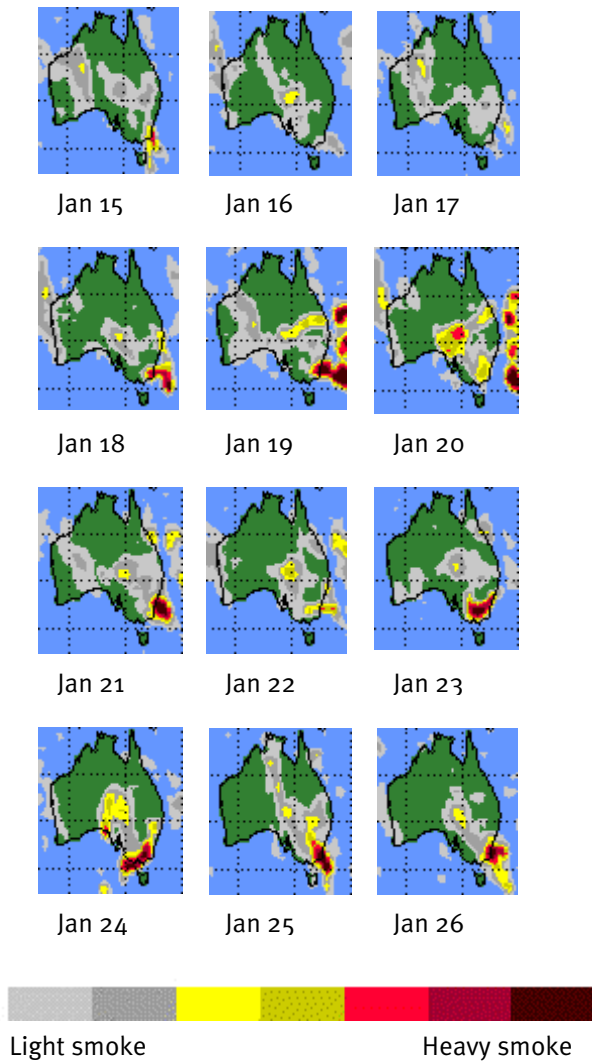


Figure 2: Extent of Victorian fires (from December 2002 to April 2003)

From the satellite images in Figure 3 we can see how much smoke was generated by these fires. Clearly much of eastern Victoria was frequently affected and, on occasion (such as 23 January), nearly the whole of the State would have been blanketed in smoke.



**Figure 3: NASA Aerosol Index
(north-east Victorian fires)**

Pollution records during the north-east Victorian bushfires show that there were serious impacts on air quality at ground level. The major pollutants involved were:

- respirable particles
- ozone
- visibility

Effects of the fires were recorded in the Latrobe Valley, Wangaratta¹, Albury and Port Phillip (which includes Melbourne and Geelong).

Respirable Particles (PM₁₀)

This measure tracks the total weight of small particles in the air. All particles smaller than 0.01 mm (about one-eighth the width of a human hair) are captured on a filter and weighed using a realtime device called a TEOM. It is known that particles in this size range can be absorbed deep into the lung.

Figures 4, 5 and 6 show PM₁₀ results for Port Phillip, the Latrobe Valley and north-east Victoria. As well as the impacts of the fires, there were two major dust storms during this period, on 29 December and 19 March.

The impacts of fires on north-east Victoria were much more severe than the impacts on Port Phillip or the Latrobe Valley.

The *State Environment Protection Policy (Ambient Air Quality)* objective for PM₁₀ is 50 µg/m³, measured as a 24-hour average. The fires caused widespread exceedences of the PM₁₀ objective in the monitored areas on six days: 20, 24 and 25 January and 3, 4 and 5 February. On a further six days the bushfires caused the PM₁₀ objective to be exceeded at some locations. Wind-blown dust caused exceedences on three further days between December and April.

¹ EPA established a temporary station at Wangaratta to track bushfire effects.

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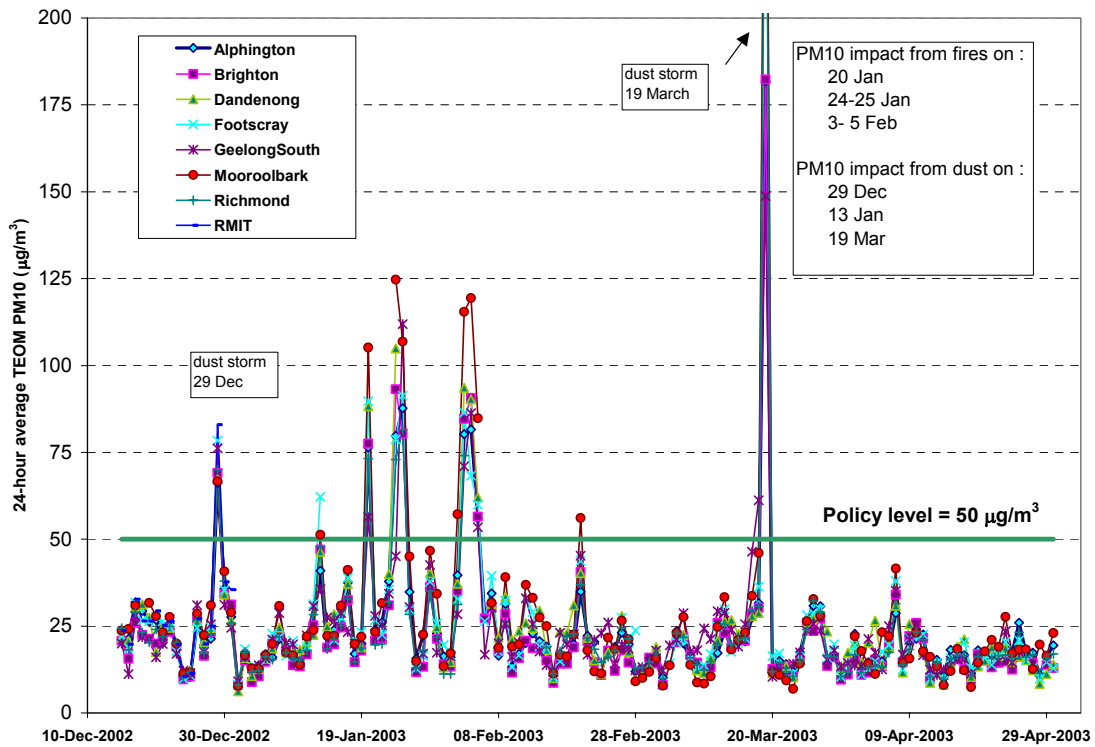


Figure 4: Port Phillip PM₁₀ during north-east Victorian fires

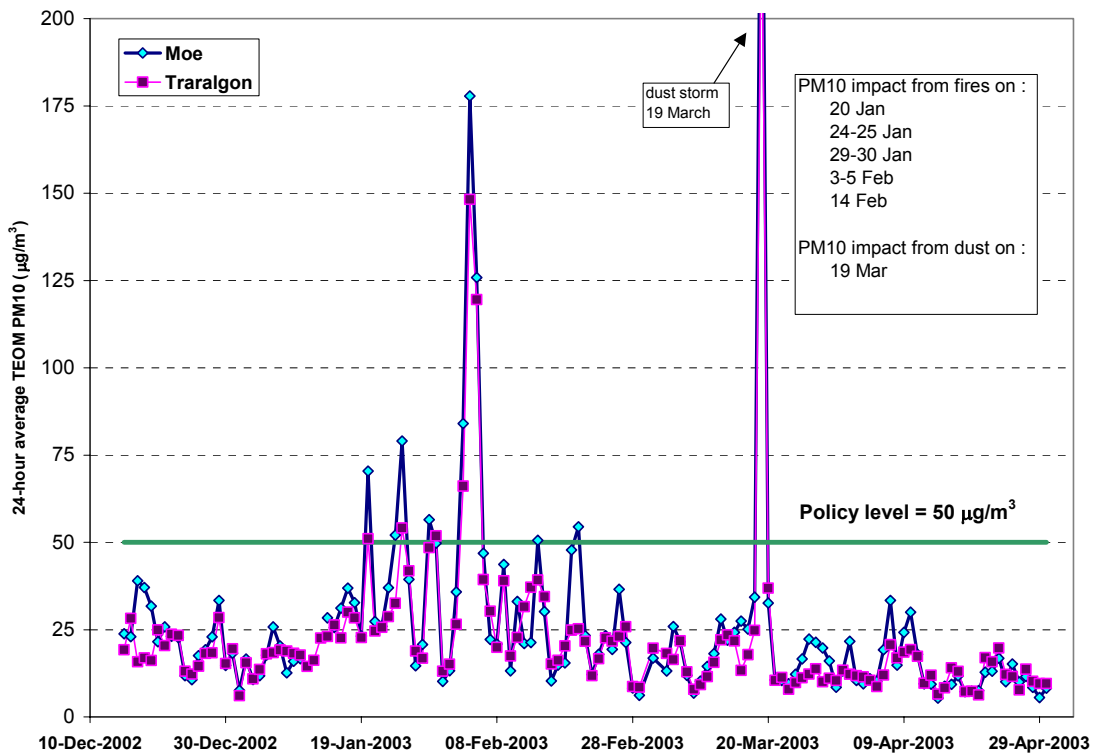


Figure 5: Latrobe Valley PM₁₀ during north-east Victorian fires

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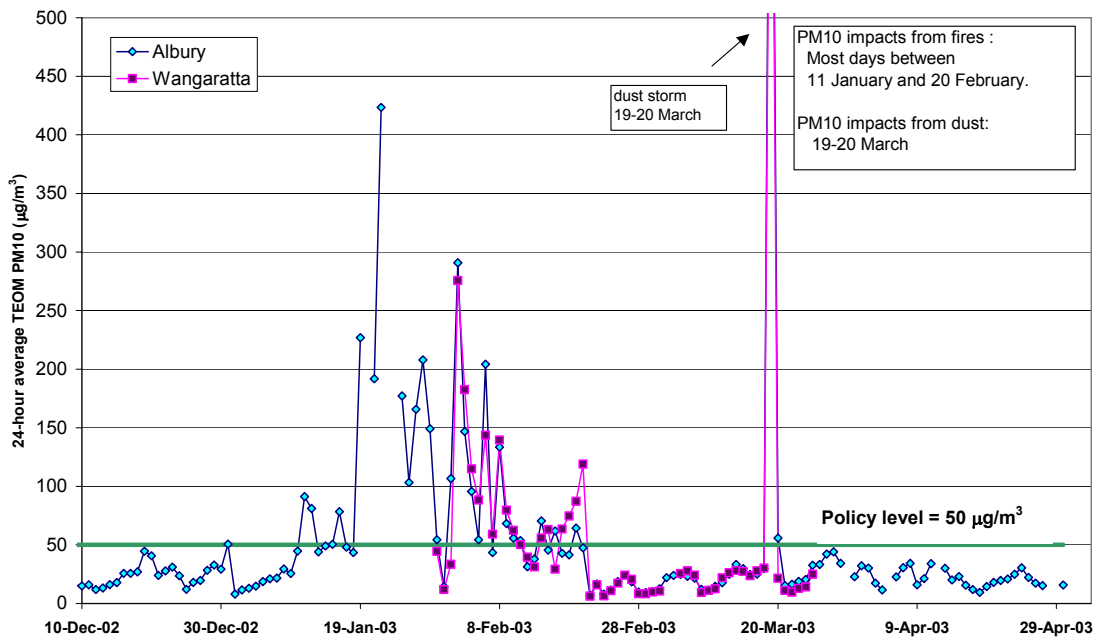


Figure 6: North-east Victorian PM₁₀ during north-east Victorian fires

This number of PM₁₀ exceedences is extraordinary, with Melbourne stations typically experiencing only one or two such events per year. This is a direct result of the 2002–03 drought.

The Latrobe Valley was also seriously affected, with 12 days recorded between December and April when PM₁₀ exceeded the objective, with ten of these caused by the bushfires (and two caused by wind-blown dust).

Ozone (O₃)

Ozone is an irritant gas, which exists naturally in the earth's atmosphere. In the upper atmosphere, naturally occurring ozone (the 'ozone layer') is very useful, as it filters out harmful UV radiation that would otherwise come down to earth.

Ozone also occurs naturally close to the ground, usually in low concentrations. In warm weather,

harmful concentrations of ozone can sometimes be formed, as various pollutants react together with sunlight to form 'summer smog'. Fortunately, due to pollutant controls on cars and industry, high ozone levels are now uncommon in Melbourne.

However, there are other ways in which ozone can be formed. Bushfires also produce the same ingredients needed to make ozone (oxides of nitrogen and reactive hydrocarbons).

Generally it takes some hours for the reactions to take place, so ozone pollution is normally only experienced on those days where polluted air is very still or being 'recirculated' around a city.

During a major bushfire, ozone can form as the pollutants and smoke are being transported by wind. In this case, smoke from north-east Victoria had to travel over 200 km before it reached Melbourne – and this allowed enough time for

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ozone to form. As a result, high levels of ozone were recorded in Melbourne, under weather conditions that would not normally have been expected to produce ozone.

The *State Environment Protection Policy (Ambient Air Quality)* objective for ozone is 100 ppb (parts per billion) over one hour and 80 ppb over four hours. As the four-hour objective is more stringent, a comparison of the monitoring results against this

objective is given here – see Figure 7. The four-hour objective was exceeded on five days (17, 24 and 25 January, 3 and 23 February). On at least four of these days the bushfires contributed a significant proportion of the ozone pollution.

In recent years, an ozone exceedance has only been reported about once every two years in the Port Phillip region.

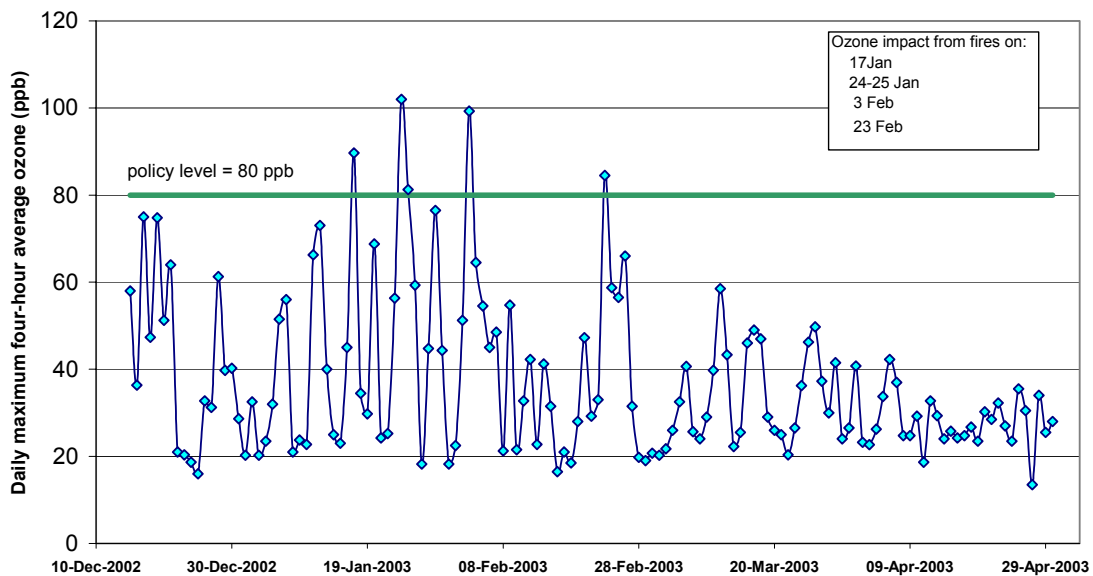


Figure 7: Port Phillip 4-hour ozone (maximum daily reading)

VISIBILITY

Visibility measurements give an indication of how far you can see, by measuring the amount of light interference or 'scattering' caused by particles in a small sample of air. It responds to very fine particles (generally smaller than 0.002 mm) – typically the size of particles generated in a bushfire.

The *State Environment Protection Policy (Ambient Air Quality)* objective for visibility-reducing particles is 20 km. The air is dried before measurement to avoid measuring effects of moisture (as fog and mist can also reduce visibility).

This objective was breached on 19 days in Port Phillip and 18 days in the Latrobe Valley between December and April. Almost all of these pollution events occurred in January and February and were caused by the north-east Victorian fires or other bushfires around the state. Severe visibility problems were recorded, both at monitoring stations and through direct observation by local residents. Typically, during the summer months only about two or three days are to be expected on which the visibility objective is exceeded in Melbourne.

Data from monitoring in Port Phillip and the Latrobe Valley are shown in Figures 8 and 9.

5. HEALTH EFFECTS

A number of overseas studies have shown significant health effects from bushfire smoke. These effects are most pronounced in those with asthma or other respiratory problems. Studies in Australia have been inconclusive, perhaps because of low study populations.

A study by the Department of Human Services (DHS) of the north-east Victorian region did not find any noticeable change in hospital admissions for respiratory disease in January–March 2003 (157 admissions) compared with the same period in 2002 (161 admissions).

Despite the lack of data, bushfire smoke is fundamentally a combustion product, similar in many respects to smoke from domestic wood heaters, which is known to cause health problems in both indoor and outdoor environments.

Furthermore, the PM₁₀ and ozone objectives for Victoria are health-based objectives and these were exceeded on a significant number of days during the 2002–03 bushfires.

Therefore it would seem likely that some health effects are to be expected, particularly in children, the elderly and those with respiratory or heart disease, and so precautionary measures are advised for those groups (see next section).

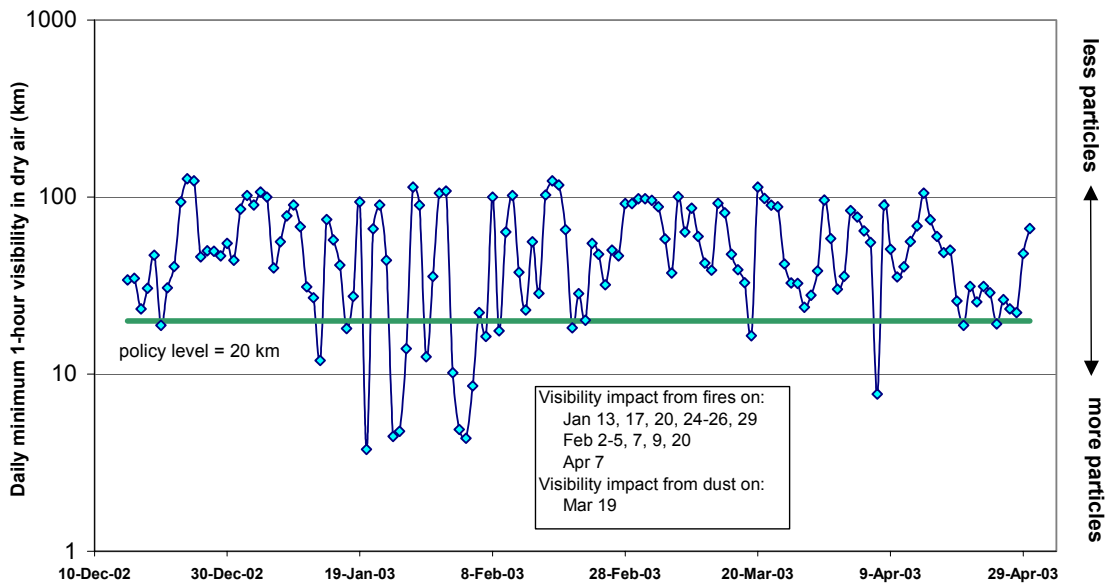


Figure 8: Port Phillip visibility (minimum daily level)

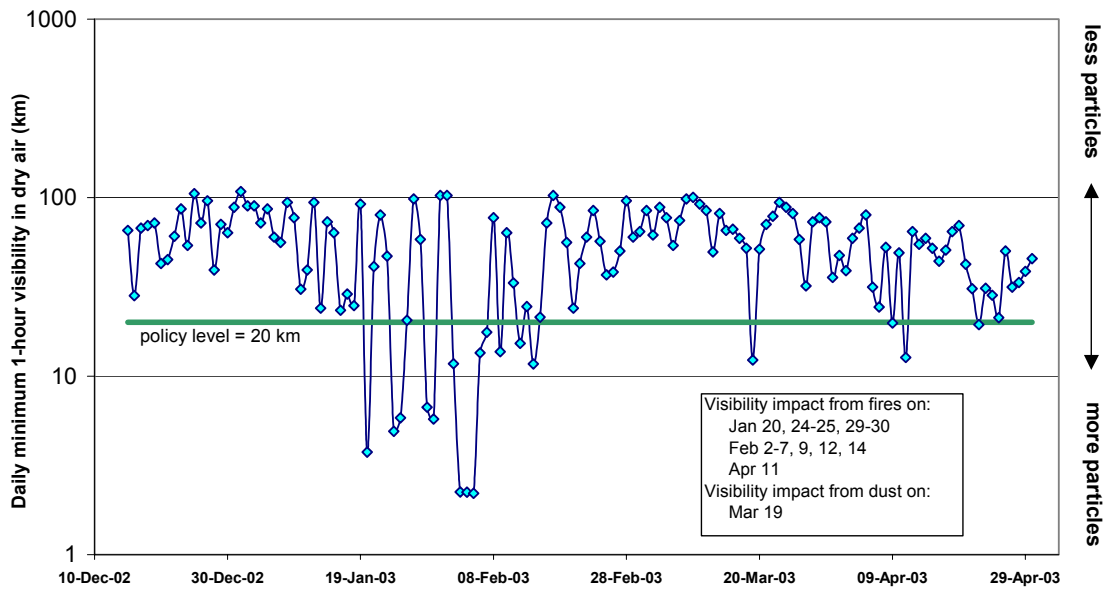


Figure 9: Latrobe Valley visibility (minimum daily level)

6. AIR QUALITY ADVICE

The Department of Human Services and EPA Victoria have developed a simple way for residents to roughly assess the quality of the air they are breathing during bushfires. This is based on visibility – which can be assessed by standing on an elevated spot and looking for large objects (buildings, for example) that are a known distance away. For example, if an object 4 km away can be seen, but an object 8 km away cannot, then visibility is somewhere in the range 4–8 km.

With a rough idea of visibility, the information presented in Table 1 can be used to estimate air quality and to see what health advice should be followed.

Hourly air quality updates from EPA’s network of air monitoring stations (Melbourne, Geelong and the Latrobe Valley) are also available at EPA’s website: <http://www.epa.vic.gov.au/Air/Bulletins>

Frequent updates are also available via major radio stations during serious pollution episodes.

There are a number of simple actions that can be taken during a bushfire emergency to minimise exposure to fine particle pollution (see Table 2). This advice is predominantly issued for people affected by smoke but not in close proximity to the fires.

Table 1: Air Quality Advice

Observed visibility	Air quality	Cautionary statement (DHS)
4–8 km	Unhealthy for sensitive groups	People with respiratory or heart disease should <i>limit</i> prolonged exertion and stay indoors when possible
2.5–4 km	Unhealthy	People with respiratory or heart disease, the elderly and children should <i>avoid</i> prolonged exertion and stay indoors when possible; everyone else should <i>limit</i> prolonged exertion
1.5–2.5 km	Very unhealthy	People with respiratory or heart disease, the elderly and children should <i>avoid</i> any outdoor activity; everyone else should <i>avoid</i> prolonged exertion
less than 1.5 km	Hazardous	Everyone should <i>avoid</i> any indoor and outdoor exertion; everyone should remain indoors whenever possible.

Table 2: Actions to minimise exposure to smoke

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| <ol style="list-style-type: none"> 1. Avoid anything that creates further smoke within the house, eg smoking, use of wood stoves, incense & candles. 2. Operate your air conditioner with the fresh air intake closed. This will effectively keep the air inside cleaner than outside. Replace the filter if it becomes dirty. 3. If you have an air filter, use it. Replace the filter if it becomes dirty. 4. If smoke is intolerable, use a face mask over your mouth and nose to filter out fine particles (P2 or P3 masks are available from hardware shops). 5. Keep doors and windows closed – unless it is too hot to tolerate. If temperatures are very high, and you have no air conditioner or filter, consider seeking alternative shelter. 6. Avoid vacuuming, as this stirs up dust particles. |
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Esplin 2003, ‘Report of the Inquiry into the 2002–2003 Victorian Bushfires’, Office of the Emergency Services Commissioner, September 2003. Available from <http://www.justice.vic.gov.au>

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- Californian Air Pollution Control Officer’s Association and NSW Health Department, for guidelines on mitigating fine particle exposure.