Air quality in the Upper Hunter: Summer 2018–19

Upper Hunter air quality for 1 December 2018 to 28 February 2019 was generally good to fair. Muswellbrook and Singleton recorded very good to fair air quality indices within national benchmarks 93% and 100% of the time, respectively.

- Levels of fine particulate matter PM$_{2.5}$ (particles less than or equal to 2.5 microns in diameter), nitrogen dioxide (NO$_2$) and sulfur dioxide (SO$_2$) were below benchmark concentrations.
- Daily average levels of PM$_{10}$ (particles less than or equal to 10 microns in diameter) were above the 50 µg/m$^3$ benchmark on 15 days (2, 4, 15–16 December, 2–3, 16–19, 31 January, and 10, 12–13, 19 February). Regional maximum daily PM$_{10}$ levels on these days ranged from 51.4 to 128.2 µg/m$^3$.
  - All sites, except Singleton, recorded days over the PM$_{10}$ benchmark, ranging from two days at Singleton South up to eight days at Camberwell (Table 1).
  - Most of New South Wales continued to be drought-affected (Figure 2), with widespread dust storms continuing throughout the season$^1$. The most extensive event occurred on 13 February, when 13 sites in the Upper Hunter and all sites in the North-west Slopes and Northern Tablelands exceeded the PM$_{10}$ benchmark. This widespread dust storm was driven by the passage of a cold front. More information on this event can be found in the DustWatch report – February 2019.
  - The larger population sites recorded PM$_{10}$ levels over the benchmark on 16 January (Aberdeen and Muswellbrook) and 17 January (Muswellbrook) partly due to bushfire smoke$^2$; 2 December (Muswellbrook) and 10, 13 and 19 February (Aberdeen and Muswellbrook) due to a combination of dust from external and local sources. See the Days above benchmark concentrations section for more information on these events.

Annual air quality trends in the Upper Hunter

A comparison of annual average PM$_{10}$ and PM$_{2.5}$ levels shows the long-term trends. The national annual average benchmarks are 25 µg/m$^3$ for PM$_{10}$ and 8 µg/m$^3$ for PM$_{2.5}$, based on a calendar year.

Figure 1 PM$_{10}$ and PM$_{2.5}$ rolling annual averages: 2012–13 to 2018–19

Figure 1 shows the PM$_{10}$ and PM$_{2.5}$ rolling annual averages, based on the 12-month periods, from summer to summer 2012–13 to 2018–19.

The comparison shows that rolling annual average PM$_{10}$ particle levels increased at all sites at the end of summer 2018–19 compared to previous years. The majority of New South Wales experienced below average to lowest on record rainfall in the past 12 months and continued to be drought-affected (Figure 2). DustWatch reported$^1$ that January was the dustiest month since records began in 2005. Widespread

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1 DustWatch report December 2018 ‘Dustiest December in DustWatch records’, DustWatch report January 2019 ‘Triple the dust activity of any other January since 2005’ and ‘It was the dustiest month ever measured’, and DustWatch report February 2019 ‘Dustiest February in DustWatch records (since 2005)’

2 Rural Fire Services ICON database: 13.8ha ‘Soup Pan Creek’ forest fire (9km west of Bulga) from 16/1 10:51 to 23/1 14:18
dust was recorded every week in January. December and February were the dustiest ever measured for those months.

The extended dry periods experienced in the Upper Hunter in recent years, in addition to long-range dust transported from other drought-affected areas in New South Wales, contributed to the increase in PM$_{10}$ particle levels observed in the region to the end of summer 2018–19.

For PM$_{2.5}$, rolling annual average particle levels remained similar to those observed in previous years. Long-range dust from drought-affected areas also would have contributed to PM$_{2.5}$ levels observed in the region over the previous 12 months.

Rolling annual averages are not intended to be compared to the annual benchmarks. The rolling annual averages provide a guide to long-term trends, using the most up to date monitoring data.

The annual averages for the 2011 to 2018 calendars years can be found in the Upper Hunter spring 2018 seasonal newsletter.
Days above benchmark concentrations

There were 15 days over the PM$_{10}$ benchmark in summer 2018–19, with all sites except for Singleton over the benchmark. There were no days over the PM$_{2.5}$ benchmark in summer 2018–19.

Table 1  Number of days above the relevant national benchmarks – summer 2018–19

<table>
<thead>
<tr>
<th>Station type*</th>
<th>Station</th>
<th>PM$_{10}$ daily [50 µg/m$^3$ benchmark]</th>
<th>PM$_{2.5}$ daily [25 µg/m$^3$ benchmark]</th>
<th>SO$_2$ hourly [0 ppm benchmark]</th>
<th>SO$_2$ daily [8 ppm benchmark]</th>
<th>NO$_2$ hourly [12 ppm benchmark]</th>
</tr>
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<tr>
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<td>-</td>
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</tr>
<tr>
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<tr>
<td>Diagnostic</td>
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<tr>
<td>Background</td>
<td>Merriwa</td>
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<tr>
<td>Background</td>
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</tr>
</tbody>
</table>

µg/m$^3$ = microgram per cubic metre and ppm = parts per hundred million by volume (i.e. parts of pollutant per hundred million parts of air)
- = not monitored  * For explanation, refer to the end of the report Definitions: Upper Hunter monitoring station types

The larger population sites recorded PM$_{10}$ levels over the benchmark on 2 December (Muswellbrook), 16 January (Aberdeen and Muswellbrook), 17 January (Muswellbrook) and 10, 13 and 19 February (Aberdeen and Muswellbrook). Elevated particle levels on 16 and 17 January were partly due to bushfire smoke. The remaining events were most likely due to a combination of dust from external and local sources:

- On 2 December, five sites exceeded the PM$_{10}$ benchmark. On this day, particle levels increased from late morning under fresh to strong westerly to north-westerly winds. The daily average at Merriwa was 40 µg/m$^3$, indicating the transport of particles from outside the region. Further spikes in particles were seen at night during a southerly change, further indicating transport of dust from outside of the valley. The North-west Slopes sites also exceeded the benchmark on this day.
- On 10 February, 11 sites exceeded the benchmark. On this day, elevated particle levels were observed overnight at Merriwa under light westerly winds indicating dust transported into the valley from the west.
- On 13 February, a widespread dust storm occurred throughout the State with the passage of a cold front. On this day, PM$_{10}$ levels were over the benchmark at 13 sites in the Upper Hunter, plus the four sites in the Northwest Slopes and Northern Tablelands. More information on this event can be found in the DustWatch report – February 2019.
- On 19 February, ten sites exceeded the benchmark. Elevated particle levels were observed in the early morning at Aberdeen and Muswellbrook under light northerly winds, indicating particles transported from outside the valley. Other sites had elevated particle levels mid to late morning under predominantly light westerly winds. Large spikes in particle levels were observed at all sites in the evening with the southerly change. This indicates additional transport of dust into the region from the south, as southerly and westerly winds converge.

Of interest, on 15 and 16 December, Merriwa was the only site in the region over the PM$_{10}$ benchmark (Figure 6). Widespread dust storms occurred on these days, originating from Queensland, with levels over the benchmark also in the Central Tablelands and North-west Slopes. Elevated levels at Merriwa occurred mainly under light to moderate north to north-west winds. Southerly winds were observed on 15 December at lower elevation sites. The different wind directions, at higher and lower elevations, suggest a separate, lower, atmospheric layer may have restricted the downward movement of dust in the westerly air flows. This would account for exceedances only at the higher elevation site of Merriwa.
Daily time series plots

Daily average time series plots for PM$_{10}$ and PM$_{2.5}$ and daily one-hour maximum plots for NO$_2$ and SO$_2$ show the daily concentrations throughout the summer season.

Figure 3  Population centre sites: daily average PM$_{10}$ – summer 2018–19

Figure 4  Smaller community sites: daily average PM$_{10}$ – summer 2018–19

Figure 5  Diagnostic sites: daily average PM$_{10}$ – summer 2018–19

Figure 6  Background sites: daily average PM$_{10}$ – summer 2018–19

Figure 7  Daily average PM$_{2.5}$ – summer 2018–19

Figure 8  Daily 1-hr maximum NO$_2$ – summer 2018–19

Figure 9  Daily 1-hr maximum SO$_2$ – summer 2018–19
Pollution roses from hourly data

The seasonal PM$_{10}$ pollution rose map$^4$ shows elevated hourly PM$_{10}$ levels$^5$ occurred mainly at sites along the central part of the valley during summer, particularly under south-east winds.

![Hourly PM$_{10}$ pollution rose map for the Upper Hunter region for summer 2018–19](image)

**Figure 10**  Hourly PM$_{10}$ pollution rose map for the Upper Hunter region for summer 2018–19

Seasonal comparisons

This section compares air quality levels in summer 2018–19 with previous summer seasons.

All days were below the national benchmark concentrations for PM$_{2.5}$, NO$_2$ and SO$_2$ in summer in the past seven years, except for one hour over the SO$_2$ benchmark on 23 December 2016.

The daily average PM$_{10}$ concentrations were above the benchmark on 15 days during summer 2018–19. This is a few more days than the previous two summers with 13 days over the benchmark in summer 2017–18 and 12 days over the benchmark in summer 2016-17. Fewer days over the benchmark were recorded in summer in earlier years, with five days in summer 2015–16, one in 2014–15, nine in 2013–14 and six in 2012–13.

New South Wales continued to experience severe drought conditions, including in the Upper Hunter. These dry conditions, with long-range and local dust transport, contributed to elevated particle levels in the region.

![Number of days above the PM$_{10}$ benchmark from 2012–13 to 2018–19 summer seasons](image)

**Figure 11**  Number of days above the PM$_{10}$ benchmark from 2012–13 to 2018–19 summer seasons

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$^4$ Pollution roses show wind direction and particle levels at a location. The length of each bar around the circle shows the percentage of time the wind blows from a particular direction. The colours along the bars indicate categories of particle levels (as outlined in the key).

$^5$ The Air NEPM sets no standard for the hourly PM$_{10}$ concentrations. An hourly PM$_{10}$ concentration of 75 µg/m$^3$ generally indicates relatively elevated PM$_{10}$ levels and a higher likelihood that the daily PM$_{10}$ benchmark of 50 µg/m$^3$ may be exceeded.
Particle air quality trends in the Upper Hunter

Figure 12 and Figure 13 show daily average levels of PM\textsubscript{10} during summer 2018–19, compared to the daily maximum and minimum (i.e. shaded range) of PM\textsubscript{10} levels for the summer periods from 2011–12 to 2017–18, at Singleton and Muswellbrook. Daily PM\textsubscript{10} levels in 2018–19 were generally within the same range as earlier years, except for some peaks at Muswellbrook. These coincided with drier conditions, resulting in increased local and long-range dust (Figure 14), plus bushfire smoke in mid-January.

Figure 12 Singleton daily average PM\textsubscript{10} during summer 2018–19 plotted against the daily maximum and minimum PM\textsubscript{10} levels recorded from summers 2011–12 to 2017–18

Figure 13 Muswellbrook daily average PM\textsubscript{10} during summer 2018–19 plotted against the daily maximum and minimum PM\textsubscript{10} levels recorded from summers 2011–12 to 2017–18

Figure 14 OEH Singleton\textsuperscript{6} cumulative monthly rainfall during summer 2018–19 plotted against the Bureau of Meteorology Singleton STP\textsuperscript{7} maximum and average monthly rainfall from summer 2011–12 to 2017–18

Figure 15 and Figure 16 show daily average levels of PM\textsubscript{2.5} during summer 2018–19, compared to the daily maximum and minimum levels (shaded range) for summer periods from 2011–12 to 2017–18, at Singleton and Muswellbrook. Daily PM\textsubscript{2.5} levels in summer 2018–19 were generally within the same range as earlier years.

Figure 15 Singleton daily average PM\textsubscript{2.5} during summer 2018–19 plotted against the daily maximum and minimum PM\textsubscript{2.5} levels recorded from summers 2011–12 to 2017–18

Figure 16 Muswellbrook daily average PM\textsubscript{2.5} during summer 2018–19 plotted against the daily maximum and minimum PM\textsubscript{2.5} levels recorded from summers 2011–12 to 2017–18

\textsuperscript{6} The OEH Singleton rainfall data for summer 2018–19 was used in lieu of the Bureau of Meteorology Singleton STP rainfall data, as no data available from this site since 21 January 2019

\textsuperscript{7} Data obtained from the Bureau of Meteorology Singleton STP monthly rainfall data web page (accessed April 2019)
Meteorological summary

Rainfall and temperature

The Upper Hunter experienced predominantly below average rainfall during summer 2018–19. The region received 25 to 100 millimetres more rainfall in summer 2018–19 compared to summer 2017–18, up to 50 millimetres more than summer 2016–17 and 50 to 400 millimetres less than summer 2015–16. Maximum and minimum temperatures were very much above average during the season.

Wind

The winds were predominantly from the south-east in the region during summer 2018–19, which is typical for this time of year. Overall, wind speeds in summer 2018–19 were similar to summer 2014–15 and 2015–16, which had lighter winds.

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8 Rainfall and temperature information is from the Bureau of Meteorology New South Wales summer 2018-19 climate statement and climate maps (accessed April 2019)

9 Wind roses show the wind direction and speed at a location. The length of each bar around the circle show the percentage of time that the wind blows from a particular direction. The colours along the bars indicate the wind speed categories.
Network performance

The target network performance is at least 95% available data for all parameters. The maximum online time that can be attained for NO₂ and SO₂ is 96%, due to daily calibrations.

Table 2  Online performance (%) during summer 2018–19

<table>
<thead>
<tr>
<th>Station</th>
<th>Particles PM₁₀ daily</th>
<th>Particles PM₂.₅ daily</th>
<th>Gases SO₂ hourly</th>
<th>Gases NO₂ hourly</th>
<th>Meteorology Wind hourly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aberdeen</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
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<tr>
<td>Bulga</td>
<td>98</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>Camberwell</td>
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<td>98</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>Jerrys Plains</td>
<td>89</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>95</td>
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<tr>
<td>Maison Dieu</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>99</td>
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<tr>
<td>Merriwa</td>
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<td>-</td>
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<td>99</td>
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<tr>
<td>Mount Thorley</td>
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<td>-</td>
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<tr>
<td>Muswellbrook</td>
<td>100</td>
<td>100</td>
<td>96</td>
<td>96</td>
<td>99</td>
</tr>
<tr>
<td>Muswellbrook NW</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<td>Singleton</td>
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<td>Wybong</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
</tbody>
</table>

- = not monitored

The overall reduced online times were mainly due to:

- Jerrys Plains PM₁₀ and wind – PM₁₀ scheduled maintenance (one day), PM₁₀ communications fault (three days) and site power outages (six days).

Definitions: Upper Hunter monitoring station types

The 14 monitoring stations in the Upper Hunter serve different purposes:

**Larger population:** stations near the larger population centres monitor the air quality in these centres.

**Smaller communities:** stations near smaller communities monitor the air quality at those locations.

**Diagnostic:** provide data that can help to diagnose the likely sources and movement of particles across the region as a whole; they do not provide information about air quality at population centres.

**Background:** the stations near Merriwa and Singleton South are at both ends of the valley and provide background data, measuring the quality of air entering and leaving the Upper Hunter Valley under predominant winds (south-easterlies and north-westerlies).

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Email: info@environment.nsw.gov.au;

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