Air quality in the Upper Hunter: Winter 2018

Upper Hunter air quality for 1 June to 31 August 2018 was generally good to fair. Muswellbrook and Singleton recorded very good to fair air quality indices within national benchmarks 93% and 97% of the time, respectively. Conditions in the region continued to be dry and warm, resulting in elevated particle levels from local sources combined with long-range dust transport, during widespread dust storms.

- Levels of nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) were below 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/m^3 (micrograms per cubic metre of air) benchmark on 21 and 25 June at Muswellbrook. These were likely due to wood smoke with cold calm conditions overnight.
- 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 29 days (6, 15–20, 22–29 and 31 July, and 1–2, 4–6, 11, 15–19, 23 and 29 August). There were 19 more days above the benchmark compared to winter 2017 (Figure 11). Regional maximum daily PM_{10} levels on these days ranged from 50.5 to 94.1 µg/m^3.
  - There were no days over the PM_{10} benchmark at Aberdeen and Jerrys Plains and up to 19 days at Camberwell (Table 1).
  - Most of NSW continued to be drought-affected (Figure 2), with widespread dust storms in July and August[1] [2]. The most extensive events occurred on 18–19 July and 4 August, being exceptional events due to long-range dust transport.
    - On 18 July, 25 air quality monitoring stations in the NSW network recorded PM_{10} levels over the benchmark. A dust storm originated in South Australia and the Victorian Mallee on 17 July[1].
    - On 4 August, 16 northern air quality monitoring stations recorded PM_{10} levels over the benchmark, with nine in the Upper Hunter, three in the Namoi and four in Newcastle. The region was affected by long-range dust from the State's west, seen by the rural network[3].
  - The larger population sites recorded PM_{10} levels over the benchmark on 18 July (Muswellbrook and Singleton), 19 July (Singleton), 20 July (Muswellbrook) and 2 August (Muswellbrook).
    - The region was impacted by long-range and local dust from 18 to 20 July[1].
    - On 2 August, elevated dust levels occurred at Muswellbrook in the early morning under light west to southwest winds. There is no clear source for this event.

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.

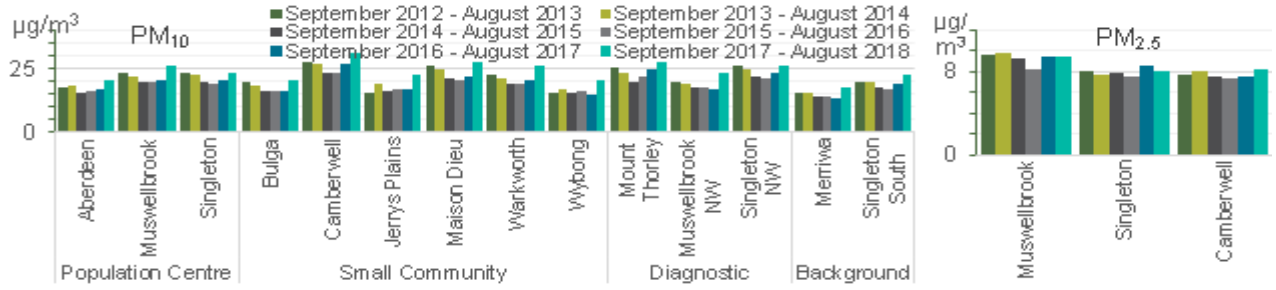

Figure 1 PM_{10} and $PM_{2.5}$ rolling annual averages to the end of winter: 2013 to 2018

[1] DustWatch report June 2018 'Dust activity low due to rain and lack of strong winds', DustWatch report July 2018 'Highest dust on record for month of July', and DustWatch report August 2018 'Dustiest August since 2005; Large dust storms'
[2] Fires may have impacted Mt Thorley on 27/7 (155ha 'Upper Yango Creek, Laguna' and 37ha 'Cedar Creek Rd, Cedar Creek' grass fires to the south); on 5/8 (360ha 'Thompson Vale Rd' grass fire to the south-east); and on 23/8 (712ha 'Jacobs Rd' fire to the south).
[3] Indicative dust monitoring levels are found on the OEH rural air quality monitoring network website

Figure 1 shows the PM_{10} and $PM_{2.5}$ rolling annual averages, based on the 12-month periods, from winter to winter for 2013 to 2018.

The comparison shows that the rolling annual average PM_{10} particle levels increased at the end of winter 2018 compared to previous years. Many NSW regions, including the Upper Hunter, experienced low rainfall over the past 12 months (Figure 2). The NSW Department of Primary Industries reported[4] that although some significant rainfall occurred in parts of New South Wales in August, including reasonable falls north of Singleton, close to 100% of the state continued to be drought-affected at the end of August 2018.

The extended dry periods experienced in the Upper Hunter during winter to early spring 2017 and summer to winter 2018, in addition to long-range dust from drought-affected areas in New South Wales, would have contributed to the increase in the particle rolling annual averages observed within the region.

For $PM_{2.5}$, rolling annual average particle levels remained similar to previous years.

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 2017 calendar years can be found in the Upper Hunter summer 2017–18 seasonal newsletter.

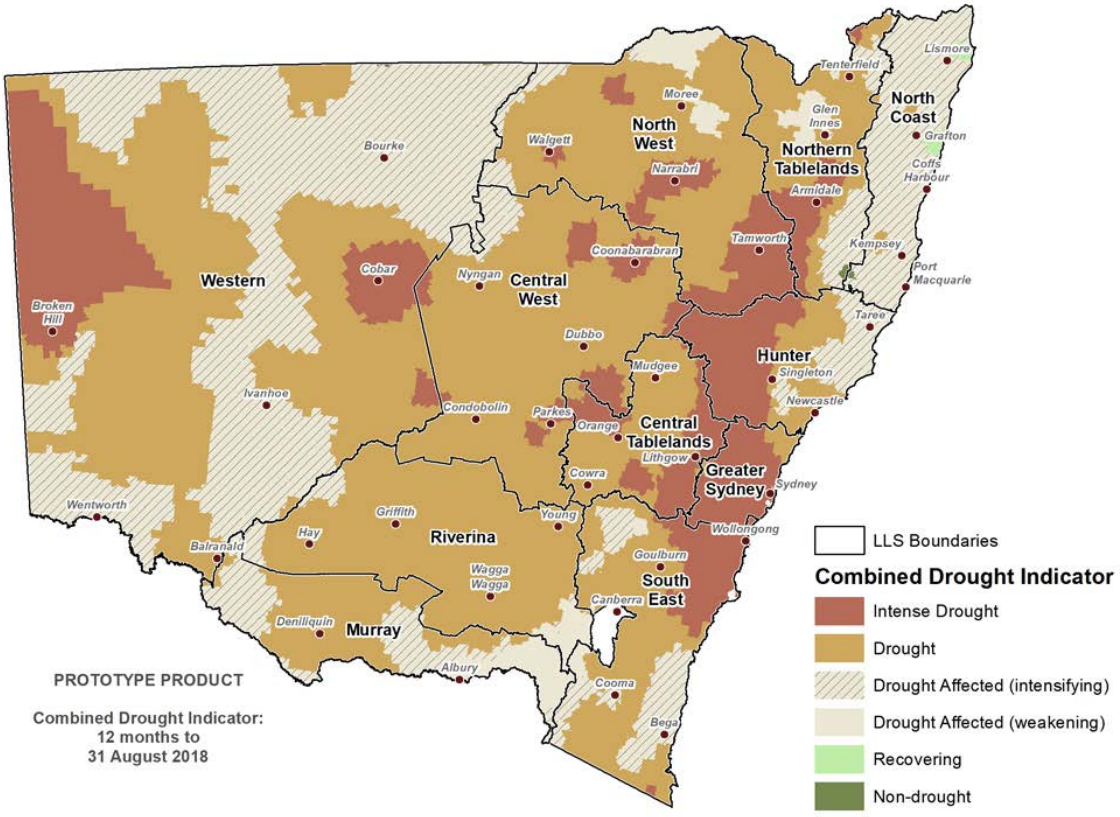

Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 31 August 2018[4]

[4] Sourced from Department of Primary Industries NSW State seasonal update - August 2018 (accessed November 2018).

Days above benchmark concentrations

There was were 29 days over the PM_{10} benchmark in winter 2018, with sites closer to mines recording the highest number of days. There were two days over the $PM_{2.5}$ benchmark in winter 2018.

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

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_2hourly [12 pphm benchmark]
Population centre	**Aberdeen**	0	-	-	-	-
Population centre	**Muswellbrook**	4	2	0	0	0
Population centre	**Singleton**	3	0	0	0	0
Smaller community	**Bulga**	1	-	-	-	-
Smaller community	**Camberwell**	19	0	-	-	-
Smaller community	**Jerrys Plains**	0	-	-	-	-
Smaller community	**Maison Dieu**	9	-	-	-	-
Smaller community	**Warkworth**	1	-	-	-	-
Smaller community	**Wybong**	2	-	-	-	-
Diagnostic	**Mount Thorley**	15	-	-	-	-
Diagnostic	**Muswellbrook NW**	1	-	-	-	-
Diagnostic	**Singleton NW**	6	-	-	-	-
Background	**Merriwa**	1	-	-	-	-
Background	**Singleton South**	3	-	-	-	-

µg/m^3 = microgram 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

Pollution roses

The seasonal PM_{10} pollution rose map[5] shows elevated hourly PM_{10} levels occurred at many sites in the southern part of the valley. These levels were generally associated with winds from the north-west.

Figure 3 Hourly PM_{10} pollution rose map for the Upper Hunter region for winter 2018

[5] 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).

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 winter season.

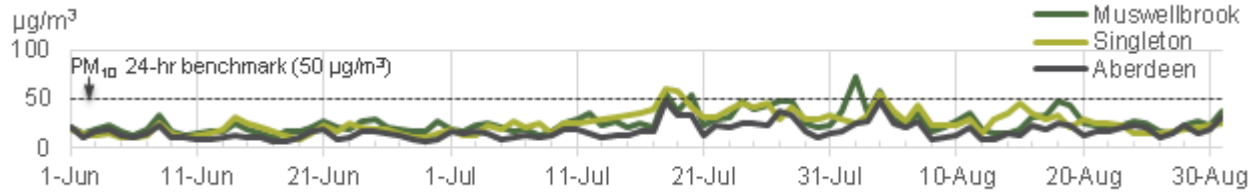

Figure 4 **Population centre sites: daily average PM_{10} – winter 2018**

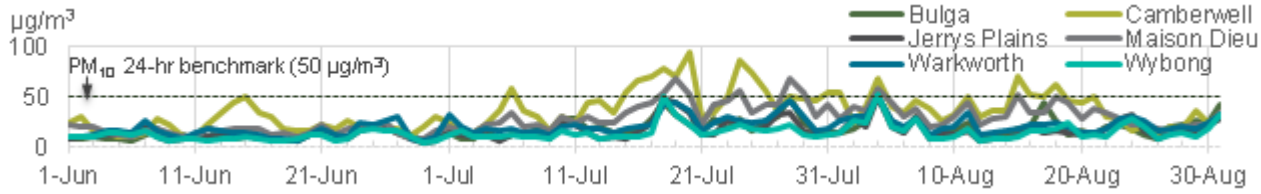

Figure 5 **Smaller community sites: daily average PM_{10} – winter 2018**

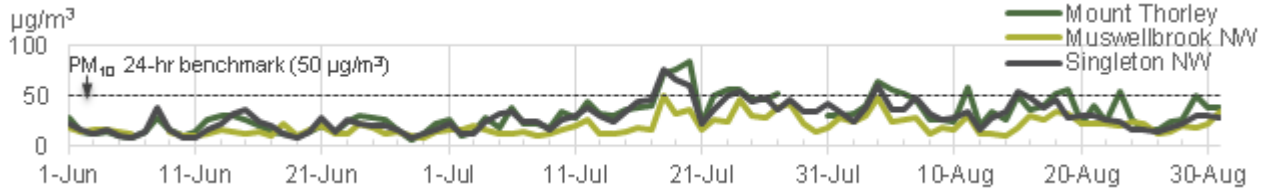

Figure 6 **Diagnostic sites: daily average PM_{10} – winter 2018**

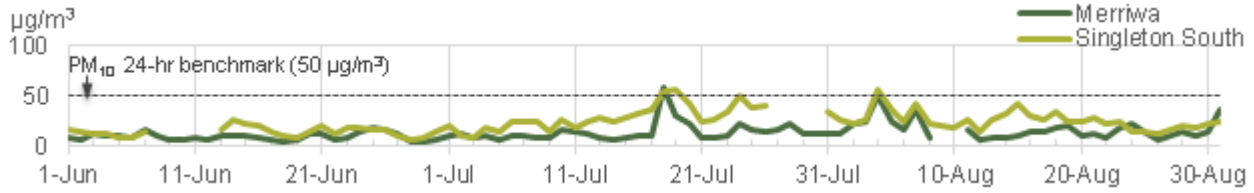

Figure 7 **Background sites: daily average PM_{10} – winter 2018**

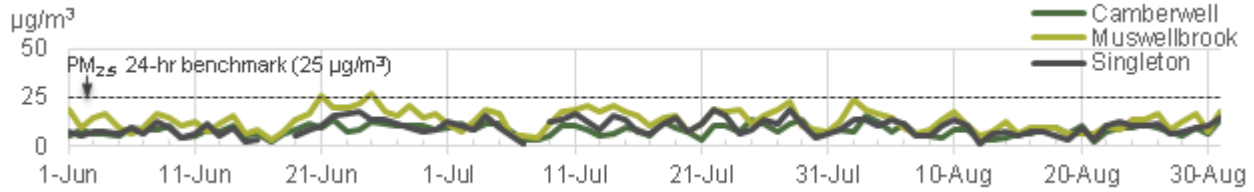

Figure 8 **Daily average $PM_{2.5}$ – winter 2018**

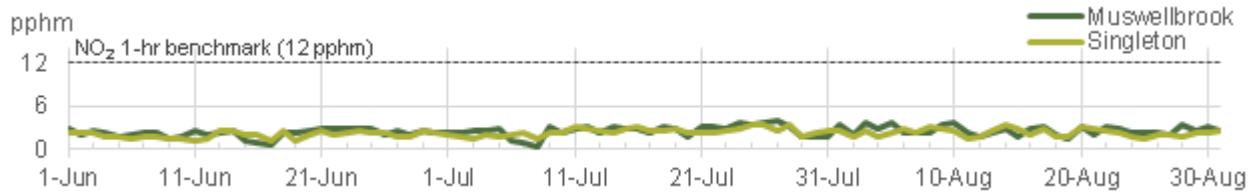

Figure 9 **Daily 1-hr maximum NO_2 – winter 2018**

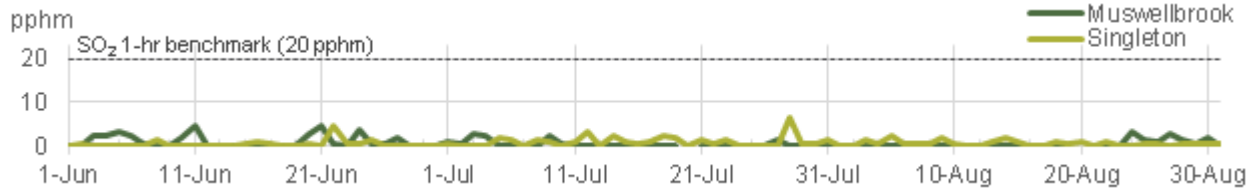

Figure 10 **Daily 1-hr maximum SO_2 – winter 2018**

Seasonal comparisons

This section compares air quality levels in winter 2018 with previous winter seasons.

All days were below the national benchmark concentrations for NO_2 and SO_2 in winter in the past seven years.

There were no days above the $PM_{2.5}$ benchmark at Singleton and Camberwell during winter in the past six years. Muswellbrook recorded two days over the $PM_{2.5}$ benchmark during winter 2018, compared to one day in winters 2016 and 2017, three days in winter 2015 and two days each in winters 2014 and 2012.

The daily average PM_{10} concentrations were above the benchmark on 29 days during winter 2018. This was higher compared to previous winter periods from 2012 to 2017, which recorded up to 10 days over the benchmark.

The Upper Hunter experienced very dry conditions in winter 2018, similar to winter 2017 and drier compared to winters 2016 and 2015. These very dry conditions, with long-range and local dust transport, contributed to elevated particle levels in the region.

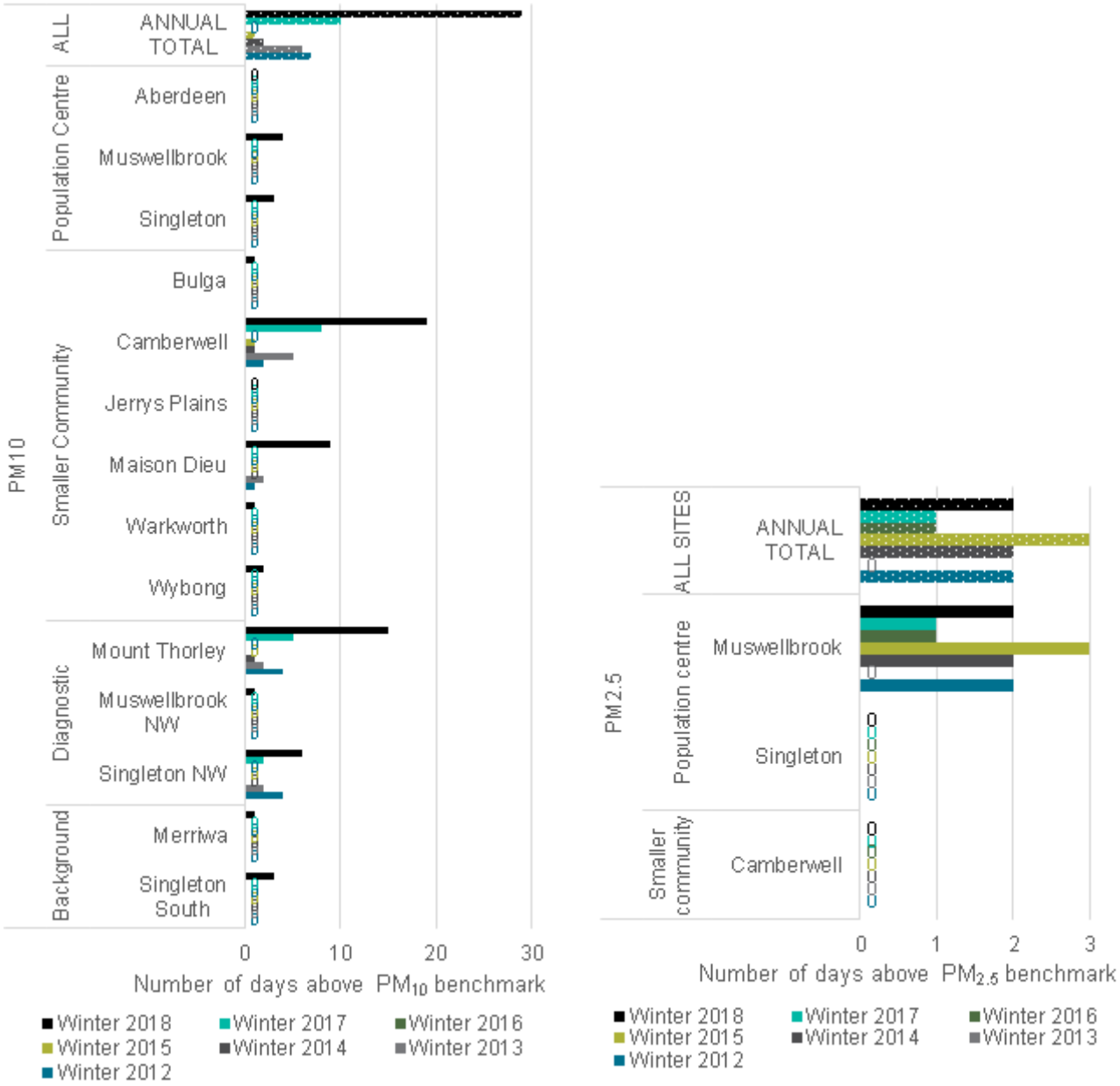

Figure 11 Number of days above the PM_{10} and $PM_{2.5}$ benchmarks during 2012 to 2018 winter seasons

Particle air quality trends in the Upper Hunter

Figure 12 and Figure 13 show daily average levels of PM_{10} during winter 2018, compared to the daily maximum and minimum (i.e. shaded range) of PM_{10} levels for the winter periods from 2011 to 2017, at Singleton and Muswellbrook. Daily PM_{10} levels in winter 2018 were generally within the same levels as earlier years in June and to mid-July. Long-range dust impacts in July and August[1] resulted in larger peaks outside of the previous years' range. Seasonal rainfall was well below average, with particularly dry conditions in July and most of August (Figure 14).

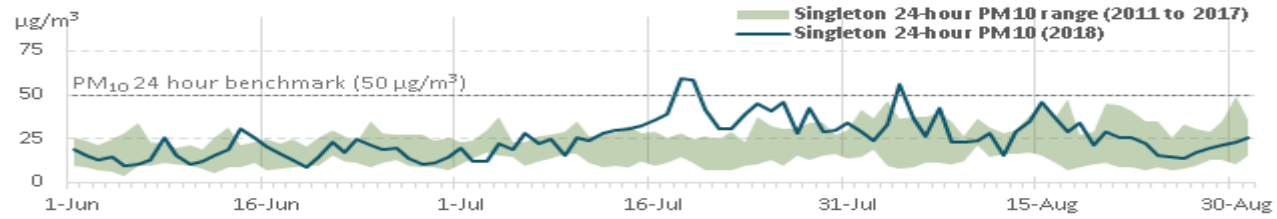

Figure 12 **Singleton daily average PM_{10} during winter 2018 plotted against the daily maximum and minimum PM_{10} levels recorded from winters 2011 to 2017**

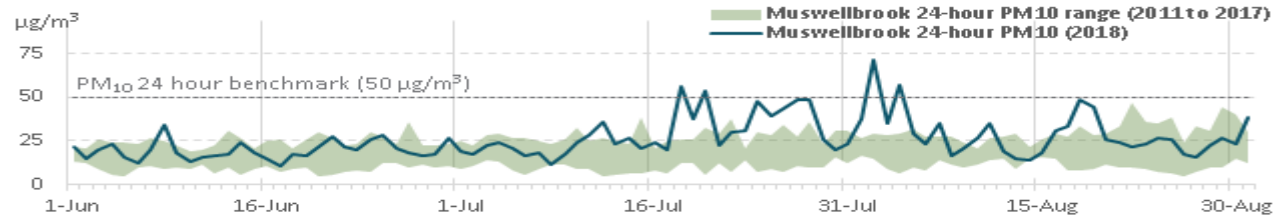

Figure 13 **Muswellbrook daily average PM_{10} during winter 2018 plotted against the daily maximum and minimum PM_{10} levels recorded from winters 2011 to 2017**

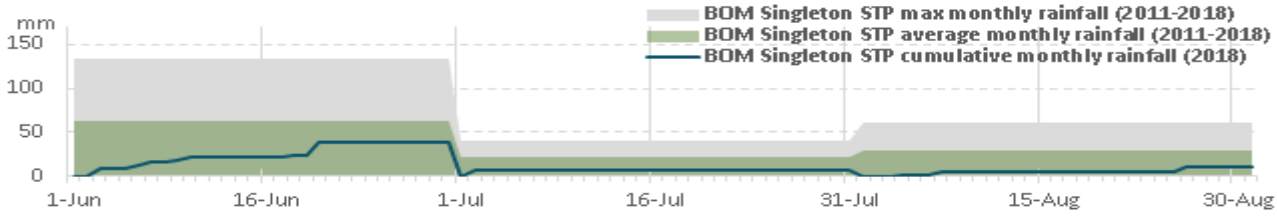

Figure 14 **Bureau of Meteorology Singleton STP[6] cumulative monthly rainfall during winter 2018 plotted against the maximum and average monthly rainfall from winter 2011 to 2018**

Figure 15 and Figure 16 show daily average levels of $PM_{2.5}$ during winter 2018, compared to the daily maximum and minimum levels (shaded range) for winter periods from 2011 to 2017, at Singleton and Muswellbrook. Daily $PM_{2.5}$ levels in winter 2018 were generally within the same range as earlier years.

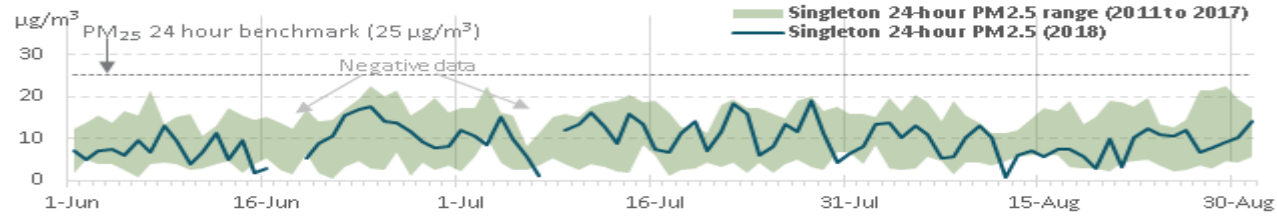

Figure 15 **Singleton daily average $PM_{2.5}$ during winter 2018 plotted against the daily maximum and minimum $PM_{2.5}$ levels recorded from winters 2011 to 2017**

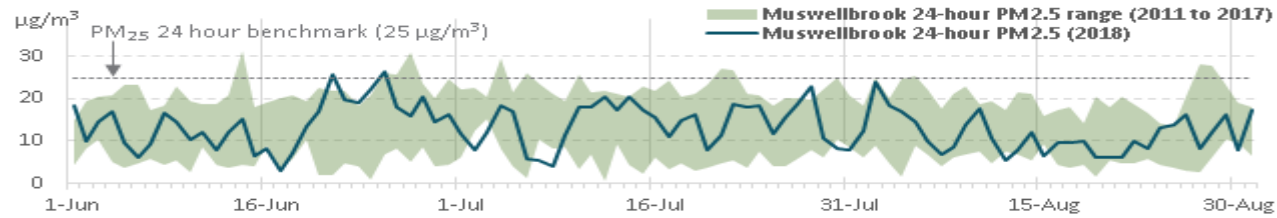

Figure 16 **Muswellbrook daily average $PM_{2.5}$ during winter 2018 plotted against the daily maximum and minimum $PM_{2.5}$ levels recorded from winters 2011 to 2017**

[6] Data obtained from the Bureau of Meteorology Singleton STP monthly rainfall data web page (accessed November 2018)

Meteorological summary

Rainfall and temperature[7]

The Upper Hunter experienced below to very much below average rainfall during winter 2018. Rainfall totals in winter 2018 were similar to 2017. There was 100 to 200 millimetres less rainfall in winter 2018 compared to winter 2016 and 25 to 100 millimetres less than winter 2015.

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

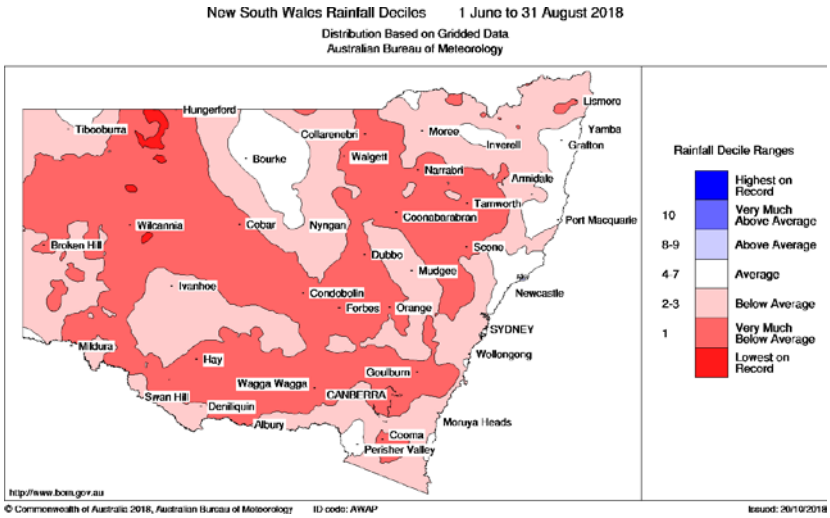

Figure 17 NSW rainfall deciles – winter 2018

Wind

The winds were predominantly from the north-west in the region during winter 2018, which was typical for this time of year. Wind speeds in winter 2018 were similar to 2016 and 2014, while generally higher than other winters.

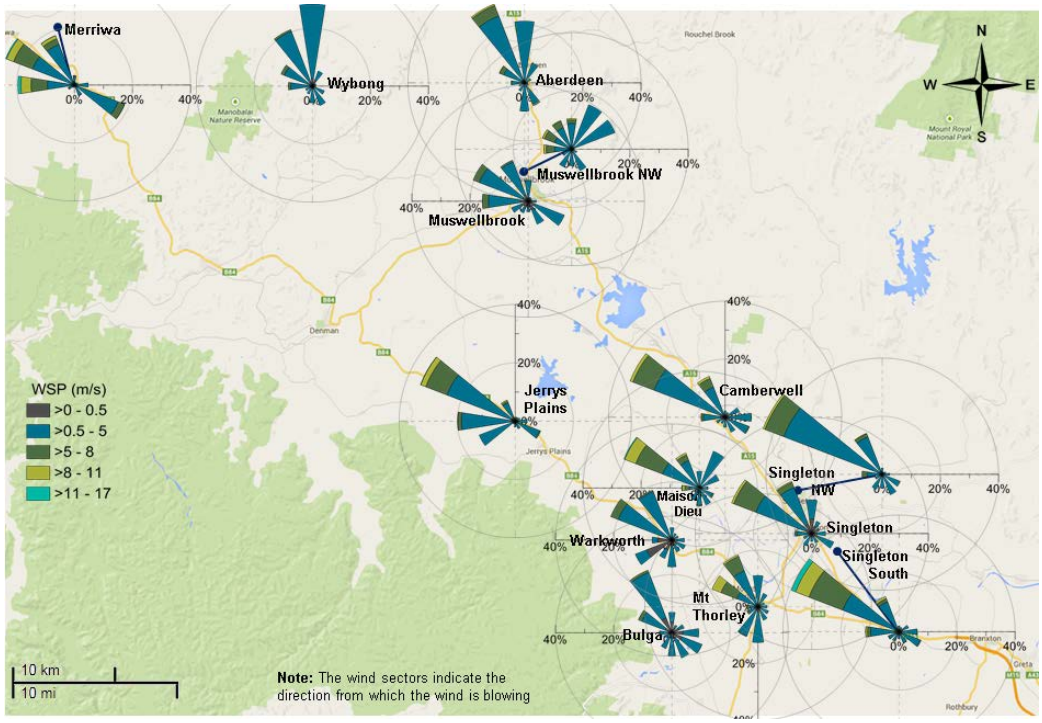

Figure 18 Wind rose map[8] for the Upper Hunter region for winter 2018

[7] Rainfall and temperature information is from the Bureau of Meteorology New South Wales winter 2018 climate statement and climate maps (accessed November 2018)

[8] Wind roses show the wind direction and speed at a location. The length of each bar around the circle in these wind roses 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 NO_2 and SO_2 is 96%, due to daily calibrations.

Table 2 Online performance (%) during winter 2018

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	98	-	-	-	100
Maison Dieu	100	-	-	-	99
Merriwa	98	-	-	-	99
Mount Thorley	97	-	-	-	98
Muswellbrook	100	100	93	96	99
Muswellbrook NW	98	-	-	-	97
Singleton	100	97	95	95	98
Singleton NW	100	-	-	-	100
Singleton South	90	-	-	-	93
Warkworth	99	-	-	-	100
Wybong	100	-	-	-	100

- = not monitored

The overall reduced online times were mainly due to:

- Singleton South PM_{10} and wind – datalogger fault (five days) and PM_{10} instrument fault (four 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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