HAPINZ 3.0

He rangi hauora he iwi ora

Frequently asked questions

As at 13 June 2022

1. What is HAPINZ 3.0?

Clean healthy air contributes to New Zealand's quality of life - not only to people's health, but also to the natural functioning and beauty of the natural and physical environment.

The health effects of air pollution in New Zealand (HAPINZ) were first assessed in HAPINZ 1.0 for a base year of 2001. This work was later updated in HAPINZ 2.0 for a base year of 2006. **HAPINZ 3.0** represents the latest update and assesses the air pollution health effects experienced by New Zealanders for 2016.

HAPINZ 3.0 found **anthropogenic** (human-generated) air pollution in New Zealand in 2016 resulted in:

- the premature deaths of more than 3,300 adult New Zealanders
- more than 13,100 hospital admissions for respiratory and cardiac illnesses, including 845 asthma hospitalisations for children
- over 13,200 cases of childhood asthma
- approximately 1.745 million restricted activity days (days on which people could not do the things they might otherwise have done if air pollution had not been present).

Of the more than 3,300 deaths associated with anthropogenic air pollution, more than 60% (2,000) were associated with nitrogen dioxide (**NO_2**) pollution – which is largely from motor vehicles – whilst the rest (nearly 1,300) were associated with fine particulate (**$PM_{2.5}$**) pollution – largely from domestic fires. For context, StatsNZ report that 31,179 New Zealanders died in 2016 from all causes.

The social costs associated with anthropogenic air pollution in New Zealand in 2016 alone were $15.6 billion.

2. What is anthropogenic" air pollution and why does HAPINZ 3.0 focus its reporting on that?

Anthropogenic air pollution means human (*anthro-*) generated (*-genic*) pollution. Examples of sources of anthropogenic air pollution include motor vehicles (e.g. cars, buses, and trucks), domestic fires (e.g. coal and wood burners used for home heating), windblown dust (e.g. from construction, land use activities and road dust) and industry.

HAPINZ 3.0 focusses on anthropogenic sources of air pollution because emissions from these sources can be controlled through a combination of central and local government legislation, rules, policies and interventions.

Examples of non-anthropogenic (natural) air pollution sources include sea spray and volcanoes which emit fine particles and harmful gases (e.g. sulphur dioxide from volcanoes).

3. Air pollution is largely invisible. How can it be causing us harm?

Air pollution is a complex mixture of particles (usually referred to as particulate matter, **PM**) and gases. The primary air pollutants are typically split into harmful air pollutants and greenhouse gases. The

harmful air pollutants most commonly released by anthropogenic (human-generated) sources in New Zealand include:

- Particulate matter smaller than 10 μm (**PM_{10}**) or smaller than 2.5 μm (**$PM_{2.5}$**) – which is emitted by domestic fires burning wood or coal, motor vehicles (especially from diesel fuel combustion), industrial sources and activities that release windblown dust (such as construction). Particulate matter is also emitted from motor vehicle brake/tyre wear and road dust.
- Nitrogen oxides (**NO_X**), in particular nitrogen dioxide (**NO_2**) – which is emitted mainly by diesel and petrol vehicles from fuel combustion.

PM_{10} and $PM_{2.5}$ are largely invisible to the naked eye as the particles are in the μm (one millionth of a metre) size range. However, NO_2 contributes to the formation of brown haze which can be seen at times over large urban centres, such as Auckland.

Harmful air pollutants are so-called because they can cause adverse human health effects ranging from increased ***morbidity*** (illness, e.g. increased respiratory hospitalisations) to increased ***mortality*** (loss of life, i.e. premature deaths). The effects depend on the pollutant itself, the concentration and the length of time exposed – acute (short-term) or chronic (long-term).

4. Isn't NZ's air quality quite good relative to other countries? How can this be such a problem?

New Zealand ***does*** have good air quality relative to many other places in the world.

However, we now know much more about the harms associated with air pollution – in particular, fine particles (**$PM_{2.5}$**) which are emitted from a range of anthropogenic sources and nitrogen dioxide (**NO_2**) which is a gas emitted mainly by motor vehicles. Not only are the impacts of NO_2 more significant than we expected, exposure to even low levels can be harmful. This is a new finding for New Zealand and one that is now being confirmed in other places around the world.

5. Doesn't our wind just blow all the air pollution away?

Many areas of New Zealand are located near the sea and ***do*** get the benefit of onshore and offshore breezes to disperse (blow away) air pollution.

However, air pollution levels can build up during calm conditions (especially when we get temperature inversions during winter) or in locations further inland in valleys and areas surrounded by hills. On busy streets, especially those with high numbers of diesel vehicles, tall buildings on either side of the street can form a 'canyon' that can trap traffic emissions.

Under these circumstances, pollution can build up and, as we found in HAPINZ 3.0, can have impacts at even low levels.

6. Why is HAPINZ 3.0 based on 2016? We're in 2022 now.

The base year for the HAPINZ 3.0 assessment was 2016, with data typically averaged over 2015-2017 to account for inter-annual variability in meteorology.

2016 was selected because it was the most recent year for which we had a complete set of suitable air quality, population and health data. Air quality data typically become available within one to two years of the end of the calendar year of interest but health data on hospitalisations and deaths can lag by three or more years.

7. Are the 3,300 deaths "real"?

Adverse health effects (i.e. premature deaths and hospitalisations) resulting from air pollution depend on the concentration of the different pollutants in the air pollution mix, as well as the length of time and sensitivity of the people who are exposed to pollution. When people get sick due to exposure to air pollution, hospitals and accident/emergency centres record these events based on a system of codes which captures the ***outcome*** (e.g. respiratory hospitalisation) rather than the ***cause*** (e.g. air pollution).

Consequently, air pollution health effects are estimated using exposure-response functions (**ERF**) which show the relative increase in a health effect for every increment of air pollution. For example, an ERF of 1.105 (per 10 μg/m^3) for premature mortality due to exposure to long-term $PM_{2.5}$ means the risk of death increases by 10.5% for every 10 μg/m^3 increase in the $PM_{2.5}$ annual average concentration. ERFs are developed in studies that look at changes in health effects in populations relative to changes in air pollution, after removing bias that can occur due to other confounding factors (such as smoking).

In HAPINZ 3.0, we reviewed long-term data and developed New Zealand-specific ERFs for a range of health outcomes – including premature deaths (mortality) and increased illness/hospitalisations (morbidity). Each ERF has a confidence interval, which indicates the range within which the actual risk is likely to fall (with a 95% probability).

Premature deaths are when people die earlier than they would have done if they had not been exposed to air pollution. In other words, people would have lived a bit longer if they had been exposed to a lower level of air pollution during their lifetime.

The deaths are ***estimated*** deaths calculated using the same methodology that is used to estimate health effects due to other causes. HAPINZ 3.0 followed international best practice for air pollution health effects assessments and our ERFs were peer reviewed by overseas experts. Consequently, we are confident that our estimated deaths reflect ***real*** deaths – unfortunately.

8. Isn't air pollution just killing old and already sick people?

Air pollution causes serious health effects. However, these impacts are not felt evenly. People can be more vulnerable if they are:

- more exposed to environmental hazards
- more sensitive to the effects
- less resilient in their ability to be able to anticipate, cope with or recover from the effects.

People's ***sensitivity*** to air pollution depends largely on internal factors such as age and health status. Based on health reviews, there are groups within the population who are more affected by air pollution than others such as:

- elderly people
- children (including babies, infants and unborn babies)
- people with pre-existing heart or lung disease
- people with respiratory conditions
- asthmatics
- diabetics and
- pregnant women.

Asthmatics are particularly sensitive to poor air quality. New Zealand has one of the highest prevalence of asthma in the world, with one in seven children aged 2–14 years (107,000 children) and one in nine adults aged over 15 years (389,000 adults) currently taking asthma medication. The Organisation for Economic Co-operation and Development (**OECD**) reports that New Zealand has the fourth highest hospital admission rates for asthma of OECD countries.

9. I'm Māori or a Pacific person – am I more at risk?

As mentioned earlier, adverse health effects resulting from air pollution depend on the concentration of the different pollutants in the air pollution mix, as well as the length of time and sensitivity of the people who are exposed to pollution.

Some studies have suggested that ethnicity can be a factor in making some individuals more ***sensitive*** to the effects of air pollution. In HAPINZ 3.0, we specifically investigated whether Māori and Pacific peoples were more sensitive to air pollution than other groups in New Zealand but we did not find any differences due to ethnicity by itself.

Regardless, other factors can also increase the risk of air pollution effects in these groups. Affordable housing for low socio-economic groups is often located in areas where air quality is poor, such as near major roads, in low lying valleys and in more industrialised areas. There is evidence that young children, adults and households in poverty experience increased ***exposure*** to traffic-related air pollution in particular. Māori and Pacific peoples are over-represented in low socio-economic groups and also often have a poorer base level of health.

10. What do we mean by social costs?

Social costs of air pollution are the total costs to society of the health effects associated with air pollution. They include the costs of premature mortality (death) and increased morbidity (illness and disease) but not just in terms of the direct medical costs but also the wider costs due to loss of output (income and time off work or school for those who need to care for affected family and friends) and recovery.

In HAPINZ 3.0, we use a value of a statistical life (**VoSL**) to cost each case of premature death. This is the same VoSL that is used to cost deaths from road crashes in New Zealand. Hospitalisations are valued based on the average number of bed nights in hospital (which vary for each type of admission), medication costs, follow-on costs, lost income and quality of life impacts. Restricted activity days are valued based on the costs of lost average income per day.

11. Why is the value of a statistical life so high? If I died tomorrow, nobody is going to pay my family over $4.5 million.

The value of a statistical life (**VoSL**) is a measure of the value to society of reducing the risk of death.

Suppose each person in a sample of 100,000 people was asked how much he or she would be willing to pay for a reduction in their individual risk of dying of 1 in 100,000, or 0.001%, over the next year. Since this reduction in risk would mean that we would expect one fewer death among the sample of 100,000 people over the next year on average, this is sometimes described as "one statistical life saved." Now suppose that the average response to this hypothetical question was $100. Then the total dollar amount that the group would be willing to pay to save one statistical life in a year would be $100 per person × 100,000 people, or $10 million. This is what is meant by the "value of a statistical life." Importantly, this is not an estimate of how much money any single individual or group would be willing to pay to prevent the certain death of any particular person.

This value is the same value used by economists for valuing roading proposals (e.g. the costs and benefits of safety improvements for a new bypass).

12. Is it bad to live near a road? Where are the best and worst places in NZ?

Air quality is typically worse near major roads (especially near intersections with stop/start traffic), in more industrialised areas (including ports and airports) and in low lying valleys (where pollution can get trapped. Increased air pollution also makes people less likely to engage in physical activity, which of itself has wide ranging public health impacts. Typically, air pollution is worst during the winter months, when the air is cold and calm and emissions from wood burners and traffic are not so readily dispersed.

Air pollution health impacts vary with region across New Zealand.

The highest levels of fine particles ($PM_{2.5}$) are in areas in which a large proportion of households use domestic fires burning wood or coal for winter-time home heating. The highest levels of NO_2 are found in areas with a high density of roads and in 'hot spots' where there is high diesel traffic and/or close to intersections and inner-city areas, where there are tall buildings on either side of the road which can trap air pollutants.

13. Didn't you tell us last time that home heating the problem? Why is it now vehicles?

The previous HAPINZ study (HAPINZ 2.0) used PM_{10} only (as a proxy for all air pollution) based on data available at the time but noted that the results likely under-estimated impacts due to NO_2. Because the impacts of sources were then assigned from their contributions to PM_{10} (rather than all) air pollution, addressing domestic fire emissions (rather than motor vehicle emissions) was identified as the priority for most locations across New Zealand.

In HAPINZ 3.0, we used $PM_{2.5}$ and NO_2 as the indicators and found the total impacts were split between $PM_{2.5}$ impacts ($6.1 billion in 2016) and NO_2 impacts ($9.5 billion in 2016), with NO_2 exposure accounting for just over 60% of the total impacts ($15.6 billion in 2016).

The extent of the NO_2 impacts found in HAPINZ 3.0 was unexpected. When the HAPINZ 3.0 draft findings first became available (February 2021), no other researchers had published such strong associations between NO_2 and mortality. To ensure the findings were genuine, the HAPINZ 3.0 research team undertook considerable additional analyses to check for bias, and the results were rigorously peer-reviewed before being published internationally. Our paper has now been referenced by other researchers who have found similarly strong NO_2 impacts in their countries. This finding shows air quality management strategies need to focus at least equally (if not more so) on addressing motor vehicle emissions.

Since 2006, despite significant improvements in domestic fire emissions, growth in the vehicle fleet (especially diesel vehicles) and in the population (the number of people exposed) has resulted in the social costs associated with air pollution increasing by more than 10%. So more still needs to be done to reflect the value we place on clean air and good health.

14. Am I harming the health of others by driving a diesel car or using a wood burner? Won't electric vehicles save us?

Certain types of motor vehicles or wood burners are definitely more polluting than others but the impact depends on how old the vehicle/appliance is, how well it is maintained and how often it is used.

Vehicles and wood burners are constructed to meet the emissions standards in place at the time and these standards have tightened considerably over time.

For example, the average age of a light duty diesel vehicle (car or ute) in New Zealand is around 14 years – meaning these vehicles were built to standards such as Euro 4 (with emissions limits of 0.25 g

NO_X per km driven and 0.025 g PM per km). By comparison, new diesel vehicles are now required to meet Euro 5 (0.18 g NO_X per km and 0.005 g PM per km) – a 28% improvement in NO_X and an 80% improvement in PM.

Similarly wood burner design has improved significantly. Pre-2005 wood burners typically release around 15 g PM per kg wood burnt, whereas since 2005 all new wood burners cannot emit more than 1.5 g PM per kg (required by the National Environmental Standards for Air Quality standards for wood burners).

Maintenance is also important as vehicle equipment (such as air filters and injectors) can degrade and reduce vehicle efficiency. Wood burners have flues which need to be cleaned each year and wood needs to be kept dry.

Cleaner fuel options such as electric vehicles and heat pumps do result in significantly reduced emissions but they are not necessarily suitable (or affordable yet) for everyone. Electric vehicles have no exhaust emissions but they still produce brake/tyre wear emissions and road dust. Similarly, heat pumps do not cause local air quality impacts but they still require electricity to operate. New Zealand has one of the highest renewable electricity proportions in the world (at 84% in 2020) but still relies on fossil fuel to generate the balance, which releases air pollution.

15. What about industry? Windblown dust?

The impact of industry and windblown dust is very low relative to the impact of motor vehicles and domestic fires ***overall*** in New Zealand. However, these sources tend to be more ***localised*** so can still cause adverse effects for select populations if not managed appropriately.

Council consenting processes and requirements for dust management plans are typically used to control emissions from industry and some (but not all) dust generating activities in urban areas.

16. Don't we have an environmental standard for air quality? Haven't the initiatives we've put in place since 2006 worked?

Since 2006, considerable improvements have occurred in domestic fire emissions following the introduction of the woodburner standards and programmes encouraging insulation and clean heat appliances. As a consequence, most airsheds that were exceeding air quality PM_{10} standards in winter-time are now in compliance.

Despite this progress, HAPINZ 3.0 estimated domestic fires in 2016 to still be responsible for 29% of the national air pollution health burden from anthropogenic sources at an estimated social cost of $4.6 billion. This is because air pollution causes significant health effects even at low concentrations.

Since 2006, the understanding of air pollution health effects has improved greatly. Studies have now found adverse health effects at even low levels of exposure to air pollution. These findings are reflected in the latest World Health Organization (**WHO**) guidelines for PM and NO_2 (released in late 2021) in which the WHO has significantly reduced their recommended thresholds. For example, the guideline value for annual average NO_2 has dropped from 40 $\mu g/m^3$ to 10 $\mu g/m^3$ – a 75% reduction.

Significant and genuine improvements were made in fuel quality and vehicle emissions standard requirements between 2001 and 2006. However, little further regulation of motor vehicle emissions has occurred since. Moving forward from HAPINZ 3.0, more attention will need to go on addressing harmful emissions from motor vehicles - from in-service vehicles as well as those entering the fleet.

17. Does the COVID-19 pandemic bias the HAPINZ 3.0 findings?

At the start of the pandemic, correlations between air pollution levels and COVID-19 outcomes were widely reported. Some researchers found that people who lived in areas of high air pollution were more likely to experience severe outcomes (such as hospitalisations and death) from COVID. Conversely, air pollution levels dropped markedly in locations where people were required to stay at home and car travel (in particular) was severely restricted. Many large cities around the world reported the best visibility (clear skies) for decades during lockdowns.

As HAPINZ 3.0 was based on 2016, prior to the pandemic, our assessment was independent of any effects on air pollution levels due to lockdowns or increased health effects due to COVID infections.