



Ministry for the
Environment
Manatū Mō Te Taiao

Stats 
Tatauranga Aotearoa

Our air 2021: preliminary data release

New Zealand's environmental reporting series

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Introduction to Our air 2021

This section provides background to *Our air 2021*, including the nature of this release and what standards we report against in this report.

About Our air 2021

Our air 2021 is part of the series of environmental reports produced by the Ministry for the Environment and Stats NZ. This report is a preliminary data release under the Environmental Reporting Act 2015. This report updates the indicators we have reported on in previous years (2014 and 2018) but does not introduce new ones.

This information release is preliminary because further work is underway on the human health impacts of air quality. We are evaluating data against the recently released 2021 World Health Organization (WHO) air quality guidelines (described below), which will form the basis of a subsequent release of *Our air* on 10 December 2021.

In addition, updated results from the Health and Air Pollution in New Zealand model, which provide us with important information on health impacts, are due to be released in early 2022.

It should be noted that while social restrictions implemented nationally in 2020 as a response to the COVID-19 pandemic temporarily decreased concentrations of several key pollutants across the country, *Our air 2021* does not specifically analyse the effect of these restrictions. However, other studies have examined the effect of Level 4 lockdown restrictions on air quality in Auckland (Patel et al., 2021) and nationally as restrictions eased through June 2020 (Talbot et al., 2021).

Standards we report against

This report evaluates monitored data against two primary standards or guidelines – one national and one international – to indicate potential impacts on human health.

The [National Environmental Standards for Air Quality](#) set limits for particulate matter and gaseous pollutants to protect communities against detrimental health impacts. The standard focuses on short-term exposure – that is, average hourly or 24-hour time periods. The standard allows some pollutants to be above the threshold limit (ie an exceedance) a few times per year.

The [World Health Organization \(WHO\) Air Quality Guidelines](#) also provide indicative limits to protect communities from the long-term or chronic health impacts of air pollution. The WHO guidelines are based on a synthesis of research on the health effects of air pollutants. Many regional councils and unitary authorities, which are responsible for monitoring and managing air quality in New Zealand, choose to report on levels of air pollutants against the WHO guidelines, in addition to the National Environmental Standards for Air Quality.

Revised World Health Organization guidelines and updated modelling of health impacts

During the final production stages of *Our air 2021*, the WHO released updated 2021 global air quality guidelines. This is the first update in 16 years, and comes after a systematic review of more than 500 publications by experts around the world. It builds on the advances in measurement and pollution assessment from a global database as well as epidemiological studies (WHO, 2021). In most cases the 2021 WHO guidelines are more stringent than the 2005 guidelines, reflecting the large body of evidence of detrimental effects of key pollutants on human health, even at low levels.

It was not possible to complete the analytical work against the 2021 guidelines in time for this release. This preliminary release reports on the 2005 WHO guidelines as these are currently referenced across New Zealand, and this enables comparability with *Our air 2018*.

As noted above, updated results from the Health and Air Pollution in New Zealand (HAPINZ) model are also underway, and we expect to receive these early next year (2022). This data will be used to update the indicator on health impacts of air pollution.

Indicator findings

This section provides a summary of key findings for each of the indicators included in this report: PM₁₀ concentrations, PM_{2.5} concentrations, nitrogen dioxide concentrations, sulphur dioxide concentrations, ground-level ozone, carbon monoxide concentrations, air pollutant emissions, and the health impacts of air pollution.

Particulate matter

In New Zealand and worldwide, the most significant human health impacts from poor air quality are associated with exposure to particulate matter (PM) (Health Effects Institute, 2018). Particulate matter is a term used for a mixture of solid particles and liquid droplets found in the air (US EPA, 2021). This report refers to two types of particulate matter:

PM₁₀: larger particles (but still small enough that they can be inhaled), generally 10 micrometres or less in diameter.

PM_{2.5}: finer particles, generally 2.5 micrometres or less in diameter. Because PM₁₀ includes particles smaller than 10 micrometres, PM_{2.5} is a subset of PM₁₀.

Note: Evaluation of data against the 2021 WHO guidelines will be released 10 December 2021.

PM₁₀ concentrations

Key findings

In the four-year period between 2017 and 2020:

- 25 of 46 sites (61 percent) had at least two exceedances of the 24-hour PM₁₀ National Environmental Standards for Air Quality over a 12-month period. Most exceedances were at sites classified as residential.
- Arrowtown (at 30 days), Pomona Street (Invercargill) (12 days), and Anzac Square (Timaru) (12 days) had the highest number of average daily exceedances of the 24-hour PM₁₀ National Environmental Standards for Air Quality per year.
- The majority (83 percent) of all exceedances recorded over this four-year period were in winter (June, July, August). A lesser amount (13 percent) were recorded in autumn (March, April, May).
- Three sites exceeded the annual average PM₁₀ 2005 World Health Organization guideline (20 µg/m³) for air quality at least once over the four-year period. These sites were: Anzac Square (Timaru), Pomona Street (Invercargill), and Arrowtown. Anzac Square (Timaru) had the most exceedances over this period, exceeding the guideline in 2017, 2019, and 2020.

For the 36 sites that were analysed for trends during the 10-year period between 2011 and 2020:

- 72 percent were improving (26 of 36) and 8 percent were worsening (3 of 36). No trend could be determined at 19 percent of sites (7 of 36).

Find out more

[Stats NZ PM₁₀ concentrations web page](#)

PM_{2.5} concentrations

Key findings

In terms of short-term exposure in the four-year period between 2017 and 2020:

- 84 percent of sites (16 of 19) were greater than the PM_{2.5} 2005 World Health Organization 24-hour average guideline. Most measurements above the World Health Organization guideline were at sites classified as residential.
- Blenheim Bowling Club (at 52 days), Masterton East (36 days), and Anzac Square (Timaru) (31 days) recorded the highest number of average daily exceedances of the 2005 World Health Organization 24-hour average guideline per year.
- The majority (82 percent) of all exceedances recorded over this period occurred in winter (June, July, August). Seventeen percent were recorded in autumn (March, April, May).

In terms of long-term exposure in the four-year period between 2017 and 2020:

- Seven sites had at least one exceedance for the annual mean PM_{2.5} 2005 World Health Organization guideline of 10 µg/m³ for air quality. These were Blenheim Bowling Club, Geraldine, Kaiapoi, Masterton East, Masterton West, Rotorua at Edmund Rd, and Anzac Square (Timaru). At four exceedances, Blenheim Bowling Club had the most exceedances over this four-year period, in 2017, 2018, 2019, and 2020.

For the eight sites that were analysed for trends in the 10-year period between 2011 and 2020:

- PM_{2.5} concentrations improved at four sites (50 percent), worsened at one site (12 percent), and trends were indeterminate at three sites (38 percent).

Find out more

[Stats NZ PM_{2.5} concentrations web page](#)

Nitrogen dioxide concentrations

Nitrogen dioxide (NO₂) is a gas primarily generated by burning fossil fuels, mainly by motor vehicles (particularly diesel vehicles), but also from industrial emissions and home heating.

There are health impacts from short-term and long-term exposure to nitrogen dioxide. Short-term exposure to high concentrations of nitrogen dioxide causes inflammation of the airways and respiratory problems, and can cause asthma attacks (US EPA, 2016). Short-term exposure may also trigger heart attacks and increase the risk of premature death (US EPA, 2016). Long-term exposure may cause asthma to develop and lead to decreased lung development in children. It may also increase the risk of certain forms of cancer and premature death (US EPA, 2016).

Note: Evaluation of data against the 2021 WHO guidelines will be released 10 December 2021.

Key findings

In terms of short-term exposure in the four-year period between 2017 and 2020:

- No site exceeded the National Environmental Standards for Air Quality short-term standard of 200 µg/m³ average over 1-hour.

In terms of long-term exposure in the four-year period between 2017 and 2020:

- Queen Street (Auckland) exceeded the 2005 WHO annual guideline in 2017 (43.9 µg/m³) and 2018 (43.9 µg/m³).
- Queen Street (Auckland) recorded the highest concentration of nitrogen dioxide (41.5 µg/m³) averaged over 2017–20. Riccarton Road (Christchurch) recorded the second highest concentration (29.9 µg/m³).
- Nitrogen dioxide concentrations at monitored sites were highest in winter (June, July, August).

Ten-year trends between 2011 and 2020 (Waka Kotahi NZ Transport Agency sites):

- Two-thirds of sites (72 of 110) had improving trends while 4 percent (4 of 110) were worsening. No trend could be determined for 31 percent of sites (34 of 110).

Find out more

[Stats NZ Nitrogen dioxide concentrations web page](#)

Sulphur dioxide concentrations

Sulphur dioxide (SO₂) is a colourless gas with a sharp, irritating odour. It is associated with combustion of fossil fuels (such as coal, diesel, and heavy fuel oil used in maritime vessels) and industrial processes (such as the production of fertilisers and the smelting of mineral ores containing sulphur).

At high levels, sulphur dioxide can have human health and ecological impacts. When inhaled, sulphur dioxide is associated with respiratory problems such as bronchitis. It can aggravate the symptoms of asthma and chronic lung disease and cause irritation to eyes. In ecosystems, it can damage vegetation, acidify water and soil (US EPA, 2017), and affect biodiversity.

Note: Evaluation of data against the 2021 WHO guidelines will be released 10 December 2021.

Key findings

In the four-year period between 2017 and 2020:

- No sites exceeded the short-term sulphur dioxide one-hour National Environmental Standards for Air Quality lower threshold of 350 µg/m³ or the upper threshold of 570 µg/m³.
- Four sites out of seven (57 percent) exceeded the 24-hour sulphur dioxide 2005 World Health Organization guideline threshold of 20 µg/m³. Totara St, Whareroa Marae, and Tauranga Bridge Marina (all in Mount Maunganui), had the highest average daily exceedances of the 24-hour 2005 World Health Organization short-term guideline over this period (81, 40, and 16 average exceedances per year respectively).
- Of all exceedances of the 2005 World health Organization 24-hour guideline recorded over this period, 32 percent were in summer (December, January, February) and 30 percent were recorded in spring (September, October, November).

Ten-year trends between 2011 and 2020:

- At five of six sites (83 percent) annual trends were improving.

Find out more

[Stats NZ Sulphur dioxide concentrations web page](#)

Ground-level ozone

Ozone (O₃) is a gas found naturally in the atmosphere. However, when it occurs at ground level, it is a pollutant generated by human activity and can have harmful effects.

Exposure to high concentrations of ground-level ozone can cause respiratory health issues and is linked to cardiovascular health problems and increased mortality. Those most at risk include people with asthma, children, older adults, and people who are active outdoors, such as outdoor workers. Exposure to ground-level ozone may also be associated with nervous system, reproductive, and developmental effects (WHO, 2013). High levels of ground-level ozone can also have harmful ecological effects: it can damage vegetation, reduce plant growth (affecting crop and forest yields), and harm sensitive ecosystems (US EPA, 2013).

Note: Evaluation of data against the 2021 WHO guidelines will be released 10 December 2021.

Key findings

In the four-year period between 2017 and 2020:

- Neither of the two monitored sites, Patumāhoe (Auckland) and Wellington Central, exceeded the National Environmental Standards for Air Quality 1-hour average threshold of 150 µg/m³ or the 2005 World Health Organization running 8-hour average guideline of 100 µg/m³.
- Ground-level ozone had higher concentrations during the mid-afternoon.
- Patumāhoe had a higher annual average ground-level ozone concentration (40.1 µg/m³) than Wellington Central (17.3 µg/m³).

Ten-year trends between 2011 and 2020:

- Patumāhoe showed an improving annual trend.

Find out more

[Stats NZ Ground-level ozone concentrations web page](#)

Carbon monoxide concentrations

Carbon monoxide (CO) is caused by the incomplete combustion of fuels, especially in petrol-fueled motor vehicles.

Carbon monoxide can have a range of health effects even after short-term exposure to relatively low concentrations. When inhaled, carbon monoxide enters the blood stream and attaches to haemoglobin in red blood cells, which transport oxygen around the body. This reduces the amount of oxygen that body tissues receive and can have adverse effects on the brain, heart, and general health (US EPA, 2010).

Note: Evaluation of data against the 2021 WHO guidelines will be released 10 December 2021.

Key findings

In the four-year period between 2017 and 2020:

- No site exceeded the National Environmental Standards for Air Quality running 8-hour average threshold of 10 mg/m³.
- No site exceeded the 2010 World Health Organization 1-hour average guideline of 35 mg/m³.
- Riccarton Road (Christchurch) had the highest average concentrations of carbon monoxide (0.4 mg/m³). The rest of the sites had average concentrations of 0.2 mg/m³.
- Across sites, peak concentrations of carbon monoxide occurred during morning and evening hours.
- Carbon monoxide concentrations were highest in winter (averaging 0.4 mg/m³ over the winter months – June, July, August).

Ten-year trends between 2011 and 2020:

- Of the 10 sites assessed for annual trends, seven were improving and three were indeterminate.

Find out more

[Stats NZ Carbon monoxide concentrations web page](#)

Air pollutant emissions (sources)

Understanding the key sources of air pollutants is critical to managing and improving air quality. Emissions inventories estimate the quantities of different pollutants emitted to the air by different sources, over a certain time period.

Nationally in 2019:

- The residential sector (primarily burning wood for home heating) contributed 30 percent of PM_{2.5} emissions and 41 percent of carbon monoxide emissions. Almost all particulate matter emissions generated by the residential sector were PM_{2.5}.
- Dust from unsealed roads was the dominant source of PM₁₀ (28 percent).
- On-road vehicles were the dominant source of nitrogen oxides (39 percent), primarily diesel vehicles.
- Burning coal was a large source of sulphur dioxide emissions (41 percent), primarily from manufacturing and construction and electricity generation. Domestic shipping (16 percent) and aluminium production (13 percent) were also significant sources of sulphur dioxide.

In the eight-year period between 2012 and 2019:

- Total emissions were lower in 2019 for all pollutants except PM₁₀. Annual emissions of carbon monoxide were down 15 percent compared to 2012 (by more than 87,000 tonnes).
- Transport emissions were lower in 2019 for all pollutants except sulphur dioxide, with emissions of carbon monoxide down 47 percent (by more than 85,000 tonnes) and nitrogen oxides down 12 percent (by more than 8,000 tonnes).
- Emissions from electricity generation were lower in 2019 across all pollutants. Most notably, sulphur dioxide emissions decreased by 40 percent (by more than 5,000 tonnes) due to lower emissions from coal burning.

Find out more

[Stats NZ Air pollutant emissions web page](#)

Health impacts of air pollution

Air pollution causes a wide range of health impacts. Because of the difficulty of separating air pollution effects from other causes, modelling is commonly used to estimate health impacts from air pollution. This indicator uses a modelling methodology informed by the Health and Air Pollution in New Zealand (HAPINZ, 2012) study, which was developed in accordance with international best practice (Kuschel et al, 2012).

Note: We are anticipating that this indicator will be updated soon, pending an update to the model. Updated information will be available on the Stats NZ website. This indicator used PM₁₀ as a proxy for all air pollution in New Zealand but the revision currently underway is investigating also reporting on PM_{2.5} and nitrogen dioxide.

Key findings

From modelling based on the current HAPINZ model:

- As shown in table 1, adult (older than 30 years) premature deaths linked to exposure to human-generated PM₁₀ were estimated to be 8 percent lower in 2016 than in 2006 (27 deaths per 100,000 people, compared to 29 in 2006).
- Total hospital admissions due to human-generated PM₁₀ were estimated to be 2 percent lower in 2016 than in 2006 (14 admissions per 10,000 people compared to 15 in 2006).
 - For cardiac illness, admissions were estimated to be 11 percent lower (5 per 100,000 people compared to 6 in 2006).
 - For respiratory illness, admissions were estimated to be 4 percent higher in 2016 than in 2006 (although rounding makes the admissions total the same: 9 admissions per 100,000 people in both years).
- Restricted activity days, in which symptoms were sufficient to prevent usual activities such as work or study, were estimated to be 12 percent lower in 2016 than 2006 (31,800 per 100,000 people compared to 36,300 in 2006).

Table 1: Modelled health effects from exposure to human-generated PM₁₀, 2006 and 2016

Health effect	Number of cases per 100,000 people		
	2006	2016	
Premature mortality (adults 30+)	29	27	
Hospital admissions	Cardiac hospital admissions	6	5
	Respiratory hospital admissions	9	9
	Total hospital admissions	15	14
Restricted activity days	36,300	31,800	

Source: HAPINZ Exposure Model (Kuschel et al, 2012), Emission Impossible Ltd

Find out more

[Stats NZ Health impacts of PM₁₀ web page](#)

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