

Air quality in the Upper Hunter: Spring 2019

Air quality in the Upper Hunter was greatly affected by the continuing intense drought conditions and unprecedented extensive bushfires during spring 2019, resulting in poorer air quality throughout the region. Muswellbrook and Singleton recorded very good to fair air quality indices within national benchmarks 71% and 74% of the time, respectively. Conditions in the region continued to be extremely dry and warm, resulting in elevated particle levels from bushfire smoke, long-range dust transport during widespread dust events, and local dust sources (including those from industrial activities).

- Levels of nitrogen dioxide (NO₂) and sulfur dioxide (SO₂) were good, remaining below national benchmark concentrations.
- Daily average levels of fine particulate matter PM_{2.5} (particles less than or equal to 2.5 microns in diameter) were above the 25 µg/m³ (micrograms per cubic metre of air) benchmark on 14 days (29–31 October and 1, 12, 16–18, 21–23, 26 and 28–29 November), all during the bushfire emergency period. Regional maximum daily PM_{2.5} levels on these days ranged from 26.1 to 80.0 µg/m³.
 - Singleton had 10 days, while Camberwell and Muswellbrook had 12 days over the benchmark.
- Daily average levels of PM₁₀ (particles less than or equal to 10 microns in diameter) were above the 50 µg/m³ benchmark on 45 days (6–7, 12–13, 16 and 27–28 September, 3–4, 7–8, 16–19 and 24–31 October, 1–3, 7–8, 12, 14–23 and 25–30 November). Regional maximum daily PM₁₀ levels on these days ranged from 50.6 to 446.1 µg/m³.
 - There were 20 days over the PM₁₀ benchmark at Merriwa, Singleton South and Wybong, and up to 38 days at Camberwell (Table 1).
 - There were many widespread events during the season, with all sites over the PM₁₀ benchmark on 13 days (29% of PM₁₀ exceedance days).
- There were eight days from late October onwards (during the bushfire emergency period), when particle levels at one or more large population centres reached hazardous levels (26, 30–31 October and 12, 21–22, 26 and 29 November). These hazardous days were due to smoke, widespread dust events or a combination of both. These were all widespread regional particle events, with hazardous levels also recorded in other NSW regions on all eight days.

The New South Wales Annual Air Quality Statement 2019 provides more information on air quality throughout the State, including focus sections on the bushfires and dust storms.

Annual air quality trends in the Upper Hunter

A comparison of annual average PM₁₀ and PM_{2.5} levels shows the long-term trends. The national annual average benchmarks are 25 µg/m³ for PM₁₀ and 8 µg/m³ for PM_{2.5}, based on a calendar year.

Figure 1 shows the PM₁₀ and PM_{2.5} annual averages from 2011 to 2019.

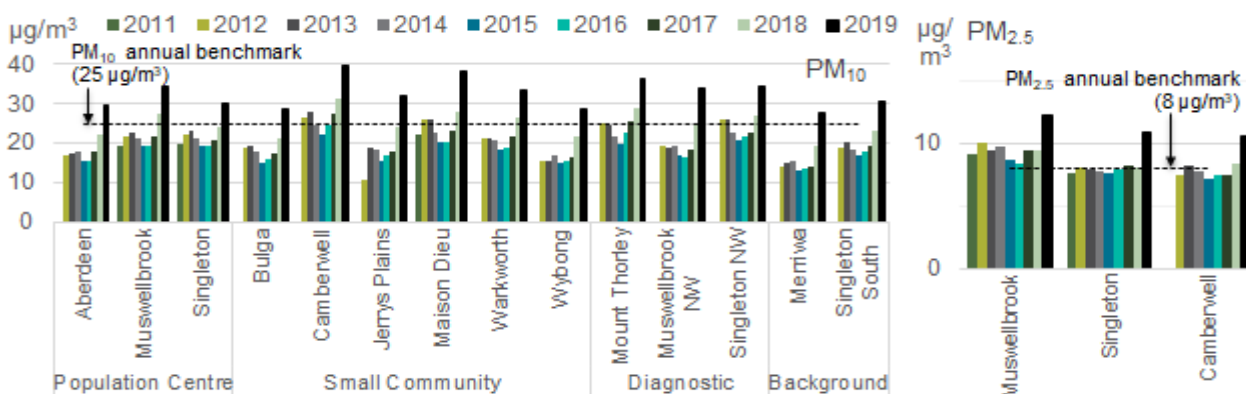


Figure 1 PM₁₀ and PM_{2.5} annual averages – 2011 to 2019

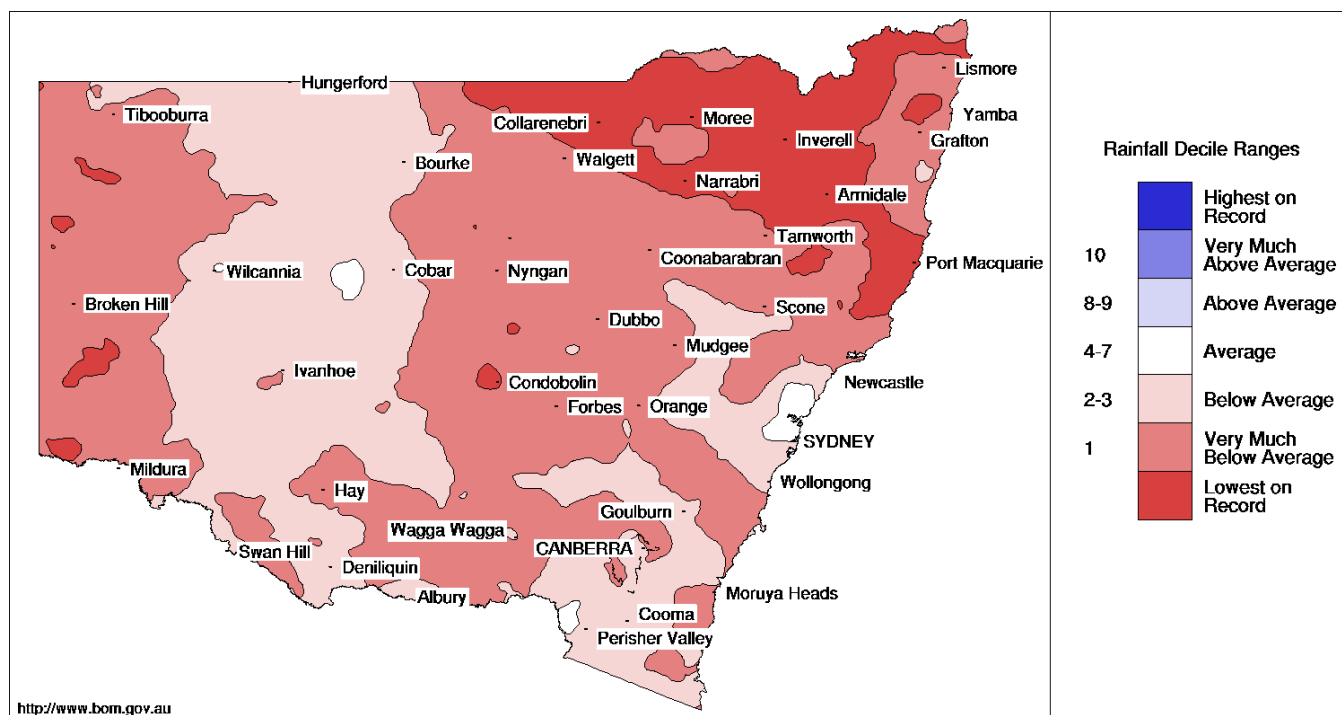
There was a large increase in particle levels throughout the region in 2019 compared to earlier years. Annual PM₁₀ and PM_{2.5} levels exceeded the benchmark at all sites in 2019. In comparison, six sites (Camberwell, Maison Dieu, Mount Thorley, Muswellbrook, Singleton North West and Warkworth) recorded PM₁₀ levels over the annual benchmark in 2018. For PM_{2.5}, all sites recorded levels over the annual benchmark in 2018, although levels were lower compared to 2019.

The bushfire emergency saw around four million hectares burnt in New South Wales from July to December 2019, resulting in widespread smoke impacts on many regions through spring and early summer. The Upper Hunter region was affected by smoke from multiple large bushfires both nearby and along the NSW coast. Also, continuing intense drought conditions led to lower ground cover¹ with an increase in dust transport into the valley from widespread dust events, along with an increase in local dust generation throughout the year. The NSW Environment Protection Authority (EPA) reported that dust from mining activities was generally well controlled during the EPA's Bust the Dust compliance and awareness campaign that ran during spring 2019. However, the EPA also observed dust blowing from exposed areas of mines on the hot, dry, windy days.

Most of New South Wales experienced below average to lowest on record rainfall in the 12 months to the end of spring 2019 (Figure 2) and was drought-affected (Figure 3). This was particularly evident in the intensely drought-affected Central West, North West, Northern Tablelands and North Coast regions.

New South Wales Rainfall Deciles 1 December 2018 to 30 November 2019

Distribution Based on Gridded Data
Australian Bureau of Meteorology



http://www.bom.gov.au © Commonwealth of Australia 2020, Bureau of Meteorology ID code: AWAP Issued: 19/02/2020

Figure 2 NSW rainfall deciles – 1 December 2018 to 30 November 2019²

¹ DustWatch reports: [September 2019](#), [October 2019](#) and [November 2019](#)

² [Rainfall deciles map](#) sourced from the Bureau of Meteorology (accessed March 2020)

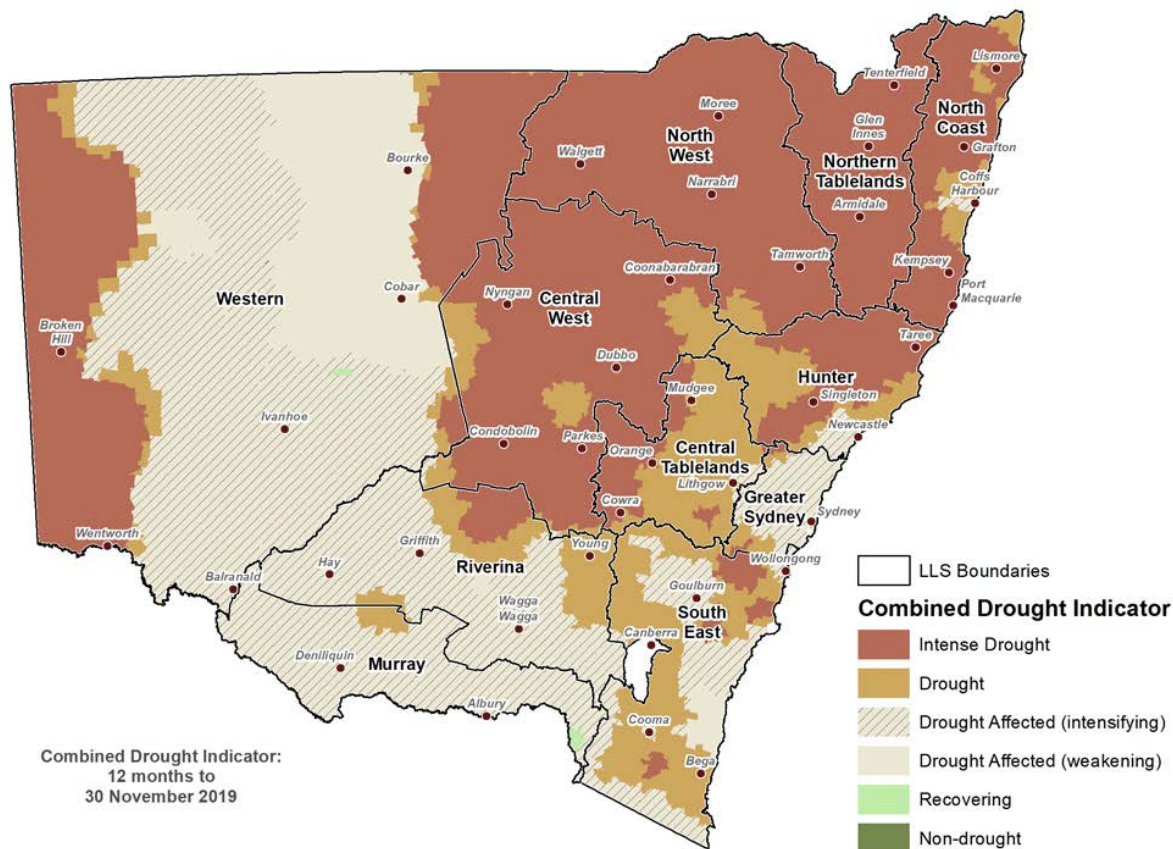


Figure 3 Department of Primary Industries NSW Combined Drought Indicator to 30 November 2019³

Days above benchmark concentrations

There were 45 days over the PM₁₀ benchmark in spring 2019, with the highest number of days occurring at Camberwell (38 days). There were 14 days over the PM_{2.5} benchmark in spring 2019.

Table 1 Number of days above the relevant national benchmarks – spring 2019

Station type*	Station	PM ₁₀ daily [50 µg/m ³ benchmark]	PM _{2.5} daily [25 µg/m ³ benchmark]	SO ₂ hourly [20 pphm benchmark]	SO ₂ daily [8 pphm benchmark]	NO ₂ hourly [12 pphm benchmark]
Population centre	Aberdeen	25	-	-	-	-
Population centre	Muswellbrook	26	12	0	0	0
Population centre	Singleton	22	10	0	0	0
Smaller community	Bulga	22	-	-	-	-
Smaller community	Camberwell	38	12	-	-	-
Smaller community	Jerrys Plains	23	-	-	-	-
Smaller community	Maison Dieu	35	-	-	-	-
Smaller community	Warkworth	25	-	-	-	-
Smaller community	Wybong	20	-	-	-	-
Diagnostic	Mount Thorley	28	-	-	-	-
Diagnostic	Muswellbrook NW	26	-	-	-	-
Diagnostic	Singleton NW	29	-	-	-	-
Background	Merriwa	20	-	-	-	-
Background	Singleton South	20	-	-	-	-

µg/m³ = micrograms per cubic metre and pphm = 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**

³ Sourced from Department of Primary Industries [NSW State seasonal update - November 2019](#) (accessed March 2020)

Pollution roses from hourly particle data

The seasonal PM₁₀ pollution rose maps⁴ (Figure 4 and Figure 5) show that elevated hourly PM₁₀ and PM_{2.5} levels⁵ were observed at all sites during the season. Elevated particle levels were observed from all directions, especially under west to north-westerly winds, as particles were transported into the region from widespread bushfires and dust storms.

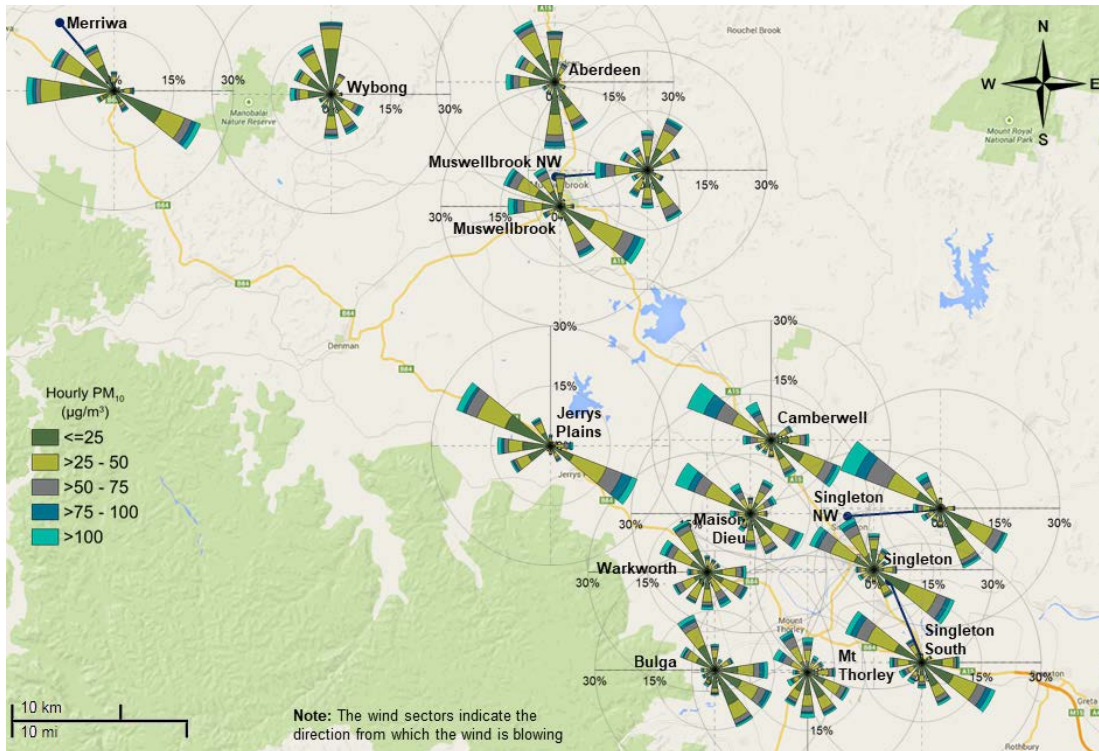


Figure 4 Hourly PM₁₀ pollution rose map for the Upper Hunter region for spring 2019

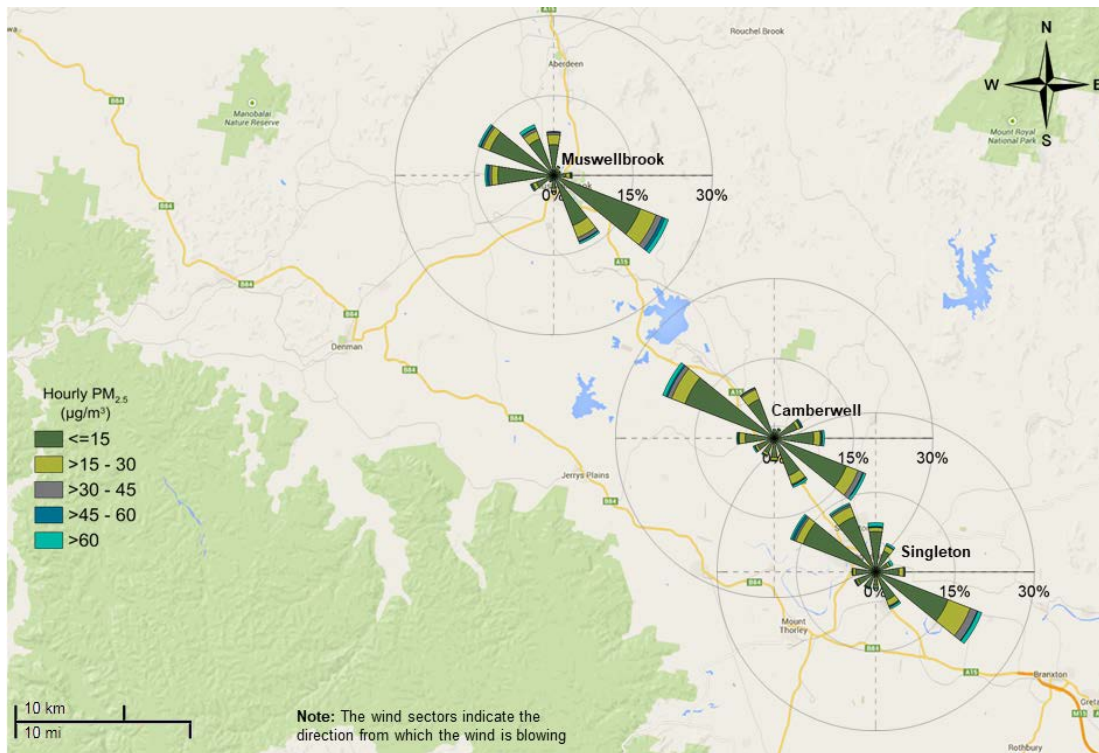


Figure 5 Hourly PM_{2.5} pollution rose map for the Upper Hunter region for spring 2019

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.

⁵ There are no standards for hourly PM₁₀ or PM_{2.5} in the National Environment Protection (Ambient Air Quality) Measure (Air NEPM).

Daily time series plots

Daily average time series plots for PM₁₀ and PM_{2.5} and daily one-hour maximum plots for NO₂ and SO₂ show the concentrations throughout spring (Figure 6 to Figure 12). NO₂ and SO₂ remained below the benchmarks. High particle levels were recorded throughout the region from late October, during the bushfire emergency period. Widespread dust storms were also present during this period.

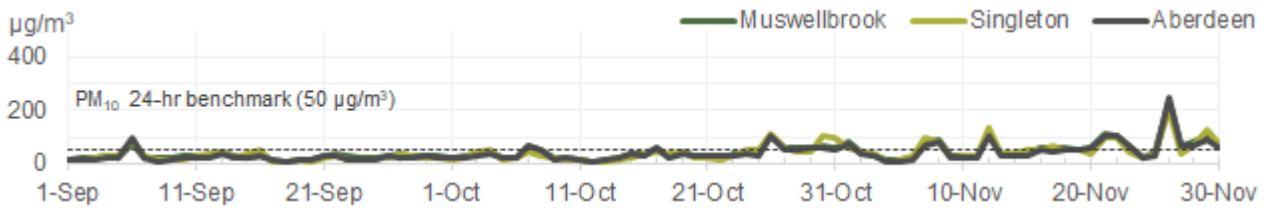


Figure 6 Population centre sites: daily average PM₁₀ – spring 2019

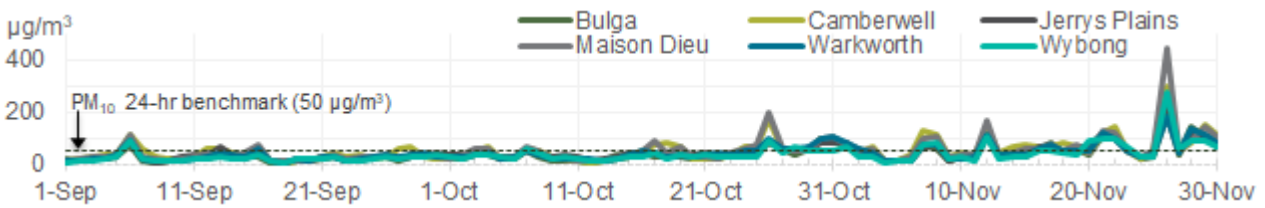


Figure 7 Smaller community sites: daily average PM₁₀ – spring 2019

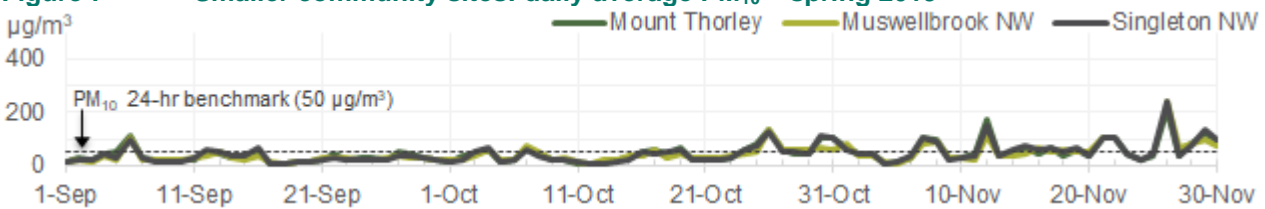


Figure 8 Diagnostic sites: daily average PM₁₀ – spring 2019

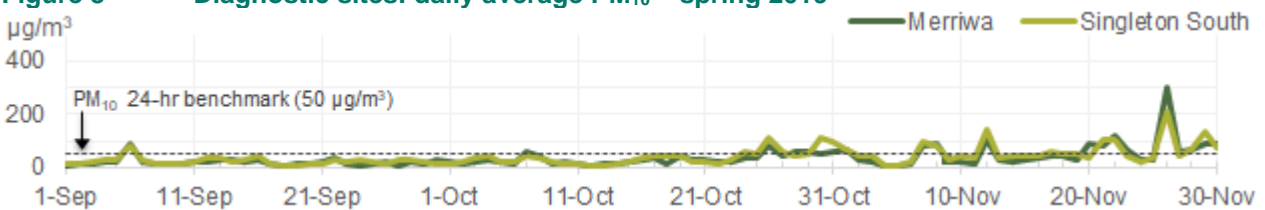


Figure 9 Background sites: daily average PM₁₀ – spring 2019

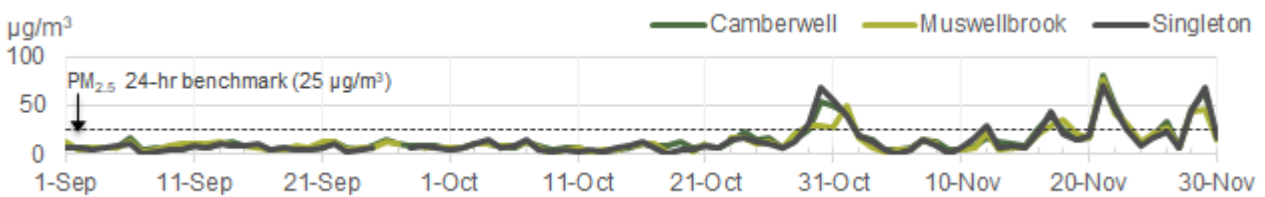


Figure 10 Daily average PM_{2.5} – spring 2019

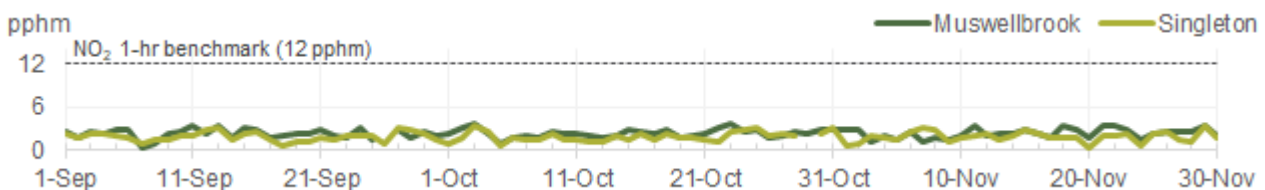


Figure 11 Daily 1-hr maximum NO₂ – spring 2019

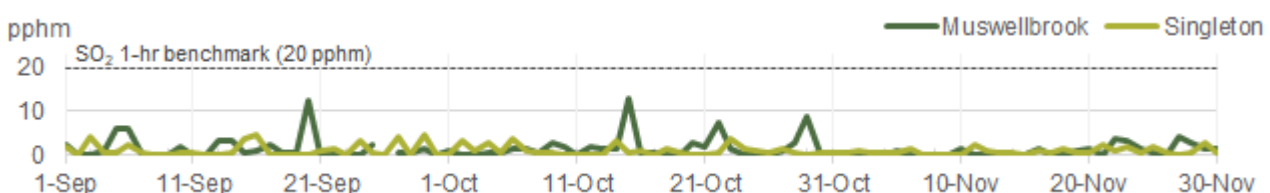


Figure 12 Daily 1-hr maximum SO₂ – spring 2019

Seasonal comparisons

This section compares air quality levels in spring 2019 with previous spring seasons.

All days were below the national benchmark concentrations for NO₂ and SO₂ in spring during the past eight years.

There were large increases in the number of days over the particle benchmarks in spring 2019, compared to earlier years 2012 to 2018 (Figure 13):

- There were 45 days over the PM₁₀ daily benchmark during spring 2019, ranging from 20 days at Merriwa, Singleton South and Wybong to 38 days at Camberwell. From 2012 to 2018, the region recorded between six days (spring 2016) to 29 days (spring 2013) over the PM₁₀ daily benchmark.
- There were 14 days over the PM_{2.5} daily benchmark during spring 2019, ranging from 10 days at Camberwell to 12 days at Muswellbrook and Singleton. From 2012 to 2018, the region recorded four days in total over the PM_{2.5} daily benchmark during spring, ranging from between zero days (spring 2015 to 2018) to two days (spring 2013).

New South Wales continued to experience intense drought conditions, including in the Upper Hunter, and saw an unprecedented area burnt during the bushfire emergency period. These prolonged dry conditions and extensive smoke impacts, with widespread long-range dust transport and local dust sources (including those from industrial activities), resulted in high particle levels in the region during the season.

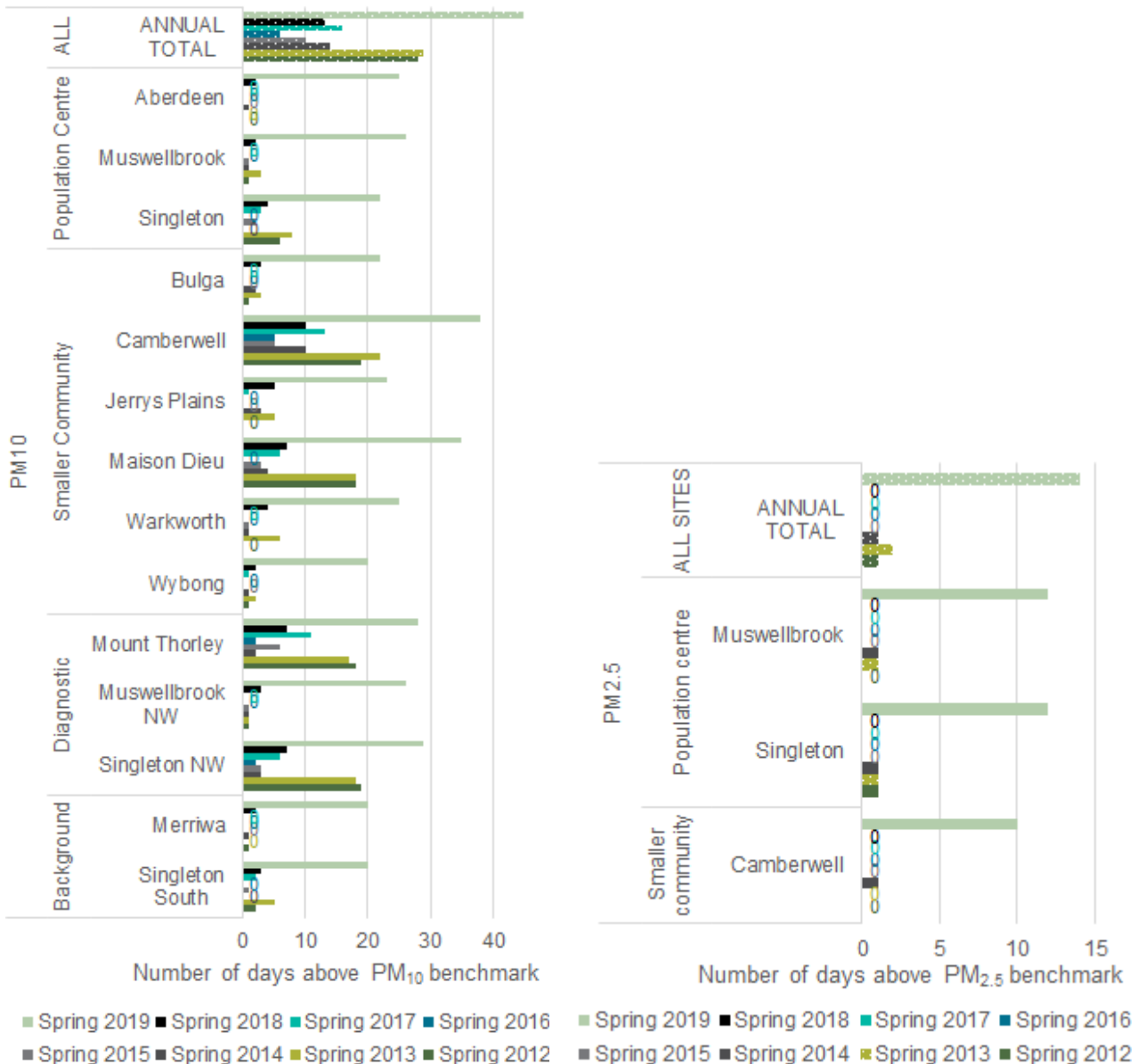


Figure 13 Number of days above the PM₁₀ and PM_{2.5} daily benchmarks – spring 2012 to 2019

Air quality in the Upper Hunter: Spring 2019

Particle air quality trends in the Upper Hunter

Figure 14 and Figure 15 show daily average PM₁₀ levels during spring 2019, compared to the daily maximum and minimum levels (i.e. shaded range) for spring periods from 2011 to 2018, at Singleton and Muswellbrook. These show that daily PM₁₀ levels were generally within the range of earlier years in the first half of the season, except for a peak on 6 September due to a widespread dust storm. From late October, due to extensive smoke impacts and widespread dust events, many days recorded levels higher than the historical range. Conditions were very dry throughout most of spring (Figure 16).

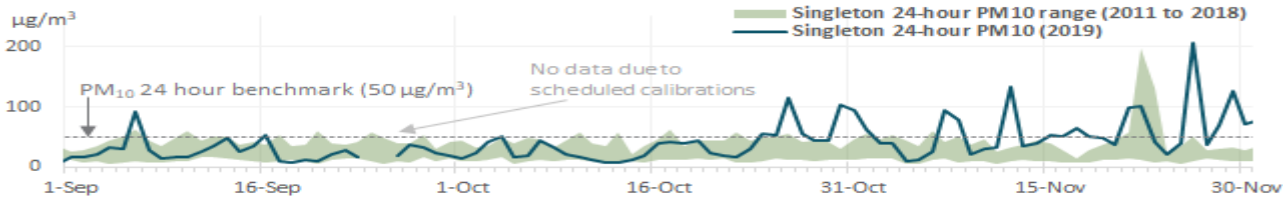


Figure 14 Singleton daily average PM₁₀ during spring 2019 plotted against the daily maximum and minimum PM₁₀ levels from 2011 to 2018

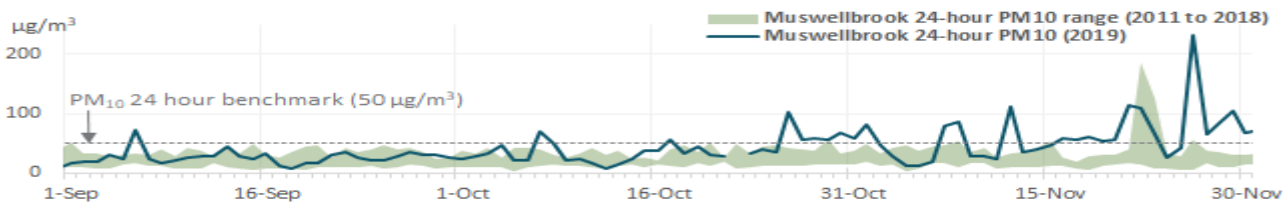


Figure 15 Muswellbrook daily average PM₁₀ during spring 2019 plotted against the daily maximum and minimum PM₁₀ levels from 2011 to 2018

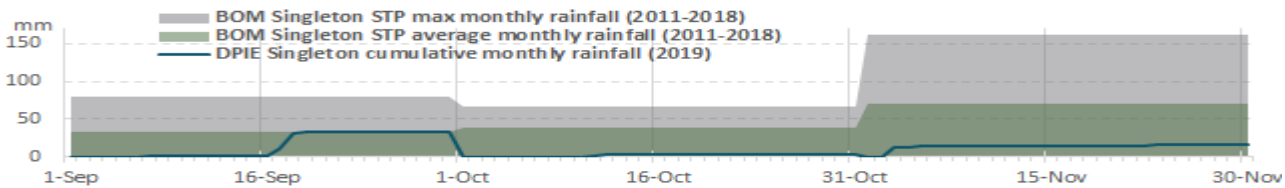


Figure 16 DPIE Singleton⁶ cumulative monthly rainfall in spring 2019 against Bureau of Meteorology Singleton STP⁷ maximum and average monthly rainfall from 2011 to 2018

Figure 17 and Figure 18 show daily average PM_{2.5} levels during spring 2019, compared to the daily maximum and minimum levels (shaded range) for spring periods from 2011 to 2018, at Singleton and Muswellbrook. These show that daily PM_{2.5} levels were within the range of earlier years in the first half of the season. From late October, due to extensive smoke during the bushfire emergency period, many days recorded levels higher than the historical range.

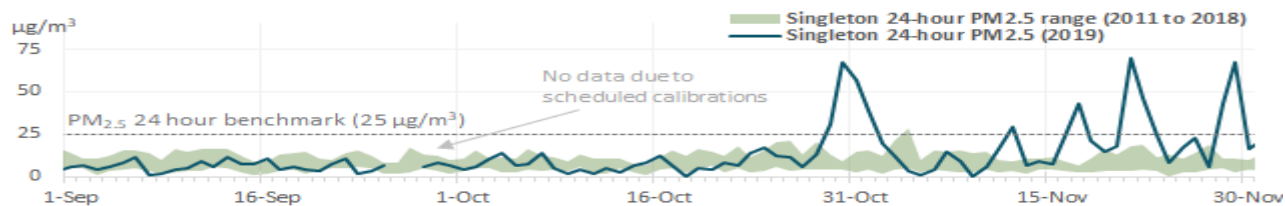


Figure 17 Singleton daily average PM_{2.5} during spring 2019 plotted against the daily maximum and minimum PM_{2.5} levels from 2011 to 2018

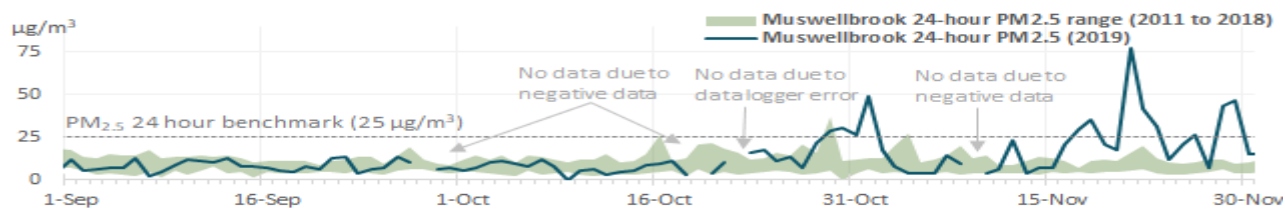


Figure 18 Muswellbrook daily average PM_{2.5} during spring 2019 plotted against the daily maximum and minimum PM_{2.5} levels from 2011 to 2018

⁶ The Department of Planning Industry and Environment (DPIE) (formerly OEH) Singleton rainfall data for spring 2019 was used in lieu of the Bureau of Meteorology Singleton STP rainfall data, as no data available from this site since 21 January 2019.

⁷ Data obtained from the Bureau of Meteorology [Singleton STP monthly rainfall data](#) web page (accessed March 2020)

Meteorological summary

Rainfall and temperature⁸

The Upper Hunter experienced below average rainfall during spring 2019 (Figure 19). The season was drier than spring 2018 with 50 to 100 millimetres less rainfall and drier than spring 2016 with 100 to 200 millimetres less rainfall. Rainfall levels in spring 2019 were similar to spring 2017.

Maximum temperatures were very much above average and minimum temperatures were above average during the season.

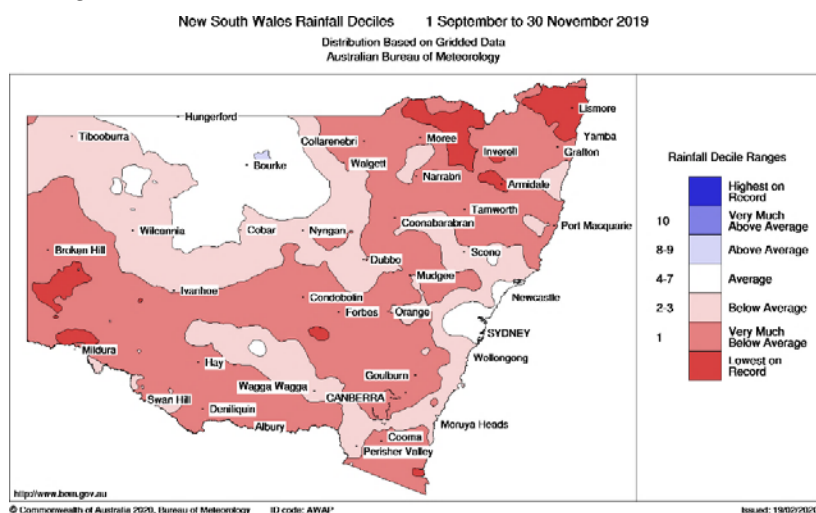


Figure 19 NSW rainfall deciles – spring 2019

Wind

Winds were variable in the region during spring 2019 (Figure 20), which was typical for this transitional season, where predominant winds change from north-westerly in winter to south-easterly in summer. Overall, wind speeds in spring 2019 were similar to previous springs, except 2015 which had lighter winds.

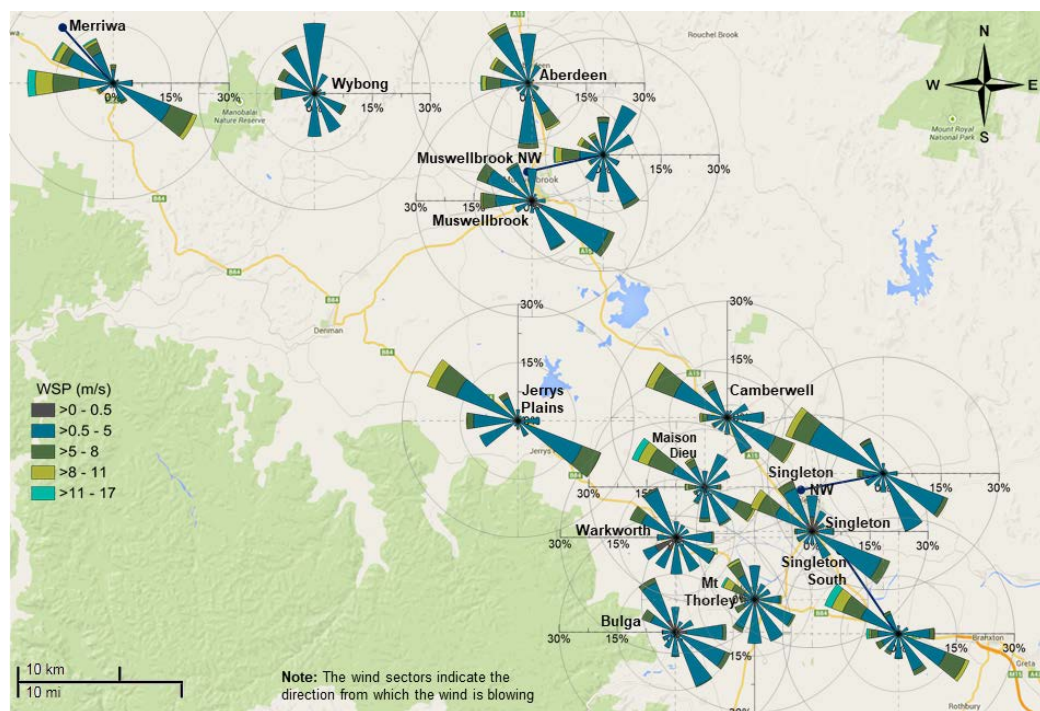


Figure 20 Wind rose map⁹ for the Upper Hunter region for spring 2019

⁸ Rainfall and temperature information is from the Bureau of Meteorology [New South Wales spring 2019 climate statement and climate maps](#) (accessed March 2020)

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 spring 2019

Station	Particles PM ₁₀ daily	Particles PM _{2.5} daily	Gases SO ₂ hourly	Gases NO ₂ hourly	Meteorology Wind hourly
Aberdeen	100	-	-	-	100
Bulga	100	-	-	-	100
Camberwell	100	100	-	-	100
Jerrys Plains	97	-	-	-	99
Maison Dieu	98	-	-	-	100
Merriwa	100	-	-	-	100
Mount Thorley	100	-	-	-	100
Muswellbrook	99	96	93	93	99
Muswellbrook NW	96	-	-	-	100
Singleton	98	98	94	93	100
Singleton NW	100	-	-	-	100
Singleton South	100	-	-	-	100
Warkworth	100	-	-	-	100
Wybong	100	-	-	-	100

- = not monitored

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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