Blue Mountains and Lithgow Ambient Air Quality Monitoring

Summer Report 2019-2020

22 May 2020

Participating Organisations:

- Blue Mountains City Council
- Blue Mountains Conservation Society
- Blue Mountains Union and Community
- Doctors for the Environment
- Environment Protection Authority
- Lithgow Environment Group
- Lithgow City Council
- Nepean Blue Mountains Local Health District
- Department of Planning, Industry and Environment
- Western Sydney University

ACRONYMS

Acronym	Meaning
AM	Arithmetic Mean
AQM	Air Quality Monitoring
BMCC	Blue Mountains City Council
BMCS	Blue Mountains Conservations Society
BMUC	Blue Mountains Union and Community
CI95	95% Confidence Interval
CO	Carbon monoxide
DPIE	Department of Planning, Industry and Environment
EPA	Environment Protection Authority
GM	Geometric Mean
KOALA	Knowing Our Local Ambient Air Quality
LCC	Lithgow City Council
NBMLHD	Nepean Blue Mountains Local Health District
NEPM	National Environment Protection Measure
PM	Particulate matter
PM2.5	Particles with a mass median aerodynamic diameter of 2.5µm
PM10	Particles with a mass median aerodynamic diameter of 10 µm
ppm	Parts per million
pphm	Part per hundred million
QUT	Queensland University of Technology
WSU	Western Sydney University

Steering Committee Members:

- Jacinta Hanemann, NSW EPA (Chair)
- Ruby Kan, DPIE (formerly OEH)
- James Plant, NSW Ministry of Health
- Jane Lambert, BMCC
- Peter Lammiman, BMUC
- Paul Vale, BMCS
- Julie Favell, Lithgow Environment Group
- Brendan Livingstone, Lithgow City Council
- vacant, Doctors for the Environment
- Maggie Davidson, WSU

	Name	Role	University	Date
Prepared by:	**Maggie Davidson**	Researcher	Western Sydney University	12/05/2020
Approved by:	**Ruby Kan**	Atmospheric Research	DPIE	13/05/2020
Released by:	**Sarah Thomson**	Metro South	NSW EPA	18/05/2020

TABLE OF CONTENTS

1. BACKGROUND

The Blue Mountains and Lithgow Air Watch project is a 12-month community initiated research project supported by the NSW Environment Protection Authority (EPA) and the NSW Department of Planning, Industry and Environment (DPIE, formerly the Office of Environment and Heritage), as well as other local stakeholders.

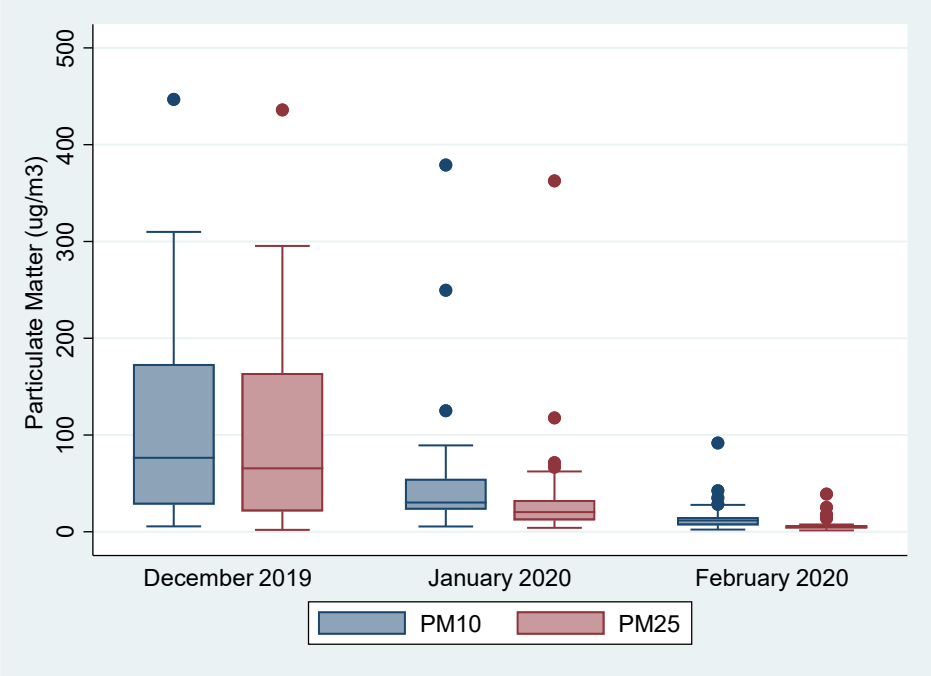
The purpose of the project is to provide a better picture of air quality in the region and help inform future initiatives to protect air quality. This report presents the summer findings from, 1 December 2019 to 29 February 2020.

2. RESULTS & DISCUSSION

Katoomba Compliance Monitoring Station

The summer air quality monitoring was undertaken at the Katoomba compliance station between the 1st December 2019 and 29th February 2020. During this period, air quality in the region declined significantly in December 2019 due to bushfires, and improved over subsequent months (Figure 1). Further detail is shown in Appendix A.

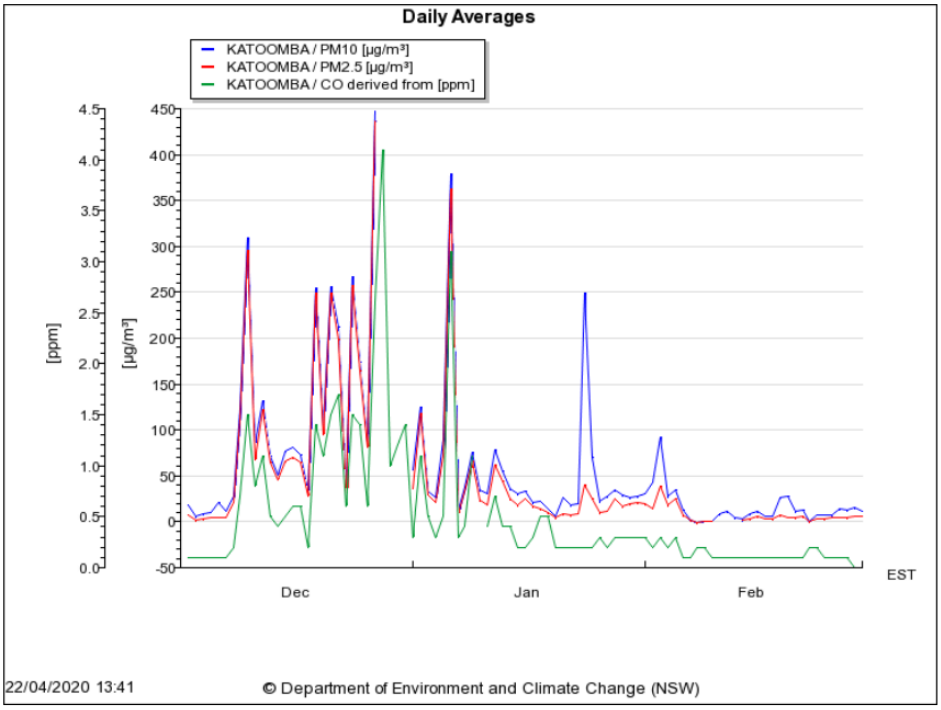
Figure 1: Comparison of Daily PM2.5 and PM10 Averages from Katoomba Compliance Station, Summer 2019-2020



During December 2019, PM_{10} and $PM_{2.5}$ peaked on boxing day (26th December) at 447 µg/m3 and 436 µg/m3 respectively, well over the air quality standards. It should also be noted that some data was invalidated during the summer period due to overloading of the particulate filters. In comparison, winter 2019 had a peak measurement of 12 µg/m3 for PM_{10}, and 10 µg/m3 for $PM_{2.5}$; while spring PM_{10} concentrations peaked at 118 for µg/m3 and 115 µg/m3 for PM_{10} and $PM_{2.5}$ respectively (data in previous reports). The decline in air quality is associated with the unprecedented bushfire season which burned over 10 million hectares Australia wide (CSIRO, 2020), as well as dust storms in summer 2020.

The PM_{10} concentrations exceeded the air quality standard of 50 µg/m3 (averaged over 24-hours) on 18 days in December 2019, eight days in January 2020, and one day in February 2020. In December 2019, $PM_{2.5}$ concentrations exceeded the daily air quality standard of 25 µg/m3 (averaged 24 hours) on 20 days in December 2019, nine days in January 2020, and two days in February 2020. The PM_{10} peaks tend to coincide with the timing of dust storms in the Sydney basin (Figure 2). The high particulate concentrations during bushfire and dust storm events pose a significant health risk to the respiratory health and well-being of residents, especially at-risk populations including children, the elderly, pregnant women and persons with pre-existing health conditions. During the period, multiple health warning were issued by the NSW Ministry of Health on taking precautions to reduce exposure to bushfire smoke (NSW Health, 2020).

Figure 2: Daily Particulate and Carbon Monoxide Averages for Katoomba Compliance Station, December 2019-February 2020 (DPIE 2020)



The average daily carbon monoxide (green line) concentration peaked at 4 ppm on the 27th December 2019 (Figure 2), with the highest rolling 8-hour average of 8.1 ppm recorded in December 2019 (Appendix 1). While below the air quality standard of 9ppm (rolling 8-hour average), the CO concentrations recorded for December and January were significantly higher in comparison to spring and winter that had peak daily CO averages of 2 ppm (21st November 2019) and 0.5 ppm (6th June 2019) respectively. Carbon monoxide and particulate peaks trended closely during the bushfire period, indicating how fire events contribute to atmospheric concentrations of both gaseous pollutants and particulate pollutants.

The readings for other air quality indicators including, nitrogen oxide (NO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) were within National air quality standards. Hourly ozone (O_3) concentrations exceeded the air quality standard of 0.1 ppm (10 pphm) on

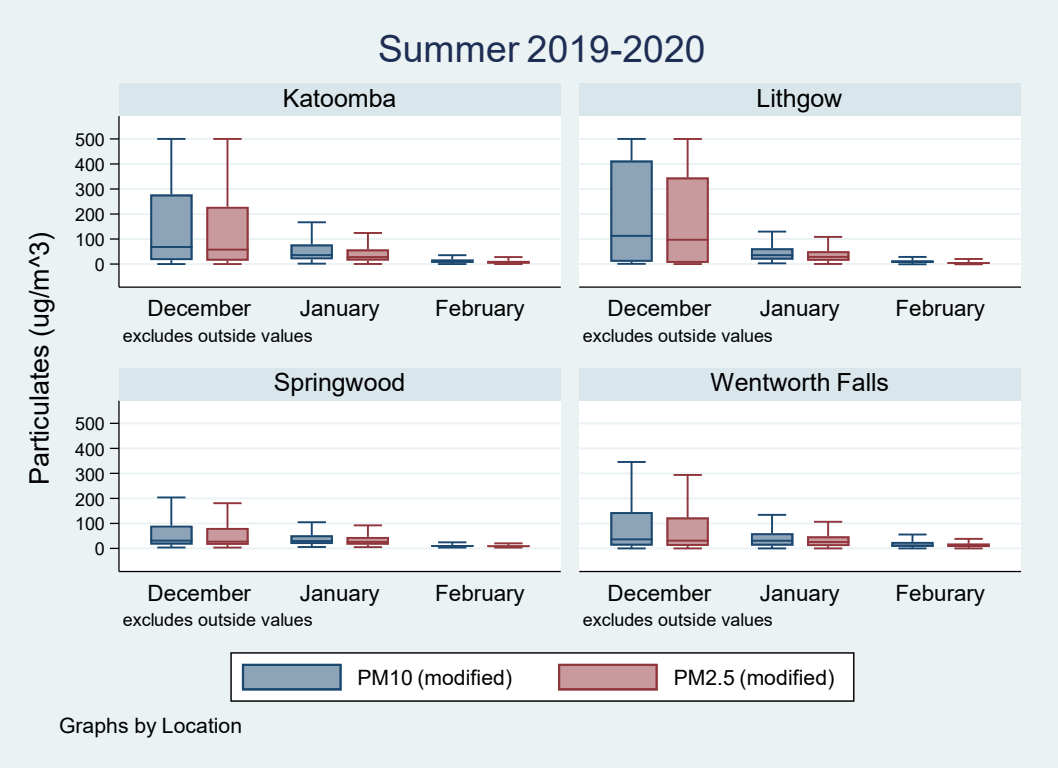
5 occasions in December 2019, as a result of high temperatures and smoke from the bushfires acting as an ozone precursor. The results for gaseous and particulate pollutants can be found in Appendix A.

KOALA Low Cost Sensor Particulate Data

Low cost air quality sensors, known as KOALAs (Knowing Our Ambient Local Air-Quality) are located at Katoomba, Lithgow, Springwood and Wentworth Falls. Hourly airborne concentrations of fine ($PM_{2.5}$) and coarse (PM_{10}) particulates were significantly higher during December 2019 in comparison to January and February 2020 (Figure 3). Outside values, also referred to as outliers, have been omitted to improve legibility of the graph.

During January and February 2020, bushfire activity subsided and significant rainfall of 700mm in Katoomba, 615mm in Springwood and 190mm at Lithgow were recorded during February 2020 (BoM, 2020). During December 2019, airborne particulate concentrations were highest for Lithgow, followed by Katoomba, Wentworth Falls and Springwood, and likely relate to the proximity of these townships to the fire fronts for the Gospers Mountain/Grose Valley bushfires to the north, and the Ruined Castle bushfire to the south.

Figure 3: Comparison of Monthly Particulate Concentrations by Township,

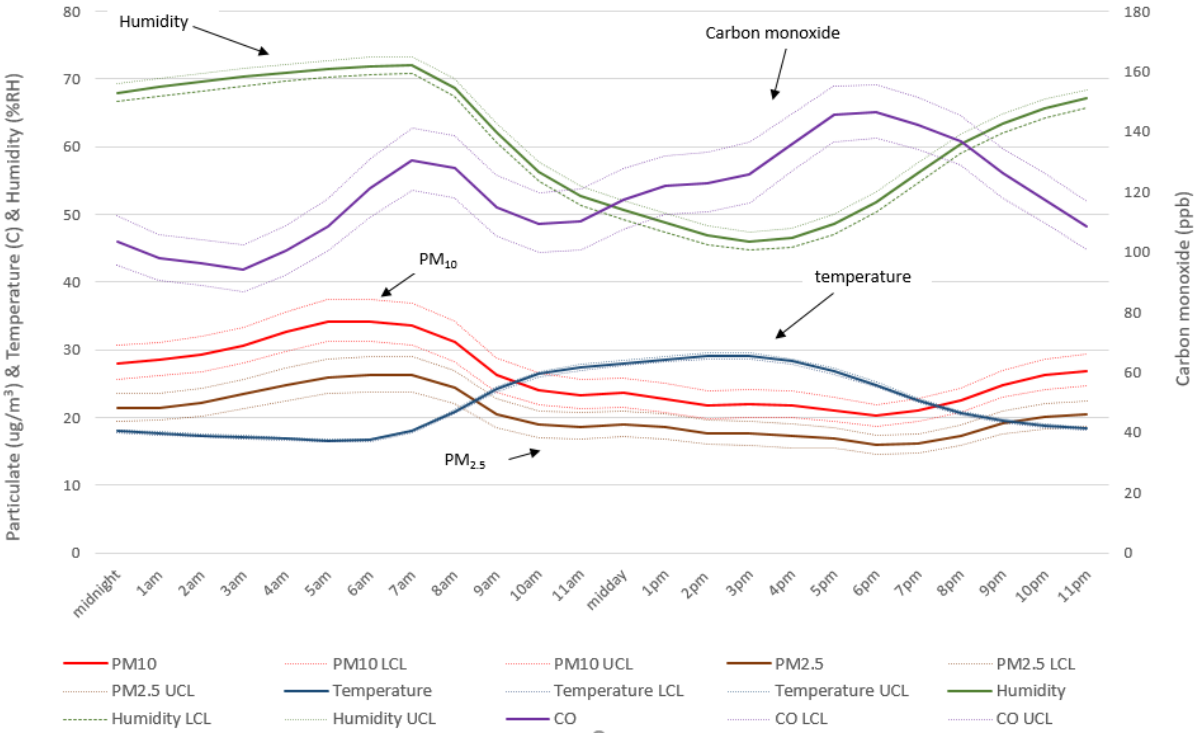


The PM_{10} and $PM_{2.5}$ data was modified by transforming any measurement over 500 $\mu g/m_3$ to a maximum value of 500 $\mu g/m_3$, the upper limit of detection for the KOALAs. This was required because although the sensor recorded high during pollution events, they have exceeded the upper limit of detection of the instrument. Therefore, the reading is considered out of range.

Two KOALAs located in Lithgow malfunctioned during the summer period. K62 between the 4th and 21st December 2019 and K63 between the 6th to 24th February 2020. Wentworth Falls K64 stopped responding between the 24th and 29th February 2020.

Hourly carbon monoxide (CO) concentrations across all sites for Summer 2019-2020 peaked around 5pm, but did not display the bimodal pattern observed in Spring and Winter 2019. The results for hourly monitoring would have been impacted by the bushfires that can obscure typical diurnal patterns associated with day-to-day human activities. Further observation across all seasonal periods will be needed to investigate the potential sources associated with these peaks.

Figure 4: Hourly Fluctuations in PM10, PM2.5 and CO averaged across all KOALAs for 1st December 2019 to 29th February 2020

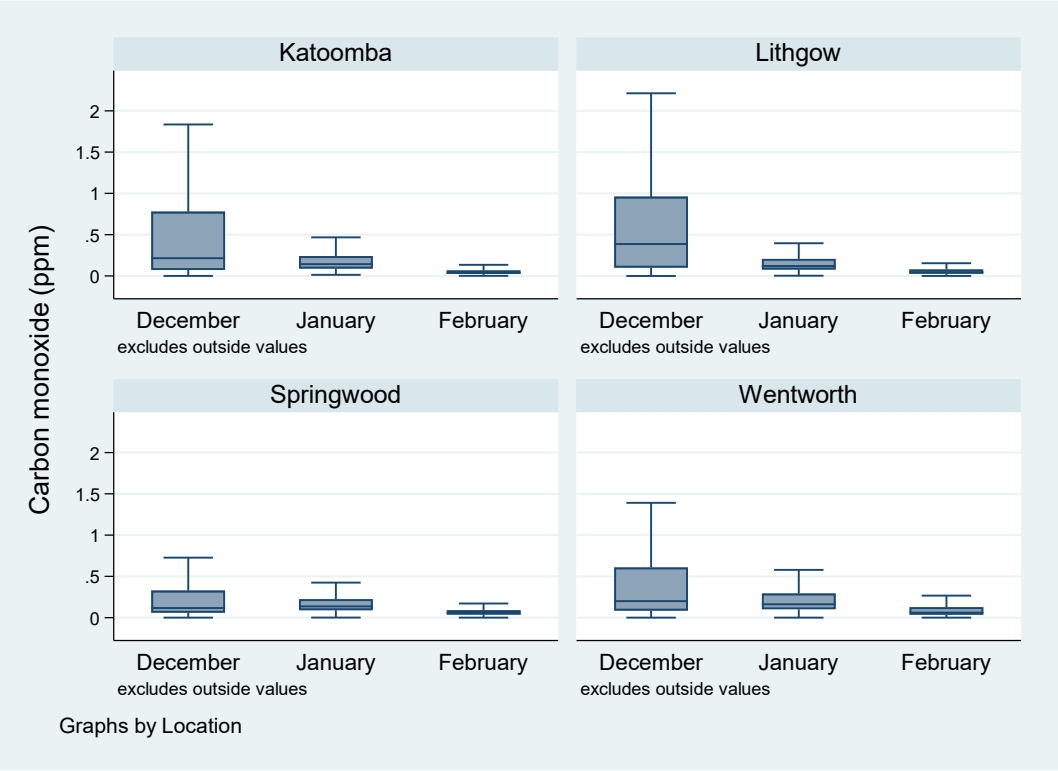


Please note that the data presented has not been adjusted for the effects of sensor variability, temperature or humidity. The findings presented here looks at trends and identifies where additional background data on local activities (e.g. date and timing of construction activities, festivals, etc) that may have influenced the KOALA readings will be collected for individual sites.

KOALA Low-cost Sensor Carbon Monoxide Data

The hourly CO concentrations were higher in comparison to winter and spring, ranging from 0 up to >2 ppm, whereas previous seasons were typically less than 0.1 ppm (Figure 5). Particulate CO concentrations peaked in December 2019 during the bushfire period, and trended higher in Lithgow, Katoomba and Wentworth Falls in comparison to Springwood, which were in closer proximity to the fire front. Outside values, also referred to as outliers, have been omitted to improve legibility of the graph.

Figure 5: Comparison of Hourly Carbon Monoxide Readings Location and Month, 1st December 2019 to 29th February 2020.



3. INTERIM FINDINGS

The summer period findings demonstrate the adverse impacts of bushfires on air quality. During this period, daily averages (24 hours) for $PM_{2.5}$ and PM_{10} exceeded air quality standards on 31 and 27 occasions respectively. During the period, $PM_{2.5}$ peaked at 436 µg/m3, over 17 times the air quality standard of 25 µg/m3 (24-hour average). PM_{10} peaked at 447 µg/m3, nearly nine times the air quality standard of 50 µg/m3 (24-hour average). Air quality improved significantly as the bushfires waned and with significant rainfalls in late January and February.

4. REFERENCES

BoM. 2020. *Climate Data Online*, Australian Government Bureau of Meteorology, viewed 20 April 2020, http://www.bom.gov.au/climate/data/.

CSIRO, 2020. *The 2019-20 bushfires: a CSIRO explainer*. Australian Government, viewed 20 April 2020, https://www.csiro.au/en/Research/Environment/Extreme-Events/Bushfire/preparing-for-climate-change/2019-20-bushfires-explainer.

NSW Health. 2020. *Media Releases*, NSW Government, viewed 20 April 2020, https://www.health.nsw.gov.au/news/Pages/default.aspx.

5. Appendix A: DPIE Compliance Station Results – Summer 2019-2020

Table A1: Comparison of Air Quality Data for the Katoomba DPIE Compliance Station, Summer 2019-2020,

Station	PM_{10}	$PM_{2.5}$	CO	NO	NO_2	O_3	SO_2
	24 hour average ($\mu g/m_3$)	24 hour average ($\mu g/m_3$)	8 hour rolling average (ppm)	1 hour average (pphm)	1 hour average (pphm)	1 hour average (pphm)	1 hour average (pphm)
Katoomba							
December							
Average (median) n=	112 (77) n=27	103(66) n=27	0.9 (0.5) n=744	0.04 (0) n=605	0.27 (0.10) n=605	3.8 (3.2) n=711	0.11 (0) n=692
Geometric mean (GSD n=)	64 (3.3) n=27	47 (4.6) n=27	0.5 (3.2) n=739	NA^	NA^	3.3 (1.7) n=711	NA^
Minimum to maximum	6-447	2-436	0-8.1	0-2.5	0-8.6	0.6-10.9	0-1.6
% above guideline	67%	74%	0%	-	0%	<0.001%~	0%
January							
Average (median) n=	56(30) n=31	38(20) n=31	0.5 (0.3) n=735	0.02 (0) n=626	0.27 (0.10) n=623	3.3 (3.1) n=672	0.05 (0) n=704
Geometric mean (GSD n=)	36 (2.3) n=31	23(2.4) n=31	0.4 (2.0) n=735	NA^	NA^	3.0 (1.6) n=672	NA^
Minimum to maximum	6-379	4-363	0.1-7	0-1.6	0-8.6	0.5-8.3	0-1.4
% above guideline	26%	29%	0%	-	0%	0%	0%
February							
Average (median) n=	15(11) n=29	7(9) n=26	0.1 (0.1) n=672	0.04 (0) n=629	0.18 (0.18) n=630)	2.5 (2.2) n=611	0.07 (0) n=634
Geometric mean (GSD n=)	9(3.2) n=27	4(3.5) n=25	0.1 (01.5) n=621	NA^	NA^	2.2 (1.5) n=611	NA^
Minimum to maximum	0-92	0-39	0-0.7	0-0.8	0-2.4	0.7-6.5	0-4.3
% above guideline	4%	8%	0%	-	0%	0%	0%
NSW Air Quality Standard	50 ($\mu g/m_3$)	25 ($\mu g/m_3$)	9 (ppm)	-	0.12 (ppm)*	10.0 (pphm)~	0.20 (ppm)*

***** to convert pphm to ppm divide by 100 ^too many null values to calculate geometric mean (GSD)
~ozone exceeded NSW Air Quality Standard 0.10 ppm (10 pphm) on 5 ocassions in December 2019