NSW Annual Air Quality Statement 2018

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Background information

The reader will find key background information on the NSW air quality program in the Background information section, at the end of this report.

This covers:

- Air quality and criteria pollutant
- National Environment Protection Measure for Ambient Air Quality
- National ambient air quality standards
- Why monitor air quality in NSW?
- NSW air quality monitoring stations
- The Air Quality Index (AQI)

Air quality in 2018

Air quality in New South Wales remained generally good during 2018. Levels of nitrogen dioxide, sulfur dioxide and carbon monoxide easily met national standards.

Ozone levels improved compared with 2017, meeting the national standards on 98% of all days. Particle levels increased across the State due to dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning.

Local sources of air pollution, including agricultural burning, mining and industrial activity, and domestic wood heaters, affected air quality in some locations.

Air quality levels vary across the State. Overall, air quality met standards for 98% of days during the year on the Central Coast through to 87% of days in South West Sydney.

Ozone levels exceeded standards on seven days in 2018, compared with 10 days in 2017.

Particle pollution (PM_{10} and $PM_{2.5}$ – airborne particle matter less than or equal to 10 and 2.5 micrometres in diameter), increased due to more frequent exceptional events, such as dust storms, bushfires and hazard reduction burning. In 2018, there were 51 days where exceptional events led to poor air quality (compared with 18 days in 2017). In 2018:

- 25 days were affected by dust storms in 2018 (three days in 2017).
- 26 days were affected by bushfires or hazard reduction burning (15 days in 2017).

An additional 10 days were affected by agricultural burning in 2018 (four days in 2017).

Most regions experienced some days of poor air quality due to dust storms. Increased hazard reduction burning, to manage bushfire risk, resulted in poor air quality in the Sydney region on some days during autumn and winter.

The national goals for particle pollution exclude exceptional events. Based on national reporting guidelines, during 2018:

- The national goal for daily PM_{10} was met at 29 of 33 large population centres.
- The national goal for daily $PM_{2.5}$ was met at 29 of 31 large population centres.
- Annual PM_{10} levels met the national standard at all Sydney, Illawarra and Central Coast stations. Annual average PM_{10} levels are generally higher across the State compared with 2017, due to impacts of intense drought conditions.
- Annual $PM_{2.5}$ levels above the national standard were recorded at about half of the NSW air quality monitoring stations. This increase, compared with 2017, was mainly due to smoke from hazard reduction burning and from increased dust due to the drought.

NSW Government achievements in air quality 2018

Extending Australia's largest air quality monitoring network

- In 2018-19 the government has committed a budget of $1.95 million in operating funds and $1.2 million in capital funds for the air quality monitoring program.
- In 2018-19 the government has committed an additional $1.1 million to establish new monitoring stations in the Sydney CBD, Penrith CBD, Orange, the North Coast and a roadside monitor in Sydney.
- The DustWatch network is now operated by OEH (Office of Environment and Heritage NSW rural air quality monitoring network). The data from 36 stations are available in near real-time on the OEH website. These data are indicative particle monitoring, using low-cost sensors to measure dust in rural New South Wales.
    - This is especially important under the current climate with the severe drought in New South Wales. It also helps as an early warning system for the transport of large-scale regional dust storms to eastern New South Wales.
- New air quality monitoring sites were commissioned:
    - Parramatta North (December 2017) – this station provides additional air quality monitoring in Sydney north-west near the Parramatta Central Business District.
    - Gunnedah and Narrabri (December 2017), as part of the new Namoi Air Quality Monitoring Network (supported by industry; operating costs for 2018-19 are estimated at $290,000).
    - Armidale (April 2018) – this station measures particle pollution to help tackle domestic wood smoke emissions.
    - Bradfield Highway (December 2018) – this station provides roadside monitoring on one of Sydney's busiest roads.

Public availability of data

- A new search and download air quality data tool has been launched – the public can now download historical air quality and meteorological data and view graphs from the OEH air quality database back to 1994.

Understanding exceptional events

Exceptional events are treated under Clause 18 of the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) when reporting compliance against PM_{10} and $PM_{2.5}$ for both the one-day average and one-year average standards.

An exceptional event is defined as 'a fire or dust occurrence that adversely affects air quality at a particular location and causes an exceedance of one-day average standards in excess of normal historical fluctuations and background levels and is directly related to: bushfire; jurisdiction authorised hazard reduction burning; or continental scale windblown dust'.

Any exceedance day deemed to be exceptional is excluded when determining compliance with NEPM goals. Where an exceedance day is determined to be a non-exceptional event, it is included.

State of the climate

In 2018, New South Wales experienced record temperatures and persistent dry conditions, with the entire State drought-declared in August.

The Bureau of Meteorology reported 2018 as the warmest year on record for maximum and mean temperatures in New South Wales. Extreme heat featured throughout 2018, especially in January, April and December. Rainfall was 40% below average, being the driest year since 2002 and the sixth-driest on record (BOM 2019).

Summer 2017-2018 was the fourth-warmest summer on record with dry conditions across the northern half of the State (BOM 2018a). Heatwave conditions were experienced in January, with some Sydney sites recording their highest January temperatures on record (BOM 2018b).

Autumn was the second-warmest autumn on record. Rainfall was below average with large parts of the State experiencing serious to severe rainfall deficiencies (BOM 2018c).

Winter brought continuing very dry conditions with the lowest rainfall on record in western parts of the State (BOM 2018d). Unusually warm and dry conditions brought a very early start to the 2018-19 bushfire season. There were between 80 and 100 active bushfires across New South Wales during August (BOM 2019).

Spring brought warm dry windy conditions associated with the passage of cold fronts in September and November. Rainfall totals continued to be below average overall, although some areas were wet, with heavy falls in November including around Sydney (BOM 2018e). Extensive dust storms continued throughout the State (DustWatch 2018).

The last week of the year saw extreme heat events over much of the State (BOM 2019). Although there was some drought relief for some north-east NSW regions, most of the State remained affected by drought until the end of the year (Figure 1).

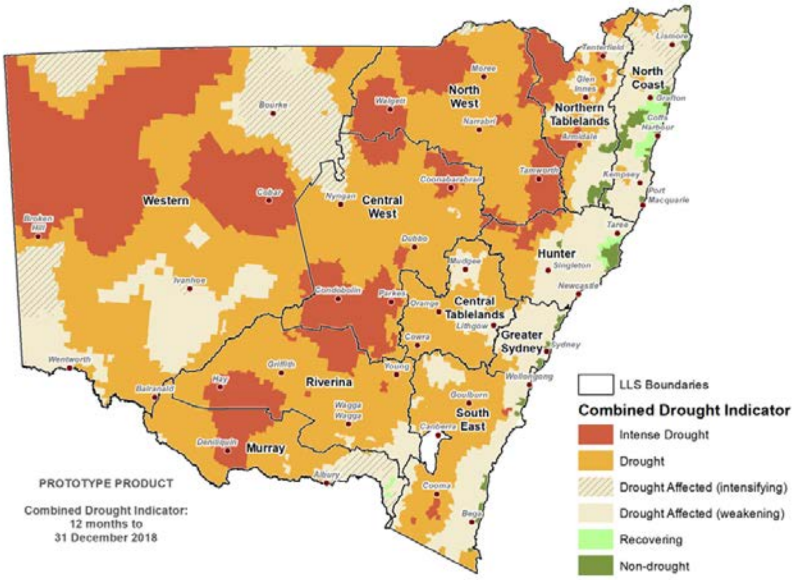

Figure 1 The Department of Primary Industries Verified NSW Combined Drought Indicator, 12 months to 31 December 2018[1]

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[1] Sourced from Department of Primary Industries NSW State Seasonal Update - December 2018 (accessed January 2019)

Air Quality Index

Air quality in New South Wales met national standards at least 87% of the time in 2018. There was an increase in the number of days reaching hazardous pollution levels compared with 2017.

The Air Quality Index (AQI) was in the 'very good', 'good' or 'fair' category for at least 87% of the time in any Sydney region, 90% in the South West Slopes, 94% in the Illawarra, 95% in the Upper Hunter and North West Slopes and 97% to 98% of the time in all other regions (Figure 2), demonstrating that air quality often met relevant standards.

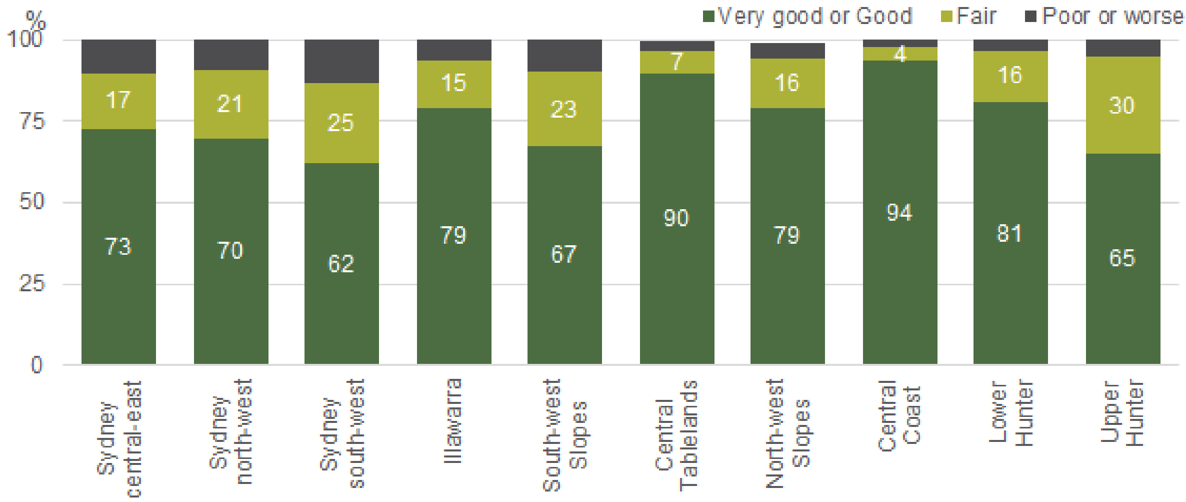

Figure 2 2018 Air Quality Index categories as a percentage of time in each region

Note: Northern Tablelands (Armidale) is not included due to less than 75% data available for the year (monitoring commenced in April 2018). Upper Hunter comprises Muswellbrook and Singleton data.

Days with hazardous air quality levels

In 2018, AQI levels reached the hazardous category (with an AQI greater than 200) on a total of 36 days (Figure 3 to Figure 5).

In Sydney, the majority of hazardous particle days (92%) were due to smoke from large hazard reduction burns from April to August (RFS, 2018), and some forest fires. The hazard reduction burns also elevated particle levels to hazardous in the Illawarra on three days.

Six of the hazardous days were due to dust storms (affecting Sydney, the Central Coast and Central Tablelands on one day, Lower Hunter, Upper Hunter, Northern Tablelands and South West Slopes on two days, and North West Slopes on four days). These occurred in March, August and November (DustWatch, 2018).

The most extensive dust storm event occurred from 21 to 23 November 2018, when particle levels at many of the sites in the NSW air quality monitoring network exceeded the PM_{10} national standard. More information on this event can be found in the case study section below.

The hazardous days for each region are:

- Sydney had 25 days in total:
  - 21 days in April (seven), May (seven), July (one), August (six) due to hazard reduction burns
  - one day each in April and July due to forest fires

  - o one day in June due to a localised unidentified source
  - o one day in November due to an extensive dust storm.
- Illawarra had five days in total:
  - o three days in July (two) and August (one) due to hazard reduction burns
  - o two days in early January due to a localised unidentified source.
- Central Coast had one day in November due to an extensive dust storm.
- Lower and Upper Hunter had two days in November due to an extensive dust storm.
- North West Slopes had six days in total in September (one), November (three) and December (two) due to dust storms.
- Central Tablelands had two days in total in November and December due to dust storms.
- South West Slopes had four days in total:
  - o one day each in March, November and December due to dust storms
  - o one day in April most likely due to agricultural stubble burning.

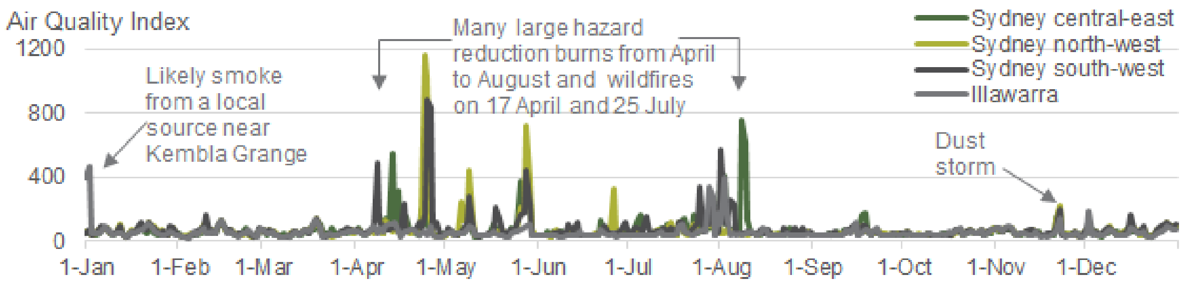

Figure 3 Sydney and Illawarra regional Air Quality Index time series during 2018

Note: The different scales in the Sydney/Illawarra graph compared with the following two regional graphs

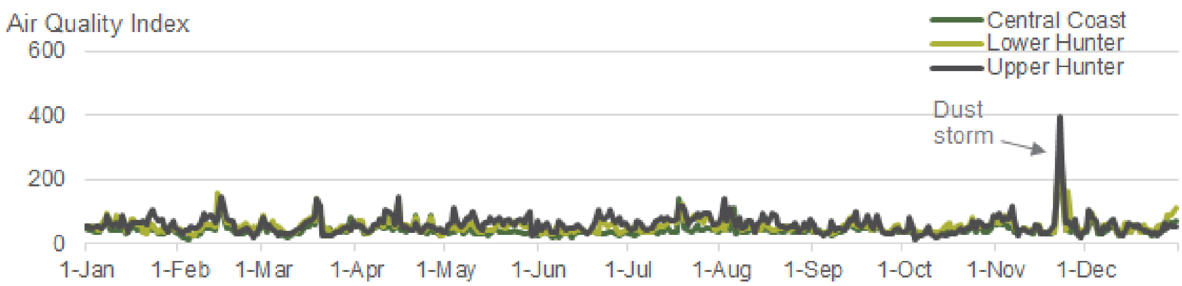

Figure 4 Central Coast, Lower Hunter and Upper Hunter regional Air Quality Index time series during 2018

Note: Lower Hunter AQI comprises Beresfield, Newcastle and Wallsend, Upper Hunter AQI comprises Muswellbrook and Singleton

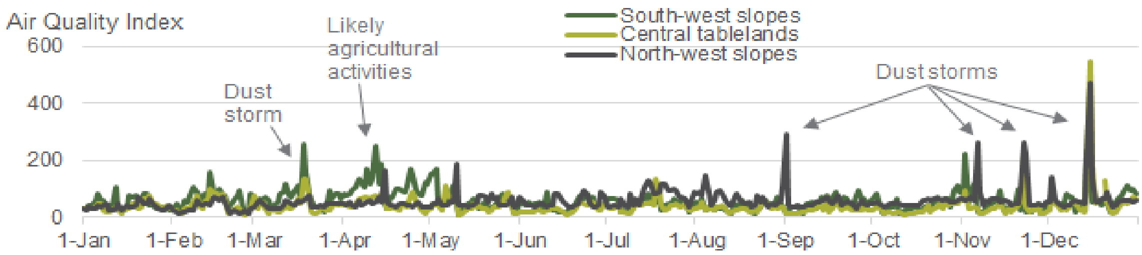

Figure 5 South West Slopes, Central Tablelands and North West Slopes regional Air Quality Index time series during 2018

Ozone pollution

National standards for ozone (O_3)

- One-hour average – ten parts per hundred million (10 pphm)
- Four-hour average – eight parts per hundred million (8 pphm)

One-hour and four-hour ozone averages

Ozone levels met national standards on 98% of days during 2018 (Table 1). There were seven days when ozone levels were over the national standards. This was fewer days than 2017 when the ozone standards were exceeded on ten days.

Ozone levels peaked in the warmer months from October to March. The most extensive ozone events are outlined below:

- On 22 January 2018, ozone levels above the national standards were recorded at eight sites in Sydney north-west and south-west (Table 1). This event occurred during a statewide heat wave (BOM 2018b). Sydney temperatures were hot, with a maximum hourly temperature of 40.9°C at St Marys.
- On 28 December 2018, ozone levels above the national standards were recorded at nine sites in Sydney north-west and south-west (Table 1). Sydney temperatures were hot, with a maximum hourly temperature of 40.4°C at St Marys.
- Ozone levels were above the standards at Beresfield in the Lower Hunter on 31 December. Four-hour average ozone levels were also over the standard at four sites in Sydney south-west on this day. Meteorological conditions were conducive to ozone formation with a stable atmosphere and very warm temperatures (maximum temperatures over 36 °C for four consecutive days before this event). Calmer conditions minimised dispersion, resulting in elevated ozone levels which exceeded the standard.

Ozone levels were below national standards in the Illawarra and Central Coast in 2018. This was an improvement in ozone air quality, compared with 2017, when the Illawarra and Central Coast recorded four and two exceedance days, respectively.

Table 1 Days above the 1-hour and 4-hour ozone standards – 2018

Date	Stations exceeding the 1-hour average ozone standard (10 pphm)	Stations exceeding the 4-hour average ozone standard (8 pphm)
12/01	-	Richmond (8.7)
19/01	Camden (10.9), Campbelltown West (11.0)	Bringelly (8.3), Camden (9.4), Campbelltown West (9.0), Oakdale (8.3)
22/01	Bringelly (11.0), Campbelltown West (11.0), Liverpool (11.1), Parramatta North (10.2), Prospect (10.5), St Marys (10.5)	Bargo (8.3), Bringelly (9.2), Camden (8.7), Campbelltown West (9.2), Liverpool (8.9), Parramatta North (9.4), Prospect (9.1), St Marys (9.4)
09/02	-	Oakdale (8.1), Richmond (8.1)
27/12	Bargo (10.2)	Bargo (8.4)
28/12	Bringelly (10.5), Camden (11.2), Campbelltown West (10.6), Richmond (10.3)	Bringelly (9.2), Camden (9.0), Campbelltown West (9.8), Chullora (8.2), Liverpool (9.3), Parramatta North (9.5), Prospect (8.7), St Marys (8.2)
31/12	Beresfield (10.7)	Beresfield (8.9), Bringelly (9), Camden (8.1), Campbelltown West (8.8), Liverpool (8.1)

Note: Values in brackets are the actual maximum ozone levels at each station on the day. pphm = parts per hundred million in volume.

Particle pollution

Fine particles (PM_{10})

National standards for PM_{10}

- Annual average – 25 micrograms per cubic metre of air (25 µg/m^3)
- Daily average – 50 micrograms per cubic metre of air (50 µg/m^3)

Annual average PM_{10} levels

During 2018, annual average PM_{10} levels met the national standard at all Sydney, Illawarra, Central Coast and Lower Hunter stations (Figure 6).

Historically, annual average PM_{10} levels are generally higher in the Upper Hunter and the Port of Newcastle than elsewhere in the State. More information about particle levels in the regions can be found in the case study section below, The Hunter Valley in focus.

In 2018, the three Newcastle local sites (Stockton, Carrington and Mayfield), Muswellbrook (in Upper Hunter) and Wagga Wagga recorded annual averages over the national standard. This was an increase in the number of exceedances, compared with 2017, mainly due to the intense drought conditions and elevated particle levels throughout the State in 2018.

Daily PM_{10} levels

All air quality monitoring sites in metropolitan and regional population centres recorded PM_{10} levels above the national standard on some days (Figure 6). This mainly was driven by the intense drought conditions, with an increase in hazard reduction burns around Sydney and the Illawarra from April to August and the increasing frequency of widespread dust storms throughout the year (DustWatch 2018).

The maximum daily PM_{10} level was 274.1 µg/m^3, recorded at Bathurst on 15 December 2018, due to an extensive dust storm.

In 2018, more stations recorded days above the PM_{10} daily standard and higher particle levels, compared with 2017.

Other known causes of elevated PM_{10} particle levels are agricultural activities (such as stubble burning) at Wagga Wagga and sea salt spray at Stockton.

In the Hunter Valley, local industrial sources also affect particle levels. More information on the special purpose industry-funded Hunter Valley monitoring networks is found below.

Most sites met the national goal for daily PM_{10}

The national goal for daily PM_{10} excludes exceptional events, such as bushfires, hazard reduction burns and broad-scale dust storms (see information under Understanding exceptional events). Based on these criteria, the national goal for daily PM_{10} was met at 29 large population air quality monitoring stations.

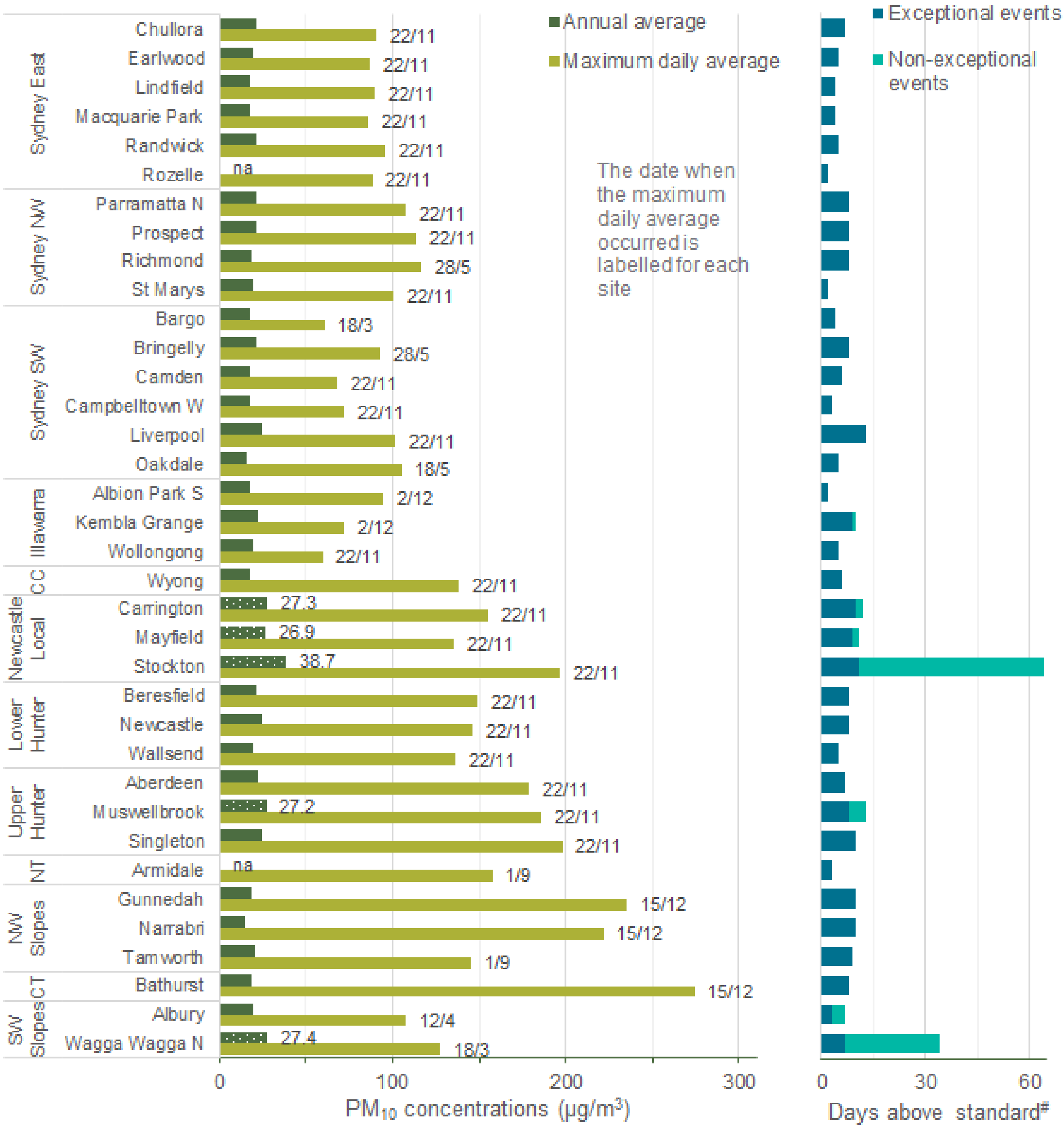

Figure 6 Summary of PM_{10} observations in New South Wales – 2018

Note: SW = South West, NW = North West, CC = Central Coast, NT = Northern Tablelands.
Annual average values above the standard are shown as shaded bars with the values against applicable sites.
na Annual average not reported (<75% of data available - Armidale monitoring began April 2018; Rozelle monitoring station was recommissioned)
Days above standard are divided into exceptional and non-exceptional events. Exceptional events are those related to bushfires, hazard reduction burns and dust storms. These are not counted towards the NEPM goal of 'no days above the particle standards in a year'.

Sea salt causes elevated PM_{10} levels at Stockton

The Stockton air quality monitoring station is approximately 300 metres from the coast and 20 metres from Hunter River and the Port of Newcastle. High PM_{10} particle levels at the station are more often associated with exposure to sea salt spray under north-easterly winds, as indicated in the pollution rose in Figure 7.

In 2018, the PM_{10} particle levels were over the daily national standard at Stockton on 64 days (compared with 60 days in 2017) and the PM_{10} annual average was 38.7 µg/m^3. Elevated hourly PM_{10} levels (>75 µg/m^3) occurred 6.9% of the time over the year. The majority of these, 67% of the time, occurred under onshore easterly winds. The Lower Hunter Particle Characterisation Study found that the largest contribution to PM_{10} at Stockton was sea salt.

As for the rest of the Hunter Valley, particle levels from the north-west were often associated with the long-range transport of dust from drought-affected regions, resulting in PM_{10} particle exceedances in the region on nine days.

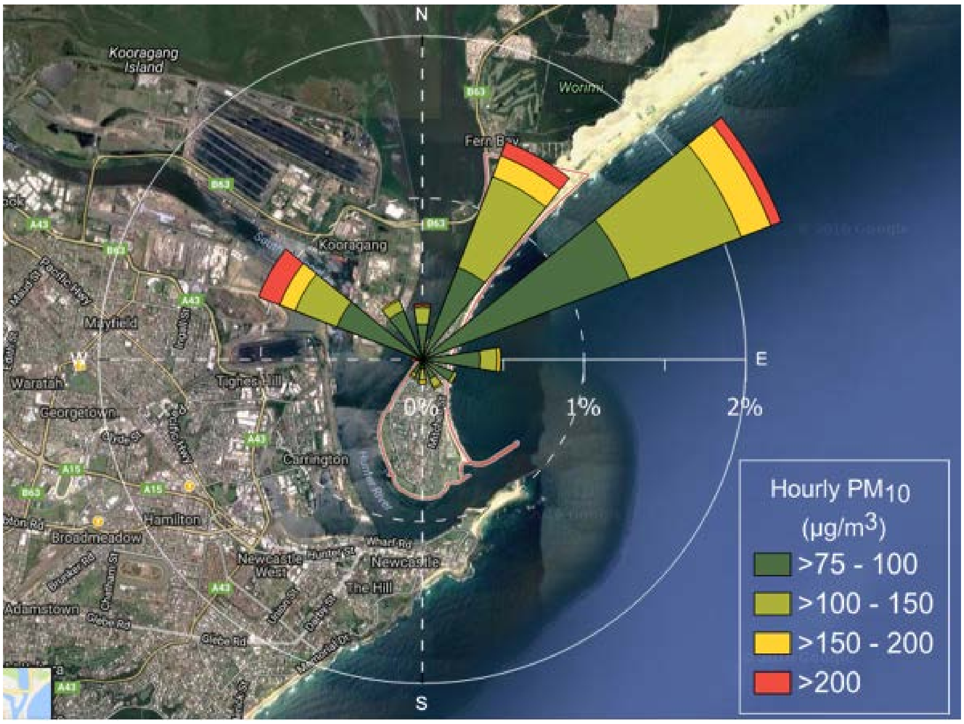

Figure 7 Stockton hourly PM_{10} levels above 75 µg/m^3 in relation to wind direction

Fine particles ($PM_{2.5}$)

National standards for $PM_{2.5}$

- Annual average – eight micrograms per cubic metre of air (8 µg/m^3)
- Daily average – 25 micrograms per cubic metre of air (25 µg/m^3)

Annual average $PM_{2.5}$ levels

During 2018, about half of the NSW air quality monitoring sites recorded annual average $PM_{2.5}$ levels above the national standard. This is an increase compared with 2017, mainly due to increased hazard reduction burns around Sydney and the Illawarra, and the increase in particles throughout the State due to the intense drought.

Daily $PM_{2.5}$ levels

Around two-thirds of the NSW air quality monitoring sites recorded daily $PM_{2.5}$ levels above the national standard (Figure 8).

The most days above the $PM_{2.5}$ daily benchmark (standard) were recorded at:

- Armidale (32 days) – most likely due to wood smoke from domestic heaters associated with cold calm nights and temperatures close to or below zero degrees.
- Liverpool (eight days) – due to hazard reduction burns and wildfires.
- Gunnedah (five days) – most likely due to smoke from domestic wood heaters in July (four days) and a large smouldering cotton debris stockpile fire during the December dust storm event (one day).

The maximum daily $PM_{2.5}$ was 123.8 $\mu g/m^3$, recorded at Richmond on 25 April 2018, due to many hazard reduction burns in and around Sydney.

In 2018, more stations recorded days above the $PM_{2.5}$ daily standard and particle levels were generally higher, compared with 2017. This was mainly due to the increase in hazard reduction burns during the cooler months.

Other known causes of elevated $PM_{2.5}$ particle levels are smoke from domestic wood heaters. For example, the Upper Hunter Fine Particle Study Upper Hunter Fine Particle Characterisation Study found that wood smoke was a major contributor to $PM_{2.5}$ levels at Muswellbrook and Singleton in winter (Hibberd et al, 2013).

Under the current NSW regulatory regime, wood smoke is managed largely by local government. Local councils have regulatory powers to control installation of wood heaters using their planning instruments. The Environment Protection Authority (EPA) oversees the existing regulatory framework and collaborates with stakeholders to improve wood heater emission and efficiency standards. The EPA also provides training and support for local councils on the regulatory and planning tools available.

Most sites met the national goal for daily $PM_{2.5}$

The national goal for daily $PM_{2.5}$ excludes exceptional events, such as bushfires, hazard reduction burns and broad-scale dust storms (see information under Understanding exceptional events up front). Based on these criteria, the national goal for daily $PM_{2.5}$ was met at 29 large population air quality monitoring stations. There were no days over the $PM_{2.5}$ standard at the Camberwell small community monitoring station in the Upper Hunter air quality monitoring network.

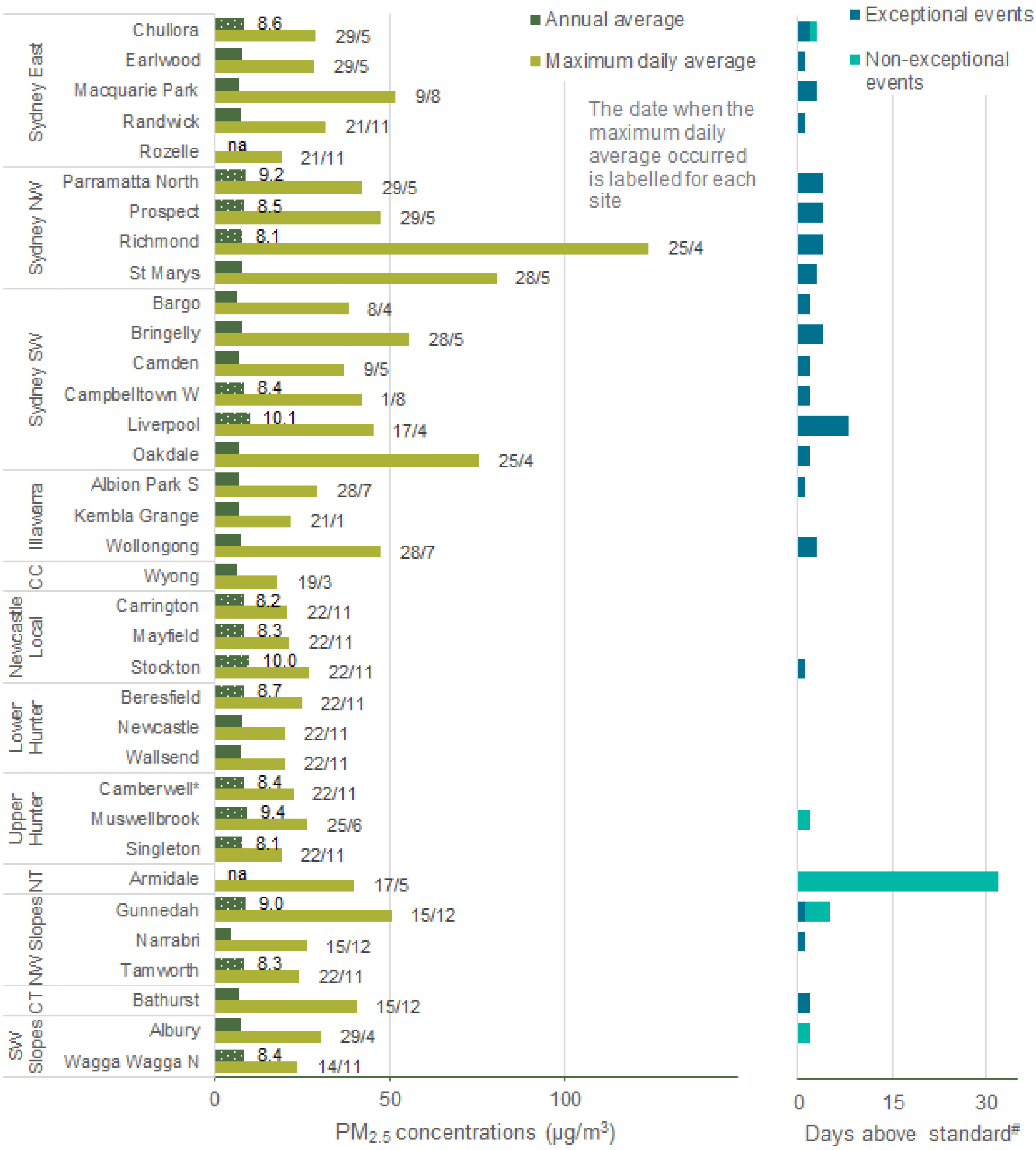

Figure 8 Summary of $PM_{2.5}$ observations in New South Wales – 2018

Note: SW = South West, NW = North West, CC = Central Coast, NT = Northern Tablelands.
Annual average values above the standard are shown as shaded bars with the values against applicable sites.
na Annual average not reported (<75% of data available). Armidale monitoring began in April 2018. The high number of days over the $PM_{2.5}$ standard is due to smoke from domestic wood heating. Refer below, '<u>Air quality in the Northern Tablelands</u>'.
Days above standard are divided into exceptional and non-exceptional events. Exceptional events are those related to bushfires, hazard reduction burns and dust storms. These are not counted towards the NEPM goal of 'no days above the particle standards in a year'.
Camberwell is a Small Upper Hunter Air Quality Monitoring Network community monitoring station which is not suitable for assessing performance against NEPM standards (see The Hunter Valley in focus).

Dust storm event on 21 to 23 November 2018

An extensive dust storm occurred throughout NSW from 21 to 23 November 2018.

On 22 November, most regions of New South Wales experienced very poor to hazardous air quality (Figure 9). Air quality was affected by long-range transport of dust particles from South Australia and drought-affected regions of New South Wales, during with the passage of a cold front (Figure 10). PM_{10} 24-hour average levels exceeded the benchmark of 50 µg/m^3 at 44 of the 47 ambient air quality monitoring stations in New South Wales. The Upper Hunter recorded the maximum daily PM_{10} level of 243.9 µg/m^3, occurring at Camberwell.

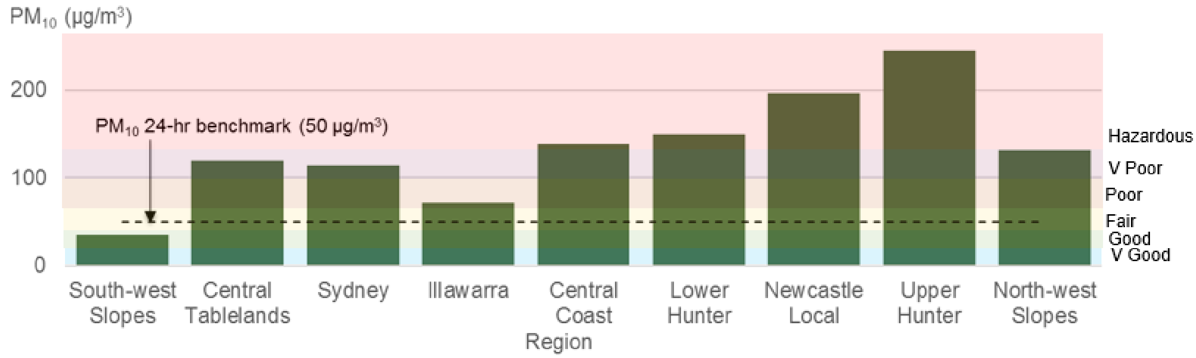

Figure 9 NSW maximum daily PM_{10} levels on 22 November 2018, by region

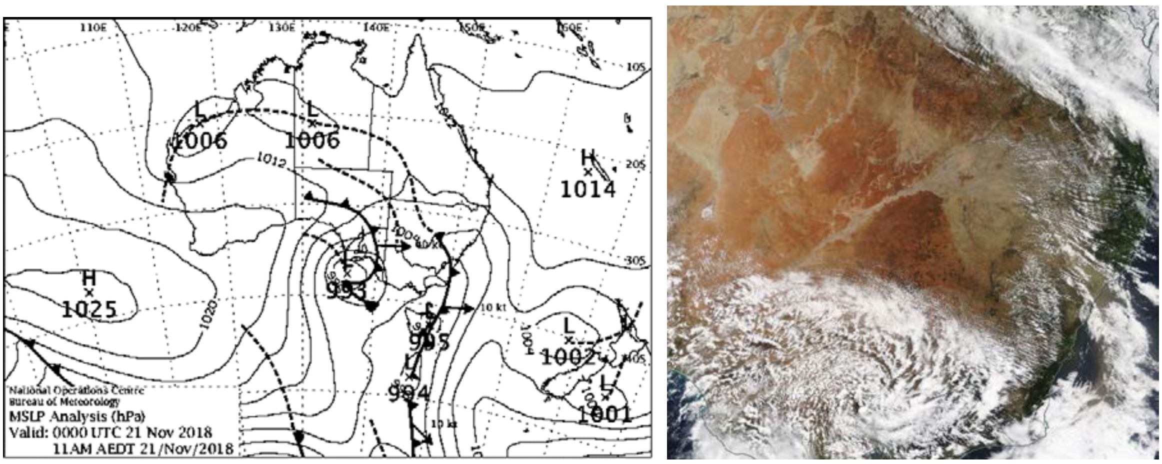

Figure 10 Synoptic weather chart for 21 November 2018[2], showing a low-pressure system and two cold fronts with associated westerly winds (left) and satellite image[3] for 22 November 2018, showing dust across New South Wales and off the east coast, elevated by strong winds associated with the passage of a cold front.

[2] Sourced from the Bureau of Meteorology Analysis Chart Archive website (accessed in November 2018)

[3] Source from NASA MODIS imagery (accessed January 2019)

The Hunter Valley in focus

OEH maintains 20 air quality monitoring stations in the Hunter Valley; three NSW Government-funded stations in the Lower Hunter, three industry-funded stations in the Port of Newcastle and 14 industry-funded stations in the Upper Hunter.

The Upper Hunter and Newcastle Local air quality monitoring networks were established in 2011 and 2014, respectively, specifically to monitor local industrial and other pollution sources in the region. Due to the specific nature of these monitoring sites, the national standards do not apply directly to the data collected within these regions. However, OEH recognises that there is a desire within the community to know how air pollution levels at these stations compare against the standards. Therefore, OEH uses national benchmarks (i.e. ambient air quality standards) in this section to evaluate air quality levels throughout the Hunter Valley.

More information on these networks can be found on the OEH website, including seasonal newsletters published on a regular basis.

Large population centres

Gaseous pollutants

Sulfur dioxide and nitrogen dioxide met national standards in the Lower and Upper Hunter during 2018.

Beresfield in the Lower Hunter recorded one day over the national ozone standards on 31 December 2018.

Particles (PM_{10})

Within the Hunter Valley, PM_{10} levels are generally highest at Stockton in the Newcastle Local region, due to the influence of sea salt under onshore winds (Lower Hunter Particle Characterisation Study). In the Upper Hunter region, PM_{10} levels are generally highest at sites closest to mining activity.

Annual averages

Annual average PM_{10} levels were above the benchmark at four industry-funded monitoring sites in large population centres in the Hunter region – Carrington, Mayfield, Stockton and Muswellbrook (Figure 6).

Daily averages

Daily average PM_{10} levels were above the benchmark on 19 days at one or more large population centres (excluding Stockton). These occurred on 8 and 23 January, 15 February, 19–20 March, 11 and 15 April, 4 May, 18–20 July, 2 and 4 August, 4, 6, 21–23 November and 2 December 2018.

At Stockton, the daily PM_{10} average was over the benchmark on 64 days, predominantly due to sea salt in onshore air flows (Figure 7).

The maximum daily PM_{10} averages in the Hunter occurred on 22 November 2018, during an extensive dust storm event. The maximum levels in the Upper Hunter and Newcastle regions on this day respectively were 198.0 µg/m^3 at Singleton and 196.6 µg/m^3 at Stockton.

Fine particles ($PM_{2.5}$)

Annual averages

Annual average $PM_{2.5}$ levels were above the benchmark at all Hunter large population centres, except Newcastle and Wallsend (Figure 8).

Daily averages

Daily average $PM_{2.5}$ levels were above the benchmark on three days – 21 and 25 June 2018 at Muswellbrook (25.8 µg/m^3 and 26.5 µg/m^3 respectively) and 22 November 2018 at Stockton (26.9 µg/m^3).

- Muswellbrook experienced elevated $PM_{2.5}$ levels overnight, most likely due to smoke from domestic heaters, under cold, calm conditions.
- Stockton experienced hazardous particle levels due to a large fire burning in the Port Stephens Local Government Area during a statewide dust event.

Upper Hunter small community and diagnostic sites

Figure 11 summaries the daily and annual PM_{10} levels for the Upper Hunter air quality monitoring stations, comprising three larger population centres, six smaller communities sites, three diagnostic sites close to mining operations and two background stations at the north-west and south-east extents of the region.

Annual averages

Six monitoring stations in the Upper Hunter recorded annual average PM_{10} levels over the benchmark. These predominantly occurred at sites closer to mines – Camberwell, Maison Dieu, Mount Thorley, Singleton NW and Warkworth – and at Muswellbrook.

Daily averages

There were 73 days in the Upper Hunter when the daily PM_{10} levels were over the benchmark at one or more sites. Camberwell recorded the highest number of days over the PM_{10} daily benchmark in the region, with a total of 44 days (Figure 11).

This was close to double the number of days over the benchmark in 2018, compared with 2017 (39 days). The increase was due to the prolonged dry period throughout New South Wales, resulting in an increase not only in particles transported into the region but also from local sources.

All sites in the Upper Hunter recorded their highest daily PM_{10} average on 22 November, during the extensive dust storm. The highest PM_{10} daily average was 243.9 µg/m^3, at Camberwell.

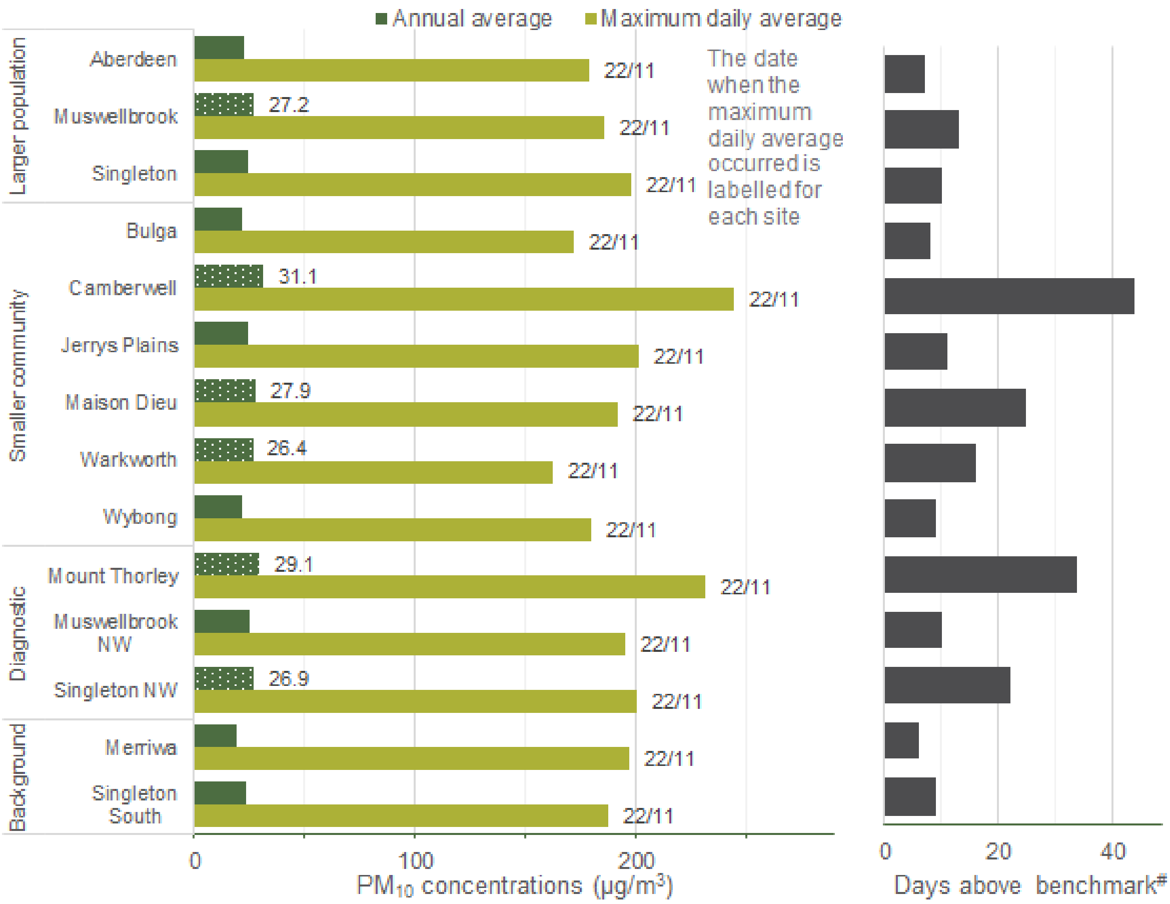

Figure 11 Summary of PM_{10} levels in the Upper Hunter – 2018

Note: Annual average values above the benchmark are shown against applicable sites.
Days above the benchmark have not been divided into exceptional and non-exceptional events, as the NEPM goals do not apply to these sites.

Air Quality in the Northern Tablelands

In April 2018, OEH commissioned an air quality monitoring station at Armidale, in the Northern Tablelands.

During winter in Armidale, smoke from domestic heaters becomes trapped within the valley under cold, calm overnight conditions. Therefore, monitoring within the region focuses on particle pollution, with the air quality monitoring site established to help identify the extent of the wood smoke issue in the area.

What is monitored at Armidale?

The following air pollutants and meteorological variables are measured at Armidale:

- Particulate matter – fine particles as PM_{10} and $PM_{2.5}$, and visibility using nephelometry
- Meteorology – wind, ambient temperature, relative humidity and rainfall

What are the results to date?

Since the monitoring commenced on 13 April, Armidale has recorded numerous days with elevated particle levels.

Daily PM_{10} averages

Armidale recorded three days over the daily PM_{10} national standard – 1 September and 22 to 23 November 2018. These were due to the long-range transport of particles by dust storms.

Daily $PM_{2.5}$ averages

Armidale recorded 32 days over the daily $PM_{2.5}$ national standard from May to September, with four days in May, six days in June, 13 days in July, eight days in August and one day in September 2018 (Figure 12). These were all most likely due to smoke from wood heaters, typically occurring overnight during cold, calm conditions, often with temperatures close to or below 0ºC.

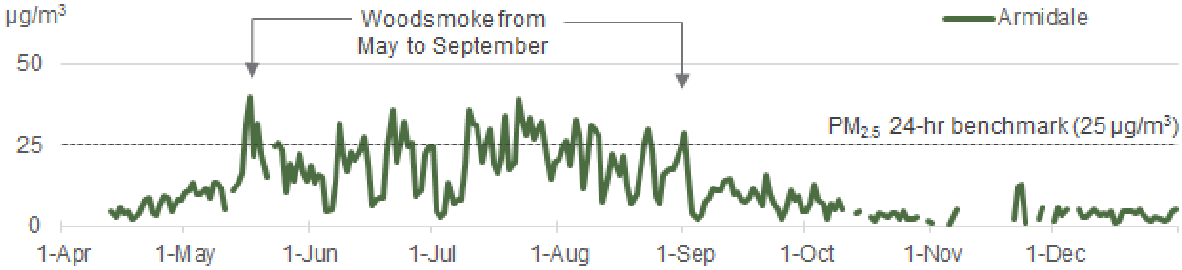

Figure 12 Armidale daily $PM_{2.5}$ levels, from April to December 2018

Where to from here?

Air quality information collected at Armidale will continue to provide invaluable data that can be used to establish trends and develop strategies to help tackle the wood heater air quality issues in the region.

Background information

Air quality and criteria pollutant

Clean air is fundamental to our health and wellbeing. An air pollutant is any substance in the air that can harm people or the environment. Air pollution is a health concern in Australia and around the world. It can be particularly critical to the health of children, older people, pregnant women and people with pre-existing health conditions. It affects the natural and built environment and liveability of our communities.

Pollutants arise from natural processes like bushfires and from human activities, such as industrial and transport processes. Some, called 'secondary pollutants', form in the air when directly emitted (or primary) pollutants react with each other or other substances.

'Criteria air pollutants' describes air pollutants that have been regulated and are used as indicators of air quality (details in the next section). These pollutants are regulated based on criteria that relate to health and/or environmental effects.

The criteria air pollutants set for Australia by the National Environment Protection Council (NEPC) are:

- Particulate matter (PM_{10} and $PM_{2.5}$, airborne particle matter with diameters less than or equal to 10 micrometres and 2.5 micrometres, respectively)
- Ozone (O_3)
- Nitrogen dioxide (NO_2)
- Carbon monoxide (CO)
- Sulfur dioxide (SO_2)
- Lead (Pb).

The NSW air quality monitoring networks provide measurements for six criterion pollutants. We also conduct short-term campaign monitoring activities. Levels of nitrogen dioxide, sulfur dioxide and carbon monoxide in New South Wales continue to meet national air quality standards set by the National Environment Protection Council (details in next section). Levels of particles (PM_{10} and $PM_{2.5}$) and ozone can exceed the national standards and remain to be pollutants of concern. Hence, this report focuses on presenting results for these three pollutants. Ambient lead monitoring for NSW air quality compliance reporting was phased out in 2004. The case for cessation of lead monitoring was approved by the NEPC.

The national context

National Environment Protection Measure for ambient air quality

The National Environment Protection Council (NEPC) established ambient air quality standards in 1998.

The NEPC sets national objectives, as National Environment Protection Measures, designed to assist in protecting and managing aspects of the environment.

Setting air quality standards and goals are essential for protecting human health and the environment from the adverse effects of air pollution.

High concentrations of the major air pollutants are associated with respiratory problems such as coughs, bronchitis, asthma and, in severe cases, developmental problems in children, and even death.

National ambient air quality standards

The National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) sets health-based air quality standards for seven criteria air pollutants. The standards set benchmarks against which the NSW Government assesses progress in managing air quality. The AAQ NEPM expresses pollutant concentrations in parts per million (ppm) by volume for the NO_2, SO_2, O_3 standards. The OEH monitoring network applies parts per hundred million (pphm) for easy display, with 1 pphm = 100 ppm (Table 2).

Table 2 National ambient air quality standards and goals for particles (as PM_{10} and $PM_{2.5}$), SO_2 and NO_2

Pollutant	Averaging period	Benchmark (concentration) [a b]	Goal: How often can the benchmark be exceeded?
Particles as PM_{10}	Daily: 1 calendar day (24 hours)	50 µg/m³	Never [c]
Particles as PM_{10}	Annual: 1 calendar year (12 months)	25 µg/m³	Never
Particles as $PM_{2.5}$	Daily: 1 calendar day (24 hours)	25 µg/m³	Never [c]
Particles as $PM_{2.5}$	Annual: 1 calendar year (12 months)	8 µg/m³	Never
Sulfur dioxide (SO_2)	Hourly	20 pphm	Maximum one day per year
Sulfur dioxide (SO_2)	Daily: 1 calendar day (24 hours)	8 pphm	Maximum one day per year
Sulfur dioxide (SO_2)	Annual: 1 calendar year (12 months)	2 pphm	Never
Nitrogen dioxide (NO_2)	Hourly	12 pphm	Maximum one day per year
Nitrogen dioxide (NO_2)	Annual: 1 calendar year (12 months)	3 pphm	Never
Ozone (O_3)	1 hour	10 pphm	1 day a year
Ozone (O_3)	4 hours	8 pphm	
Carbon monoxide (CO)	8 hours	9 ppm	1 day a year
Lead (Pb)	Annual: 1 calendar year (12 months)	0.50 µg/m³	Never

a The concentration of particles in the air is measured as the mass of the particle in micrograms (µg) per volume of air in cubic metres (m^3)

b SO_2, O_3 and NO_2 are measured in parts per hundred million (pphm) by volume, i.e. parts of pollutant per hundred million parts of air, with 1 pphm = 100 ppm

c Not including exceptional events. An exceptional event is defined in the AAQ NEPM as a fire or dust occurrence that adversely affects air quality at a particular location, and causes an exceedance of one day average standards in excess of normal historical fluctuations and background levels, and is directly related to: bushfire; jurisdiction authorised hazard reduction burning; or continental scale windblown dust

About our monitoring program

Why monitor air quality in NSW?

We monitor air quality to provide accurate and up-to-date information to the community about air quality. Our monitoring allows us to determine if air quality is sufficient to protect public health, and it provides a platform for developing strategies to improve air quality where required.

Monitoring also provides information in accordance with the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM).

We review our strategies frequently, and our current work is outlined in the *NSW ambient air quality monitoring plan 2018* (to be published in early 2019).

NSW air quality monitoring stations

The NSW Government monitors air quality at 47 air quality monitoring stations in metropolitan and regional centres and 36 rural air quality monitoring stations (Figure 13).

The NSW air quality monitoring network in metropolitan and regional centre continuously measures air pollutants and meteorological conditions, including the following:

- particulate matter PM_{10} (particles less than or equal to 10 micrometres in diameter) and finer particulate matter $PM_{2.5}$ (particles less than or equal to 2.5 micrometres in diameter) at all three monitoring sites
- the gases sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and ozone (O_3)
- the gas ammonia (NH_3) at Stockton
- wind speed, wind direction, temperature, humidity, solar radiation and rainfall.

The NSW air quality monitoring network is split into two categories:

- A set of NSW Government-funded and -operated networks monitor regional air quality to assess general population exposures and compliance with national standards. This comprises the following networks:
    - 16-station Greater Sydney network
    - three-station Lower Hunter network
    - three-station Illawarra network
    - one station on the Central Coast
    - five-station regional network, consisting of monitoring stations at Albury, Bathurst, Tamworth, Wagga Wagga North and Armidale
    - a rural network of 36 monitoring stations to monitor indicative dust and smoke levels in rural NSW, South Australia and Victoria
- A set of industry-funded (or supported), OEH-operated networks monitors specific pollutants generated by industry. This includes the following networks:
    - 14-station Upper Hunter network
    - three-station Newcastle Local network
    - two-station Namoi network.

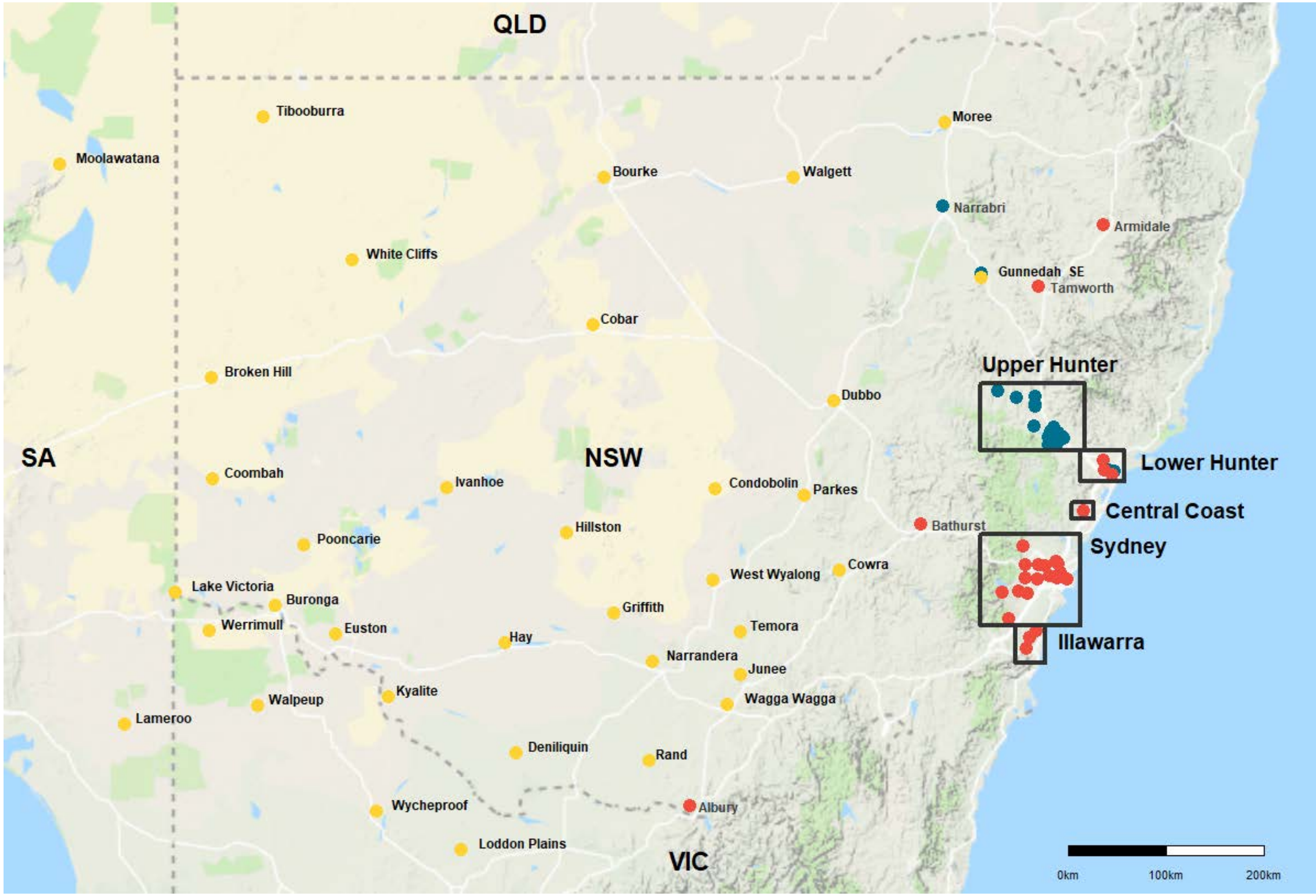

Figure 13 NSW air quality monitoring stations, showing 28 OEH-funded sites (red dots), 19 industry-funded/supported sites (blue dots) and 36 rural air quality monitoring sites (yellow dots)

The Air Quality Index (AQI)

The Office of Environment and Heritage uses an Air Quality Index (AQI) to display air quality levels measured within the NSW air quality monitoring network. The AQI provides a comparison of air pollutants, standardising measurements of ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, airborne particles and visibility into one easy-to-understand index.

An AQI of 100 or above indicates that one or more air pollutants have exceeded relevant standards.

AQI values above 200 indicate that air quality is in the hazardous category, and people sensitive to air pollution are advised to avoid all outdoor physical activities (Table 3). Find out more about the AQI on the OEH website.

$$Air\ Quality\ Index = \frac{pollutant\ level}{air\ quality\ standard}\ x\ 100$$

Table 3 Air Quality Index category, air pollution level and health advice

Air Quality Index (AQI) category and numbers	Air pollution level	NSW Health Advice – what AQI numbers mean
Very good **0-33**	0-33% of national ambient air quality standard	No health impacts expected with air quality within this range
Good **34-66**	34-66% of national ambient air quality standard	No health impacts expected with air quality within this range
Fair **67-99**	67-99% of national ambient air quality standard	People unusually sensitive to air pollution – reschedule strenuous outdoor activities until air quality is better
Poor **100-149**	100-149% of national ambient air quality standard	Air Pollution Health Alert – sensitive groups reschedule strenuous outdoor activities until air quality is better
Very poor **150-200**	150-200% of national ambient air quality standard	Air Pollution Health Alert – sensitive groups avoid strenuous outdoor activities. Everyone cut back or reschedule strenuous outdoor activities until air quality is better
Hazardous **200+**	≥ 200% of national ambient air quality standard	Air Pollution Health Alert – sensitive groups avoid all outdoor physical activities. Everyone significantly cut back on outdoor physical activities until air quality is better

More information

Data from the NSW air quality monitoring network is updated hourly and made available online on the OEH current air quality website. Historical data are also available through the online data search form. You can also subscribe to automated email and/or SMS air pollution alerts at the OEH Subscribe to air quality website.

Information about sources of emissions in New South Wales is available from the NSW Air Emissions Inventory.

Information about the principles and programs used in New South Wales to manage particle pollution is available on the EPA Managing particles and improving air quality in NSW website.

Information about actions to reduce emissions in the Upper Hunter is available on the EPA Upper Hunter air quality website.

Information about sources and research into particle pollution is available at Upper Hunter Fine Particle Characterisation Study, Lower Hunter Particle Characterisation Study and Sydney Particle Study websites.

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