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Related indicators

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Fine particulate matter ($PM_{2.5}$) concentrations

This factsheet reports on concentrations of fine particulate matter ($PM_{2.5}$) at monitoring sites in Aotearoa New Zealand between 2007 and 2020. Concentrations are measured against WHO guidelines for $PM_{2.5}$ exposure, in lieu of a national standard.

New Zealand's ability to monitor concentrations of fine particulate matter is limited by the number and distribution of $PM_{2.5}$ monitoring stations, particularly in the South Island.

Most (22 out of 25) monitoring stations exceeded the 2021 WHO guideline for annual average $PM_{2.5}$ concentrations in 2020.

In 2020, 20 of 25 stations recorded at least one exceedance of the 2021 WHO guideline for daily average $PM_{2.5}$ concentrations.

Between 2007 and 2020, over 90% of all exceedances of the daily average guideline occurred in colder months of autumn and winter, coinciding with periods when home heaters are most used.

How $PM_{2.5}$ can affect our health

Fine particulate matter consists of small airborne particles, including solid matter and liquid droplets. $PM_{2.5}$ refers specifically to particles with a diameter of less than 2.5 micrometres. These particles are mainly produced by the combustion of various fuels (e.g. fossil fuels or wood/coal burning heaters) and through the transformation of other particles such as nitrogen oxides, sulphur dioxide, and organic matter. The finer-grained $PM_{2.5}$ poses a relatively high health risk compared to coarser particulates, as it can pass further into the respiratory system, depositing in the tiny airways deep in the lungs.

Exposure to $PM_{2.5}$ is associated with various health impacts. Mild impacts include shortness of breath or coughing. More severe effects include premature death from cardiovascular and respiratory problems and increased lung cancer risk. Exposure to $PM_{2.5}$ is also associated with asthma, diabetes and adverse birth outcomes such as low birth weight, preterm birth and small-for-gestational-age births (Ministry for the Environment and Statistics NZ 2018; WHO 2013).

In 2016, anthropogenic $PM_{2.5}$ was responsible for:

1,292 premature deaths

4,626 hospitalisations for cardiovascular & respiratory disease

$1.75 million restricted activity days

Source: Kuschel, Metcalfe, Sridhar, Davy, Hastings, Mason et al 2022

The HAPINZ 3.0 project found that the bulk of $PM_{2.5}$-related deaths in 2016 was due to domestic wood and coal fires. $PM_{2.5}$ produced by these accounted for 962 of the 1,292 premature deaths that year. $PM_{2.5}$ from motor vehicles led to 222 deaths; 106 were caused by wind-blown dust and just two from industrial pollution (Kuschel et al 2022).

COVID-19 and air quality

As some $PM_{2.5}$ is generated by the combustion of fossil fuels in motor vehicles, travel and economic restrictions implemented during the 2020 COVID-19 lockdowns are likely to have contributed to decreases in $PM_{2.5}$ concentrations around New Zealand (Ministry for the Environment and Stats NZ 2021).

$PM_{2.5}$ air quality guidelines

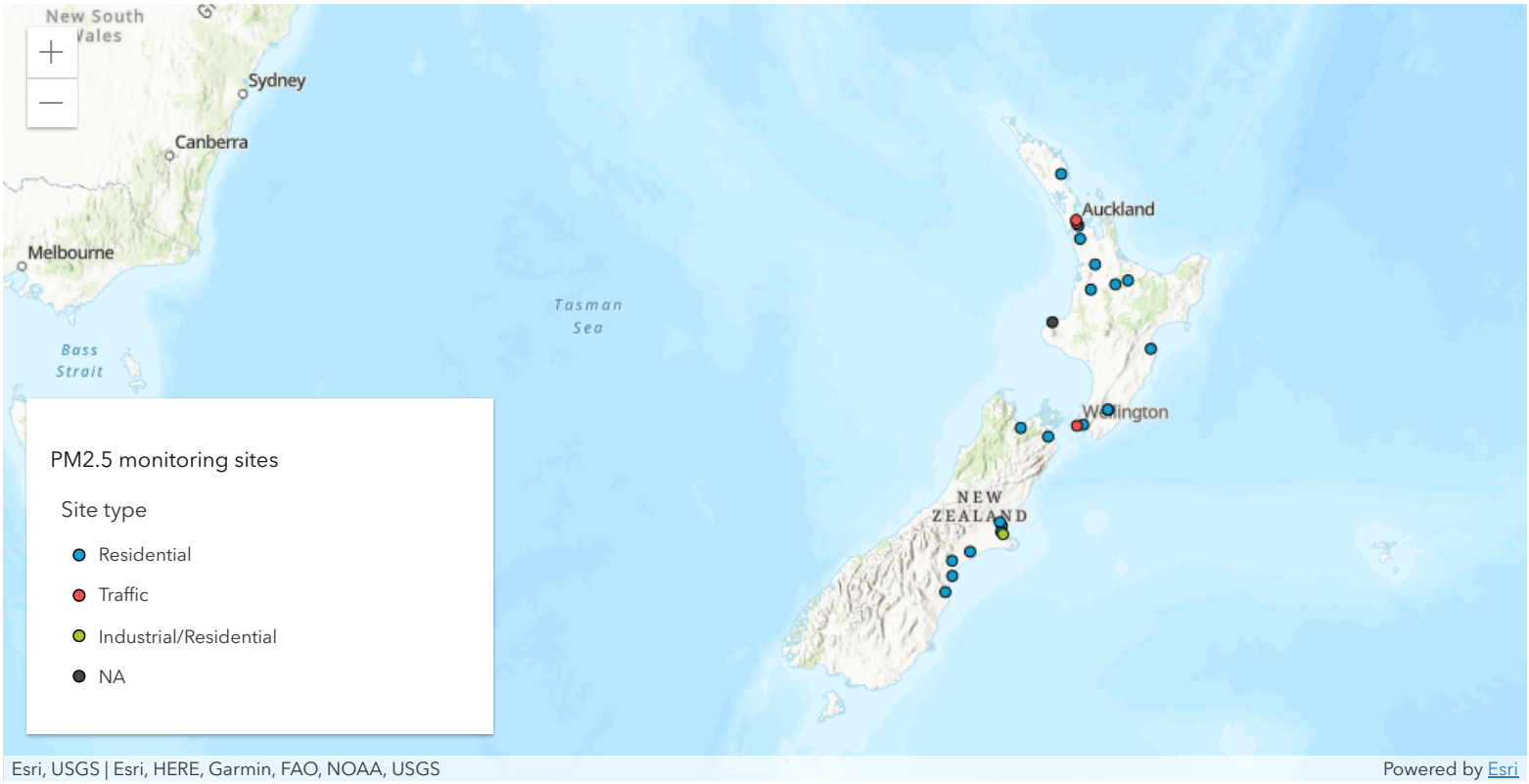
New Zealand does not currently have a National Environmental Standard for Air Quality (NESAQ) for $PM_{2.5}$ as it does for other pollutants (e.g. PM_{10} or NO_2). Instead, $PM_{2.5}$ concentrations have been assessed against the World Health Organization guidelines for air quality (WHO 2013, 2021). However, these guidelines currently carry no regulatory weight in New Zealand.

This factsheet focuses on the limits recommended in 2021, of 15 micrograms (µg)/m^3 as an average over the course of a day and 5 µg/m^3 as an average for a full year. Though the new recommendations are stricter than previous guidelines, there is no evidence for a threshold below which health effects do not occur (Ministry for the Environment & Statistics NZ 2018).

Twenty-five monitoring sites had valid data between 2007–2020

Between 2007 and 2020, 25 monitoring stations had valid records of $PM_{2.5}$ concentrations for at least one year. Stations were generally well distributed across the country, though the southern and western areas of the South Island are not represented in the list. Several large population centres in these areas (e.g. Dunedin, Invercargill and Tauranga) have no facility to monitor $PM_{2.5}$ – though these places do monitor the larger-grained PM_{10}.

Figure 1 Monitoring stations with valid data, 2007-2020



Source: Ministry for the Environment and Statistics New Zealand 2021

The WHO 2021 guideline for annual average $PM_{2.5}$ was exceeded by 22 out of 25 monitoring stations in 2020

In 2020, 22 out of 25 stations across 17 towns and cities exceeded the WHO 2021 guideline for annual average $PM_{2.5}$ concentrations. The highest concentration was recorded at the Blenheim Bowling Club station (11.8µg/m^3). Of the three stations that did not exceed the WHO guideline, only one station (the Auckland-based monitoring station at Patumahoe) had valid data for 2020 to confirm its annual average value was below 5µg/m^3. Patumahoe is the only station that has not regularly exceeded either the 2021 guideline or the less strict guideline the WHO recommended in 2005 of 10µg/m^3.

Table 1 Annual average $PM_{2.5}$ concentrations at monitoring stations, 2007–2020

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Whangārei (Robert Street)											6.1	6.5	6.8	7.7
Takapuna		7.2	7.3	7.4	7.0	6.8	7.0	6.3	5.7	6.4	6.3	7.2	7.2	6.0
Queen Street (Auckland CBD)												6.8	7.2	6.5
Penrose	7.3	7.6	7.2	6.5	6.6	6.6	6.7	6.5	6.2	6.6	6.6	6.9	7.3	5.7
Patumahoe			4.0	3.9	4.2	4.3	4.6	4.2	3.9	4.3	5.7	4.9	5.3	4.5
Claudelands (Hamilton)														6.9
Rotorua at Edmund Road											11.4	9.9	9.6	8.2
SWDC Billah Street Water Reservoir (Tokoroa)										13.4	14.7	10.2		11.4
Waitomo District Council Yard (Te Kuiti)														7.8
New Plymouth Central School										4.4	4.0	4.0	4.5	
Saint Johns (Hastings)											9.1	8.2	7.7	
Masterton East								12.2	11.4	10.5	11.1	10.2	11.5	11.1
Masterton West					11.6	11.7	10.9	10.5	9.5	8.9	9.9	9.9	11.1	10.4
Wainuiomata							5.6	6.0	5.9	6.1	6.4	5.8	6.1	6.0
Wellington Central										5.5	5.5	5.5	5.9	5.4
Richmond Central at Plunket										11.9			9.8	9.7
Blenheim Bowling Club											14.6	13.3	11.5	11.8
Rangiora										9.4	9.5	7.4	9.1	10.1
Kaiapoi											12.0	10.0	10.6	9.5
Saint Albans (Christchurch)					11.5	10.3	11.9	11.7	11.4	9.7	9.4	8.1	9.1	8.9
Woolston (Christchurch)						8.6	10.3	8.9	8.6	7.7	7.3	6.8	7.2	6.7
Ashburton										10.1	9.4	8.9	9.1	8.8
Geraldine										10.6	10.6	9.6	9.4	9.3
Timaru Anzac Square						15.8	15.7	17.2	15.3	12.8	11.8	11.1	10.6	10.0
Waimate Kennedy										9.8	9.3	7.7	8.6	8.5

Note: Blank cells are associated with no data for that year, i.e. no monitoring data was available or the data for that year was invalid.

Source: Ministry for the Environment and Statistics New Zealand 2021

Most monitoring sites exceeded recommended daily levels of $PM_{2.5}$

In 2020, 20 of 25 stations recorded at least one exceedance of the 2021 WHO daily guideline for daily $PM_{2.5}$ concentrations (15µg/m^3). (Table 1). In total, this guideline was exceeded a total of 1,084 times in 2020. Roughly 10% of these exceedances were at a single site – Blenheim Bowling Club, which exceeded the WHO daily guideline on 107 days, roughly a third of the year. The same station has recorded the most annual exceedances in any given year since 2017.

Between 2007 and 2020, 24 out of the 25 monitoring stations with valid data exceeded the daily guideline at least once. Only the New Plymouth Central School station did not record a single exceedance in this period.

Table 2 Number of exceedances of the WHO 2021 guideline (daily average concentrations) at monitoring stations, 2007–2020

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Whangārei (Robert Street)										5	9	13	8	14
Takapuna	5	20	23	25	9	21	11	8	6	9	6	12	8	
Queen Street (Auckland CDB)												1	4	
Penrose (Auckland CDB)	10	20	20	7	4	13	7	7	9	10	5	15	6	
Patumahoe		5	1			3	1				3		1	
Claudelands (Hamilton)								20				2	14	23
Rotorua at Edmund Road										45	91	61	58	48
SWDC Billah Street Water Reservoir (Tokoroa)					74	57	60	74	66	50	50	35	44	40
Waitomo District Council Yard (Te Kuiti)													56	42
New Plymouth Central School	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saint Johns (Hastings)									30	91	96	64	25	84
Masterton East								77	80	73	87	82	92	90
Masterton West					84	92	74	80	68	61	79	72	78	86
Wainuiomata						29	15	27	19	19	27	19	16	28
Wellington Central											1		2	2
Richmond Central at Plunket									1	83	72	7	64	74
Blenheim Bowling Club											127	128	107	107
Rangiora									19	60	68	44	55	64
Kaiapoi										1	89	66	80	59
Saint Albans (Christchurch)										36	74	55	50	30
Woolston (Christchurch)					3	51	65	50	37	29	33	24	31	28
Ashburton									0	66	67	58	51	51
Geraldine										77	95	73	64	73
Timaru Anzac Square						105	119	137	116	95	87	79	72	77
Waimate Kennedy									1	77	75	46	60	64

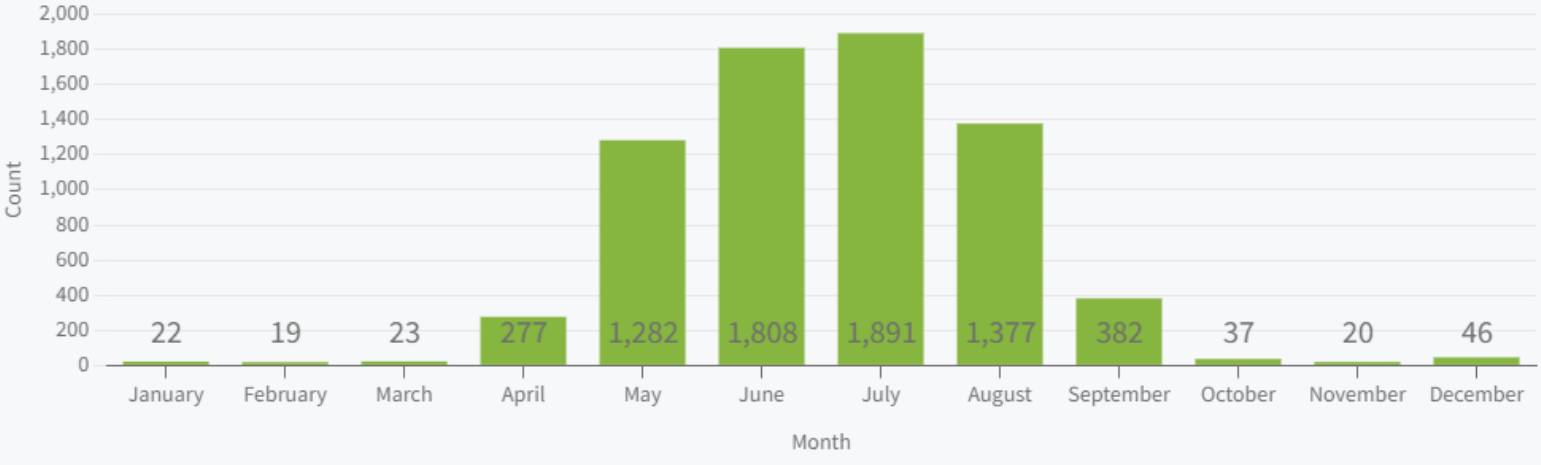
Note: Blank cells are associated with no data for that year, i.e. no monitoring data was available or the data for that year was invalid.

Source: Ministry for the Environment and Statistics New Zealand 2021

Most exceedances occur in colder months

Between 2007 and 2020, almost three-quarters (5,076) of all exceedances of the daily average threshold occurred in the winter months (June-August) (Figure 3). More than a fifth (1,582) occurred in autumn, predominantly in May. Therefore, most exceedances (92.7%) happen in the colder months. During the colder months, home heating emissions increase, contributing to worse $PM_{2.5}$ concentrations. Furthermore, calm and frosty weather conditions in the winter months more easily allow for a build-up of air pollutants (Ministry for the Environment and Statistics NZ 2021).

Figure 3 Number of exceedances of the WHO guideline (daily average concentrations) in New Zealand, by month, 2007–2020



Source: Ministry for the Environment and Statistics New Zealand 2021

Data for these indicators

Monitoring sites exceeding the WHO daily guideline (24-hour average) for $PM_{2.5}$

Daily average $PM_{2.5}$ concentration data comes from the Ministry for the Environment and Statistics NZ (Ministry for the Environment and Statistics NZ 2021) as part of New Zealand's Environmental Reporting Series. These daily concentrations (in $\mu g/m^3$) are compared with the WHO's 2021 guideline for $PM_{2.5}$. The threshold is exceeded when concentrations are above $15\mu g/m^3$. For additional information, see the metadata link below.

Monitoring sites exceeding the WHO annual average guideline for $PM_{2.5}$

Annual average values are created by EHINZ using the 24-hour average values for each year as a basis. Annual average values are then compared with the WHO's 2021 guideline for $PM_{2.5}$. Exceedances occur when concentrations are above $5\mu g/m^3$. For additional information, see the metadata link below.

What is 'valid data'?

For a monitoring site's records to count as 'valid' data, it must meet Ministry for the Environment 'completeness' criteria; that is, it must have records that cover:

- at least 75% of the hours in a day (18 hours) for a valid daily average.
- at least 75% of the days in a year (274 days) for a valid annual average. The days used must all meet the daily requirement above.

If a given year does not meet this requirement, no daily average values or count of exceedances will be reported for that year either. This is discussed in greater detail in the metadata. If a given day/year does not meet this requirement, no daily average values or count of exceedances will be reported for that year. This is discussed in greater detail in the methodology.

References

Kuschel G, Metcalfe J, Sridhar S, Davy P, Hastings K, Mason, K et al. 2022. *Health and air pollution in New Zealand 2016 (HAPINZ 3.0): Volume 1 – Findings and implications.* Report prepared by G Kuschel, J Metcalfe, S Sridhar, P Davy, K Hastings, K Mason, T Denne, J Berentson-Shaw, S Bell, S Hales, J Atkinson and A Woodward for Ministry for the Environment, Ministry of Health, Te Manatū Waka Ministry of Transport and Waka Kotahi NZ Transport Agency.

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Other related topics include:

Particulate matter (PM_{10})
Other air pollutants
Motor vehicles
Health effects of air pollution
Wood and coal fires
HAPINZ 3.0

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Further information

For descriptive information about the data Metadata Sheet

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