



ROAD DUST

PM₁₀ and Health Effects



NEW SEAL





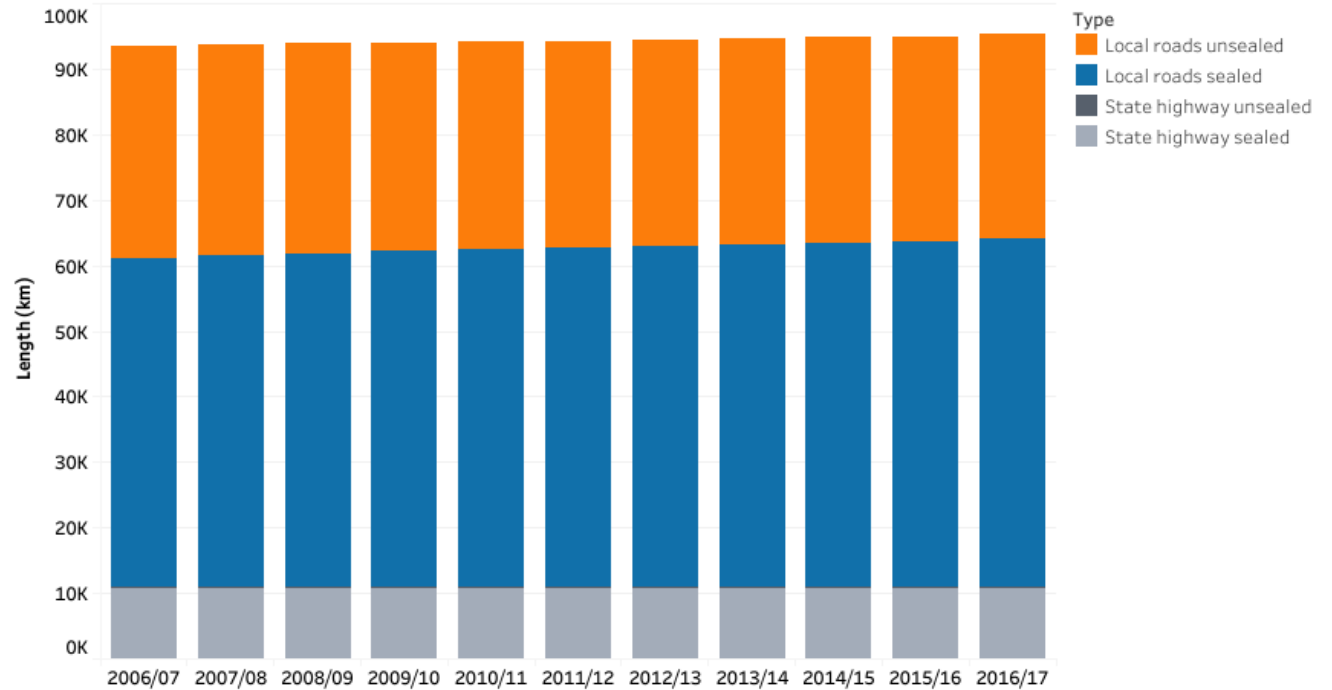
CONTENTS

- introduction
- ambient monitoring in Northland
- modelled vs measured
- health effects
- where to from here?

Unsealed roads

~ 31,000 km of unsealed roads
in New Zealand

RD001 - Length of road network, sealed and unsealed (km)

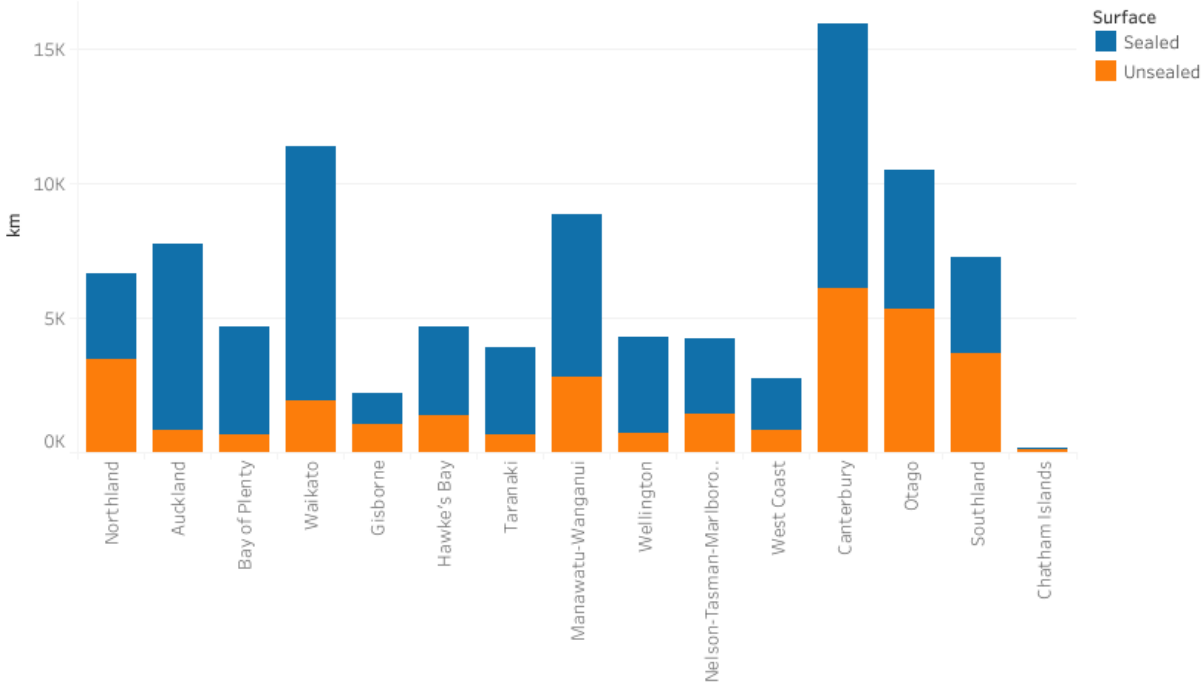


Source: NZ Transport Agency

Unsealed roads

~ 3,500km in Northland

RDO02 - Length of road network by region (km)



Source: NZ Transport Agency

adverse effects

- safety and health hazards for road users and those living or working nearby
- economic costs from reduced productivity of land, crops and livestock,
- increased road and vehicle maintenance costs
- contaminated drinking water
- soiling of houses and property, reduced amenity
- health effects

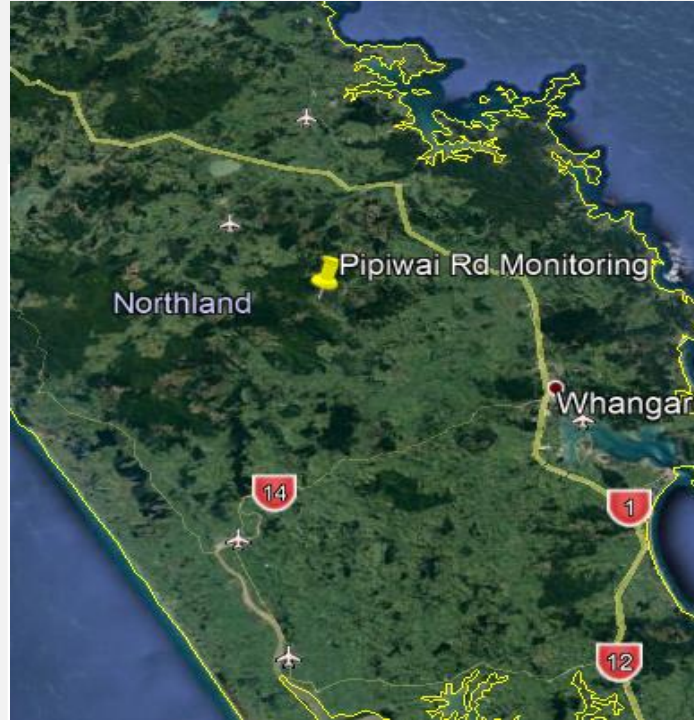


Fed up Northlanders take dusty road fight to Prime Minister



Piawai residents say dust whipped up by logging trucks is making them sick, and driving dangerous.
Source: 1 NEWS

PM₁₀
monitoring
in
Northland
(NRC and FNDC)

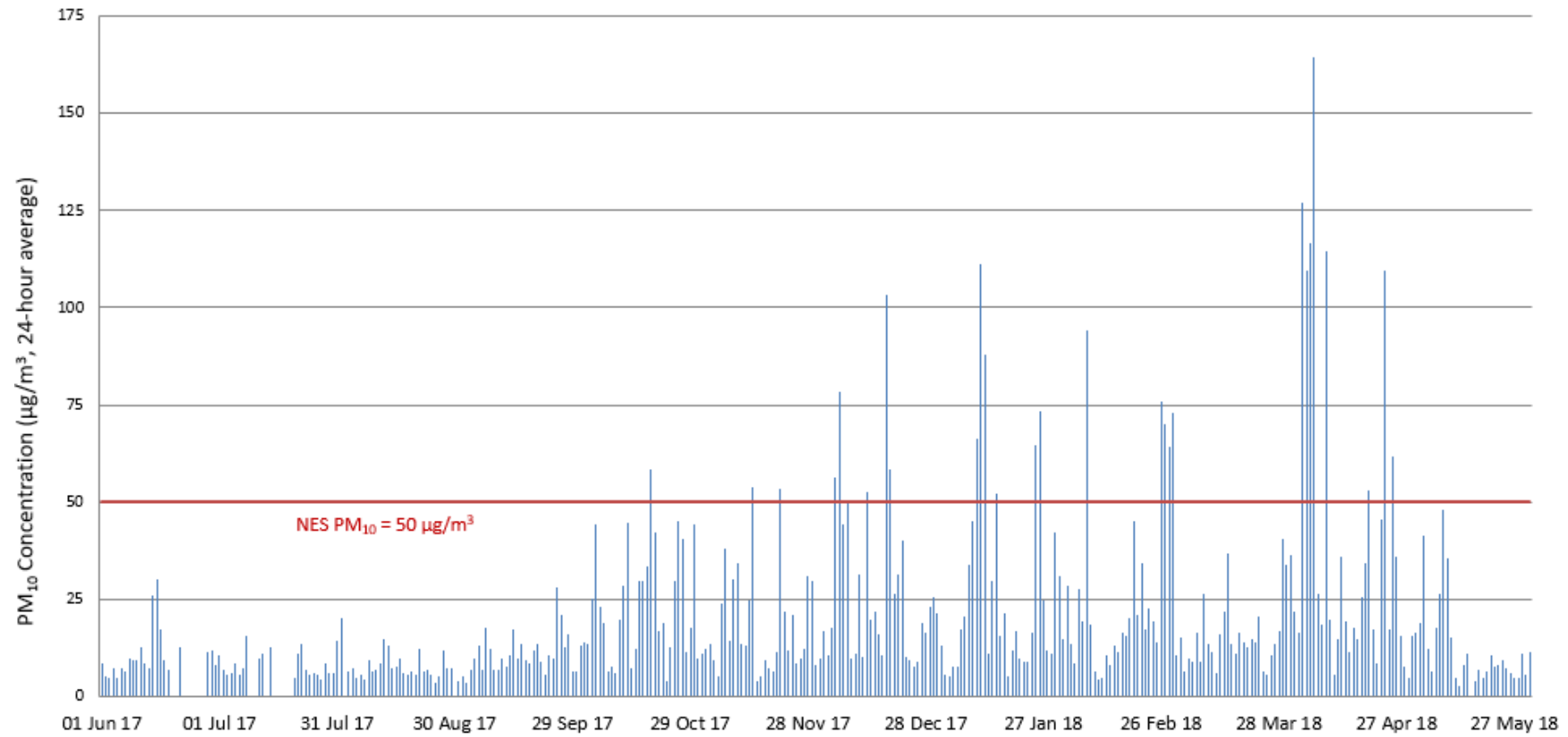




% valid data

- 91% PM₁₀ (hourly)
- 95% PM₁₀ (daily)
- 96% Wind speed/direction (hourly)

Daily PM₁₀ Levels Pipiwai Rd 1 Jun 2017 - 31 May 2018



monitoring
results

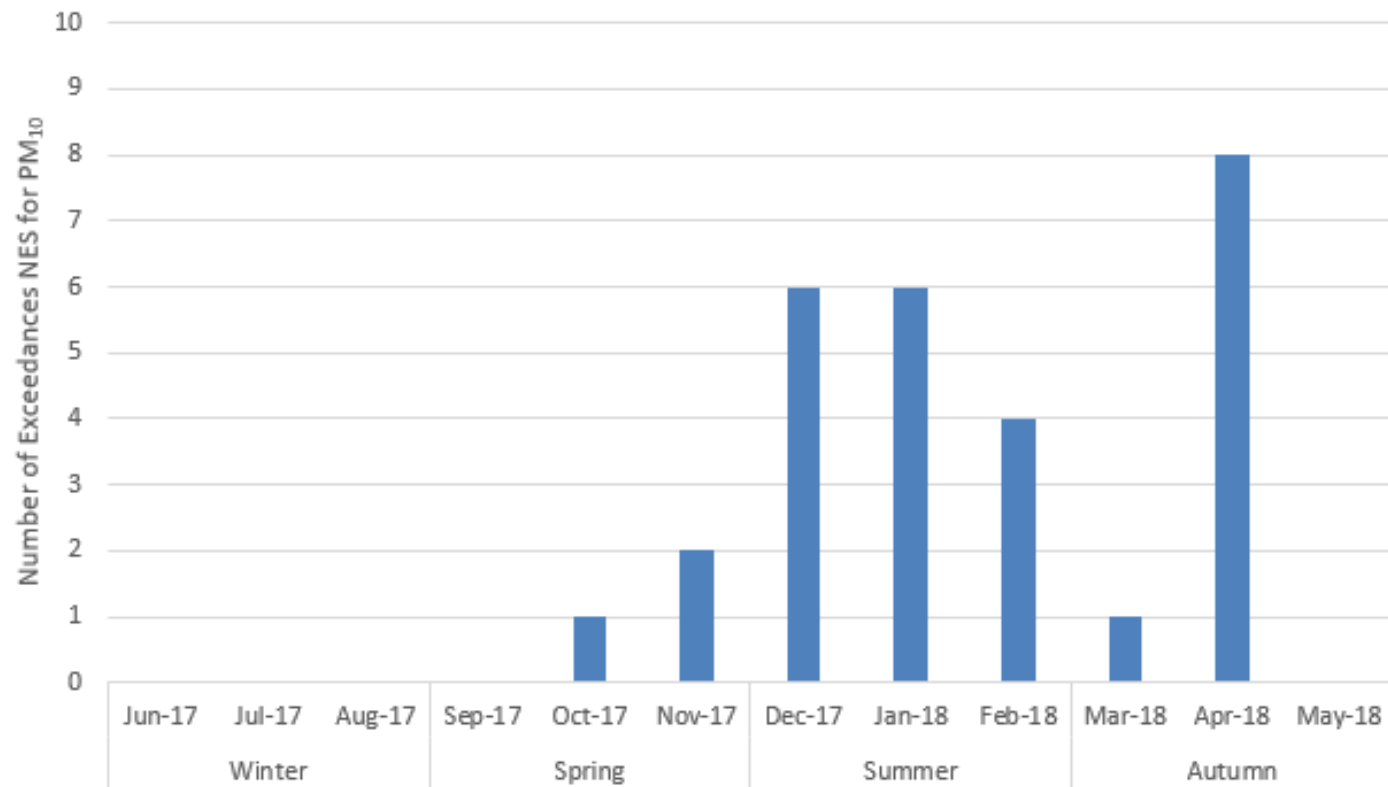
24-hour PM₁₀ 1 Jun 2017 – 31 May 2018	Concentration ($\mu\text{g}/\text{m}^3$)
Maximum	164
Second highest	127
Minimum	3
Mean (annual average)	20
Standard deviation	22
95 th percentile	64
70 th percentile	19
<i>Number of days > 50 $\mu\text{g}/\text{m}^3$</i>	28 (8%)

monitoring
results

1-hour PM₁₀ 1 Jun 2017 – 31 May 2018	Concentration ($\mu\text{g}/\text{m}^3$)
Maximum	1,101
Minimum	0
Standard deviation	44
95 th percentile	200
95 th percentile	69
70 th percentile	18
<i>Number of hours > 150 $\mu\text{g}/\text{m}^3$</i>	<i>124 (1.4%)</i>

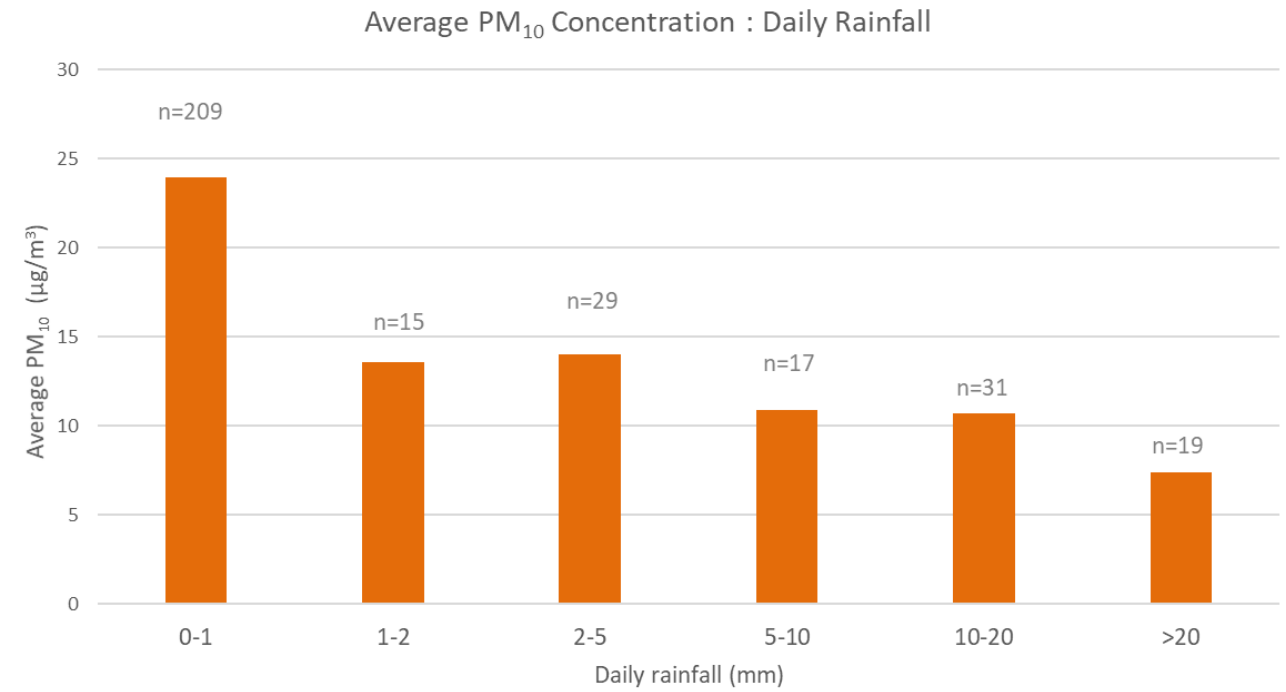
NES for PM₁₀ exceedances

1 Jun 17 – 31 May 18



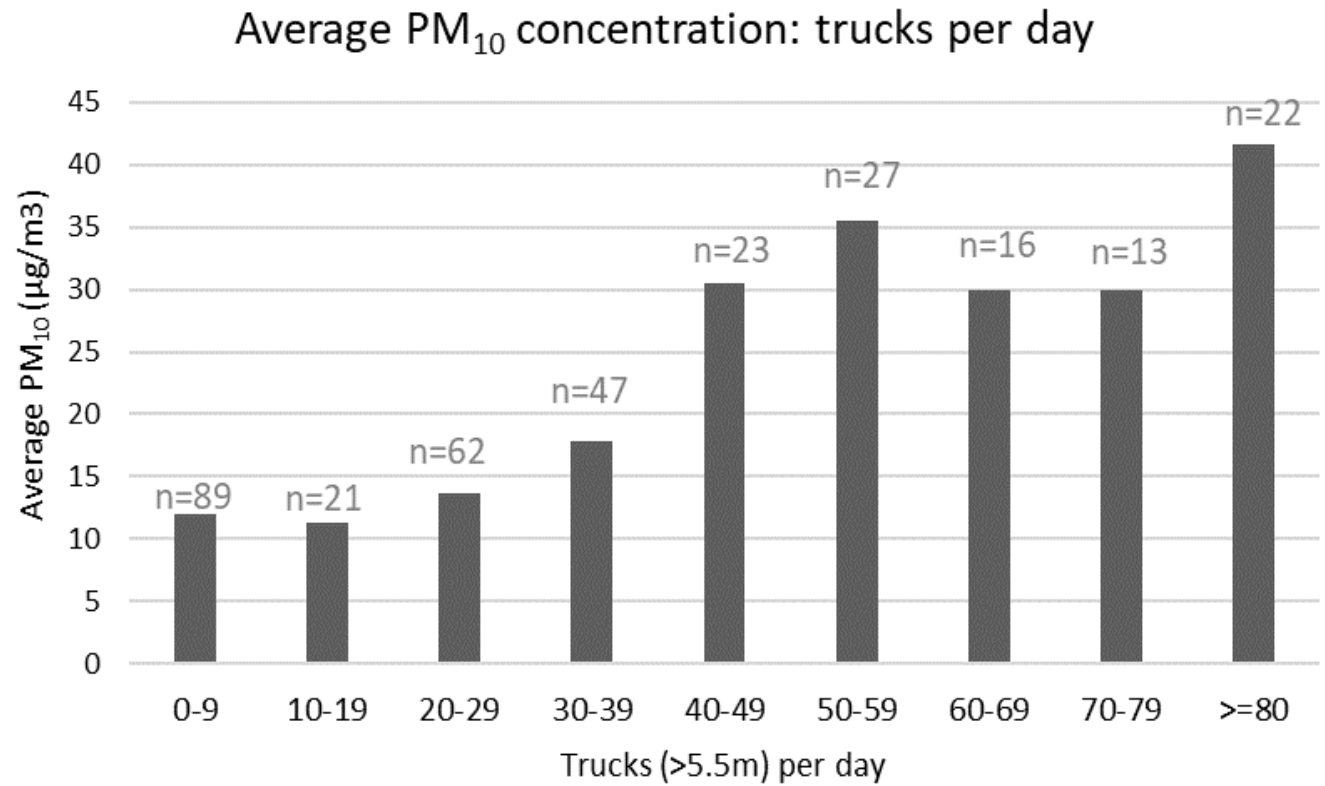
PM₁₀ highest on days when rainfall < 1mm per day

Average of Daily PM10



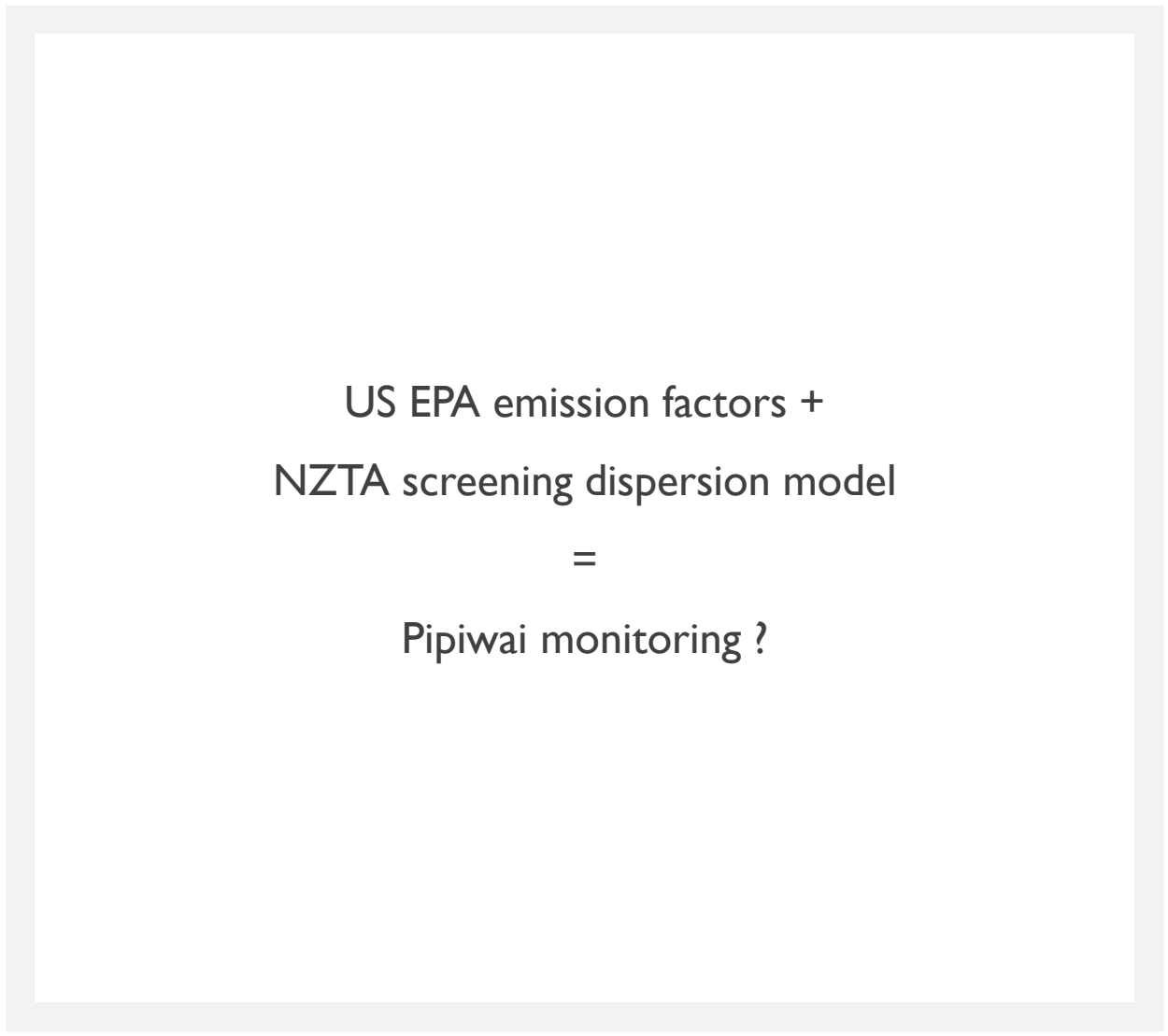
Daily rainfall ▼

PM₁₀ highest on days when there are 40, or more, trucks per day





modelled vs
measured



US EPA emission factors +
NZTA screening dispersion model
=
Piiwai monitoring ?

Emission factor

$$EF = k (s/12)^a (W/3)^b$$

Where:

k, a and b are (US EPA) constants

s = silt content

W = mean vehicle weight

Dispersion

$$24 \text{ hour } PM_{10} (\mu g/m^3) = 0.325 \exp(-0.3d^{0.5}) \times \left(\frac{AADT}{24}\right) \times EF \times 0.5$$

Where:

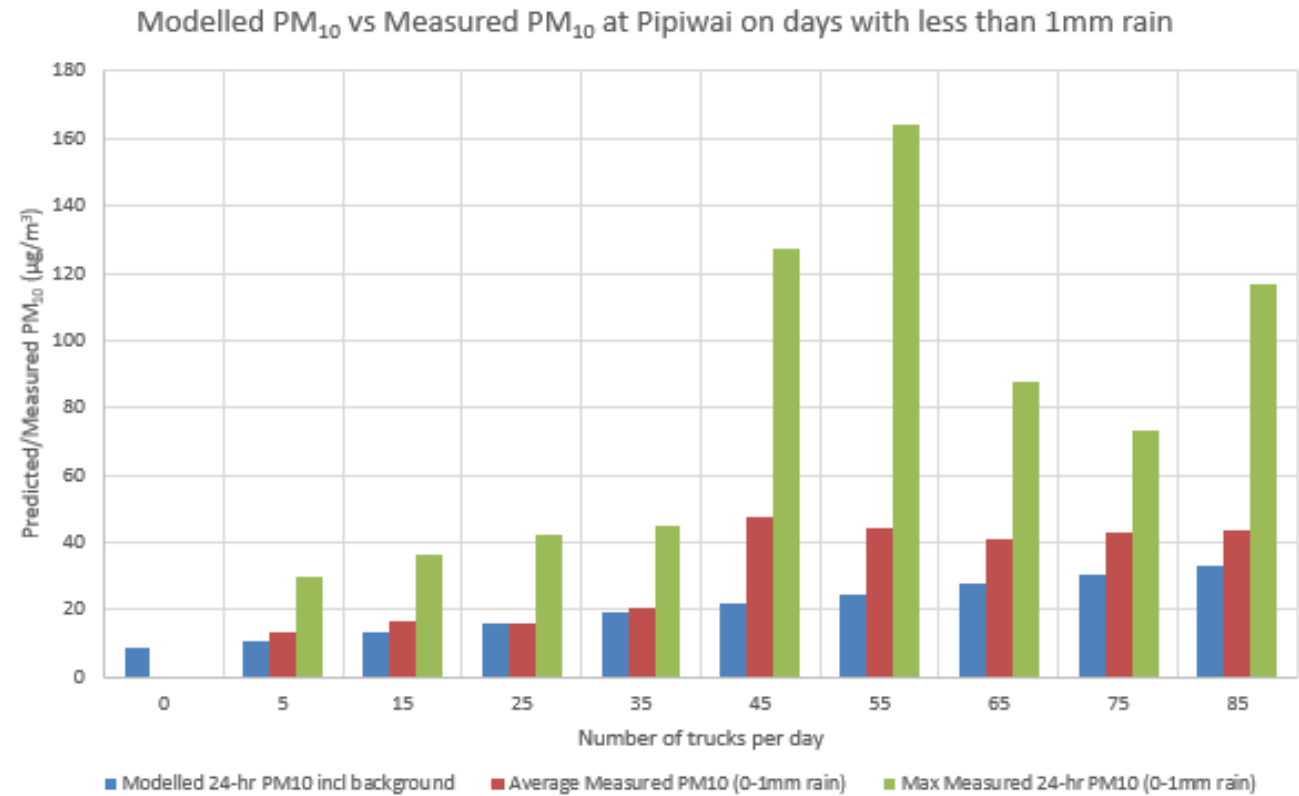
d = distance from road

EF = (US EPA) emission factor

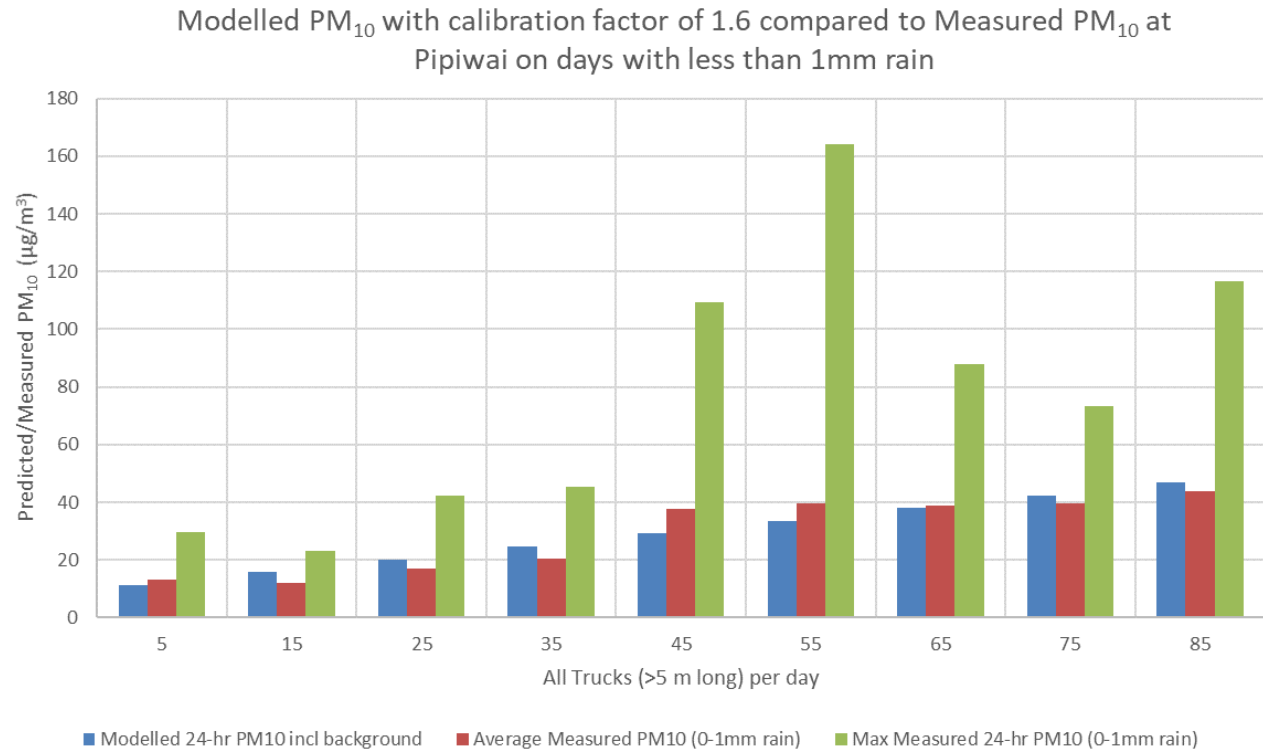
AADT = annual average daily traffic

Modelled vs measured

- Preliminary emission factor
- Model significantly underestimates maximum and average



Modelled vs measured




- “Calibrated” emission factor
- Average modelled PM₁₀ = average measured PM₁₀
- Model still underestimates maximum PM₁₀

MODELLED VS MEASURED

Annual emission factor
estimated based on
days of rain

Road	AADT (heavy)	(Calibrated) Modelled annual PM ₁₀	Background annual PM ₁₀	Modelled annual PM ₁₀ (including background)	Measured annual PM ₁₀ Pipiwai Road
	vehicles/day	(µg/m ³)			
Pipiwai Road	32	9	9	18	20 (measured)

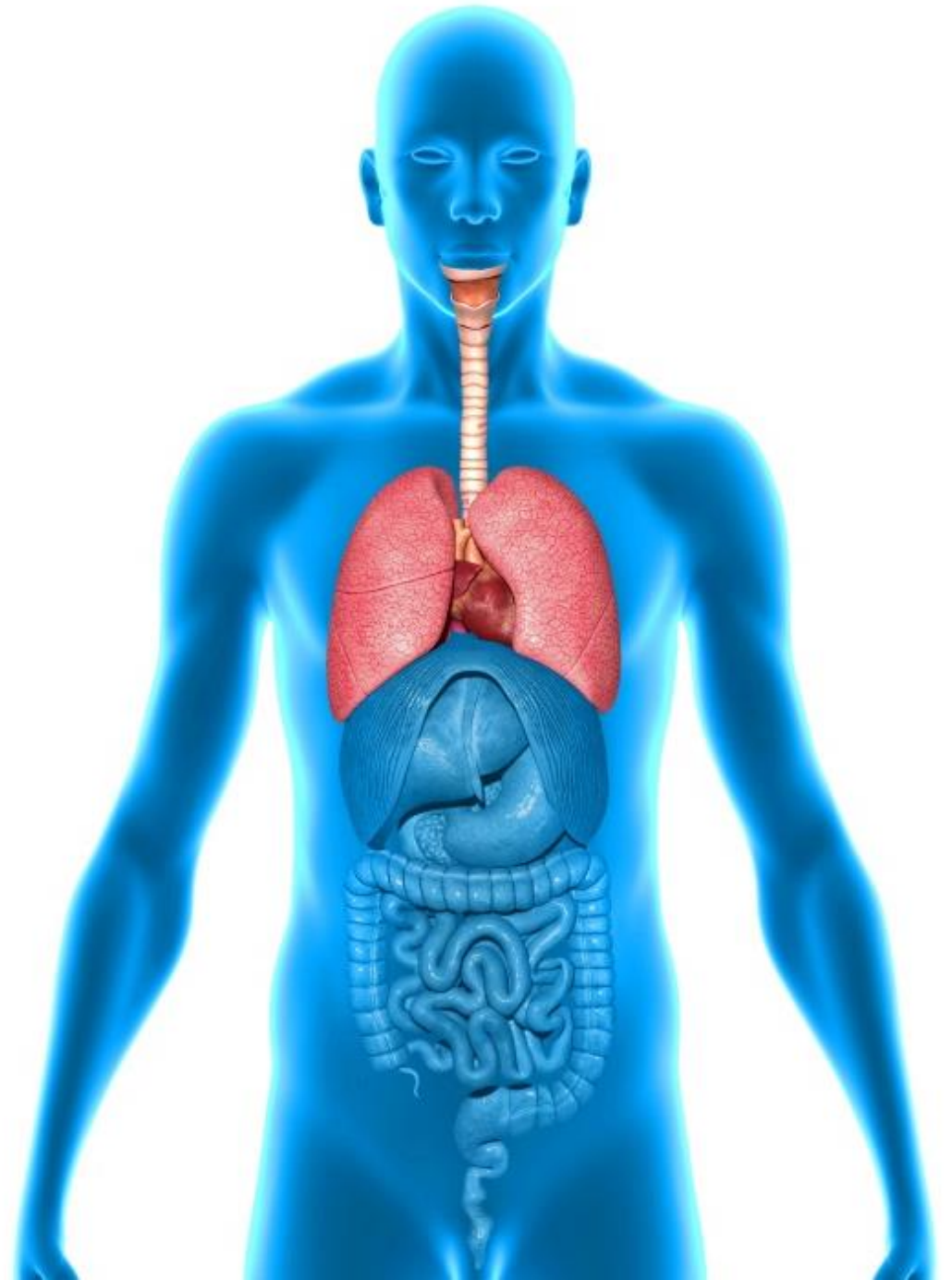


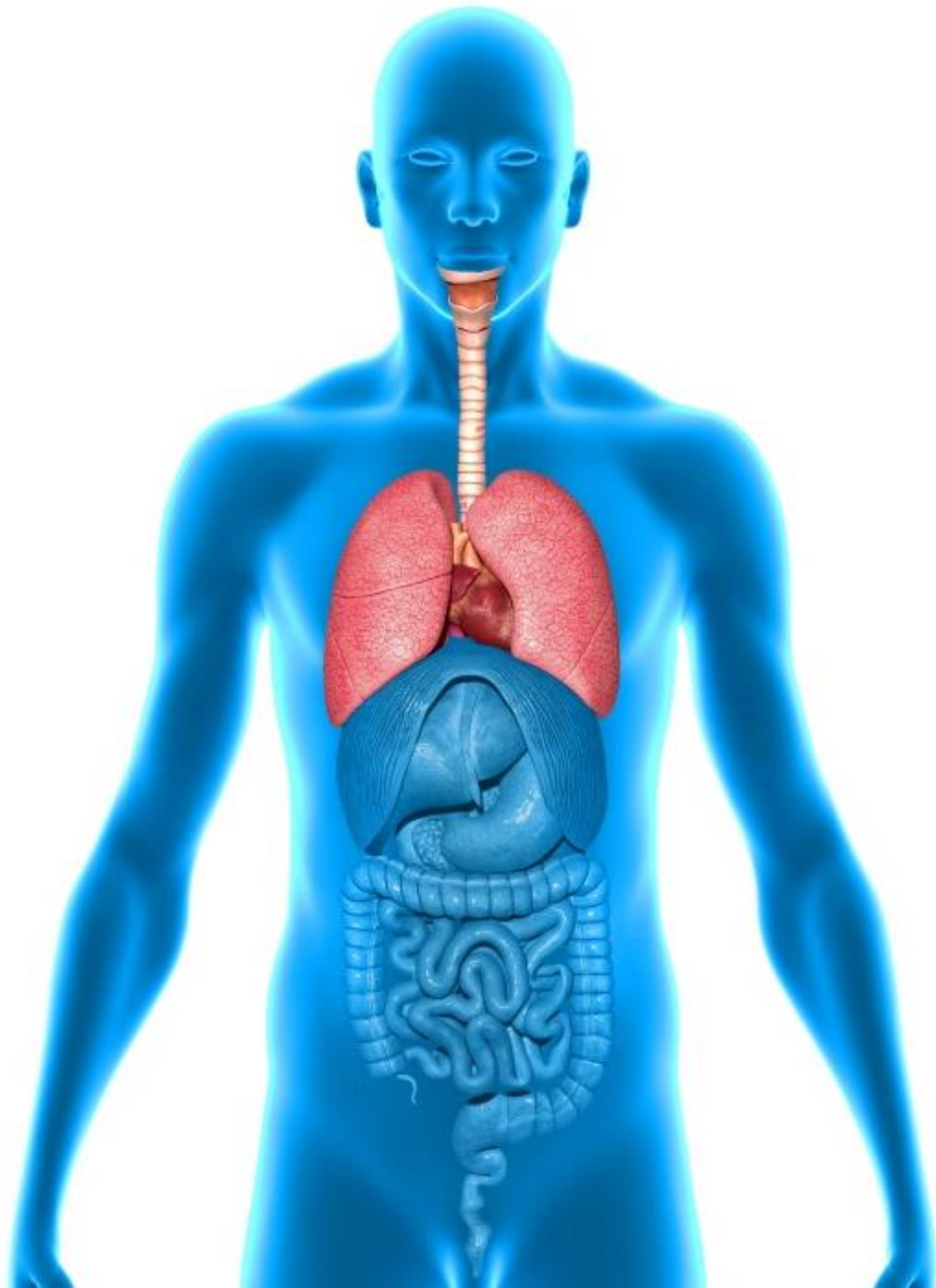
health
effects of
road dust?

current research: PM

Causative

- exacerbation of asthma
- cardiovascular morbidity
- cardiovascular mortality
- infant mortality
- lung cancer

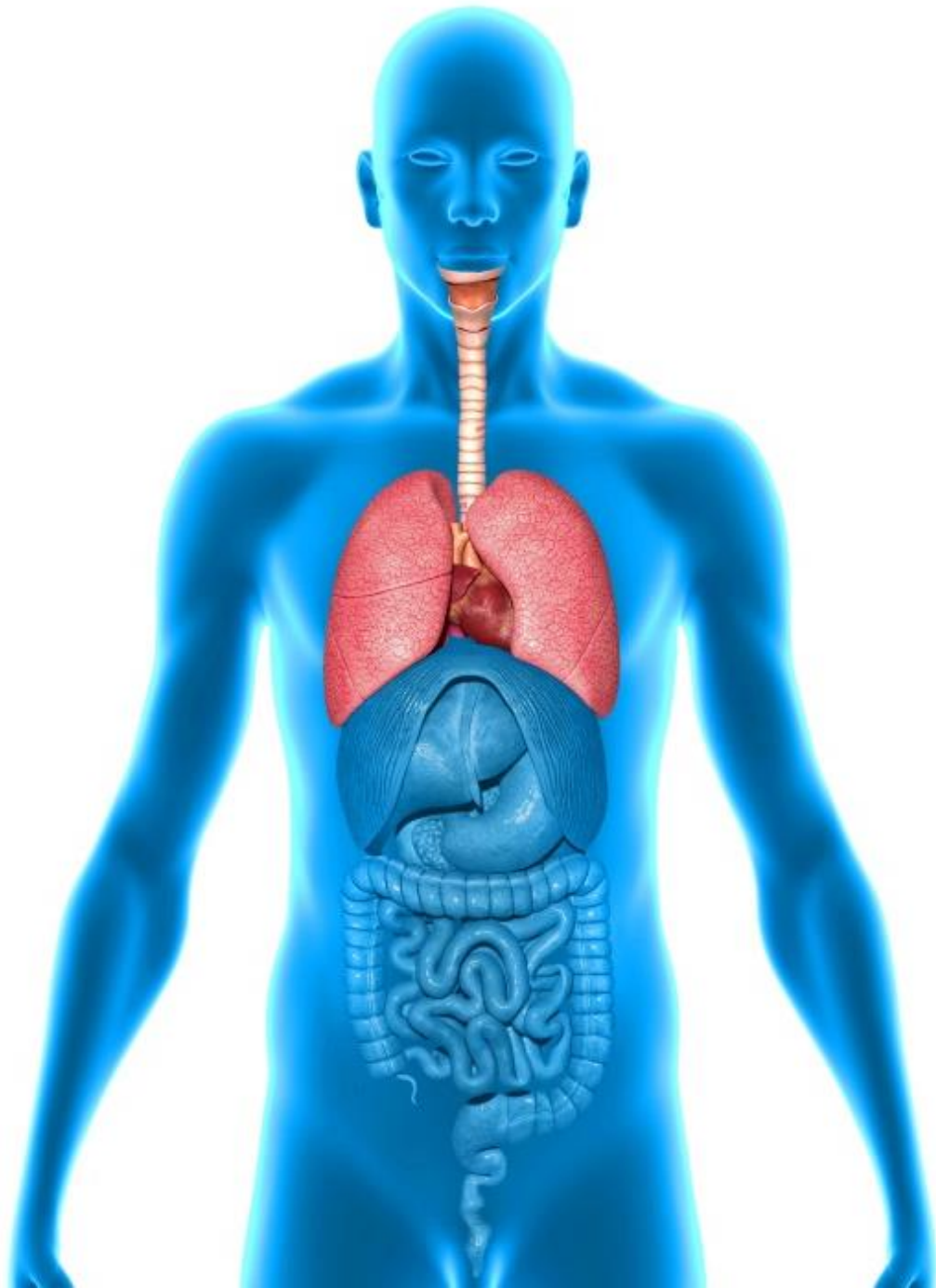




current research: PM

Associative

- artherosclerosis
- adverse birth outcomes
- childhood respiratory disease
- cognitive impairment
- neurological disorders
- diabetes
- systemic inflammation



current research: $PM_{10-2.5}$

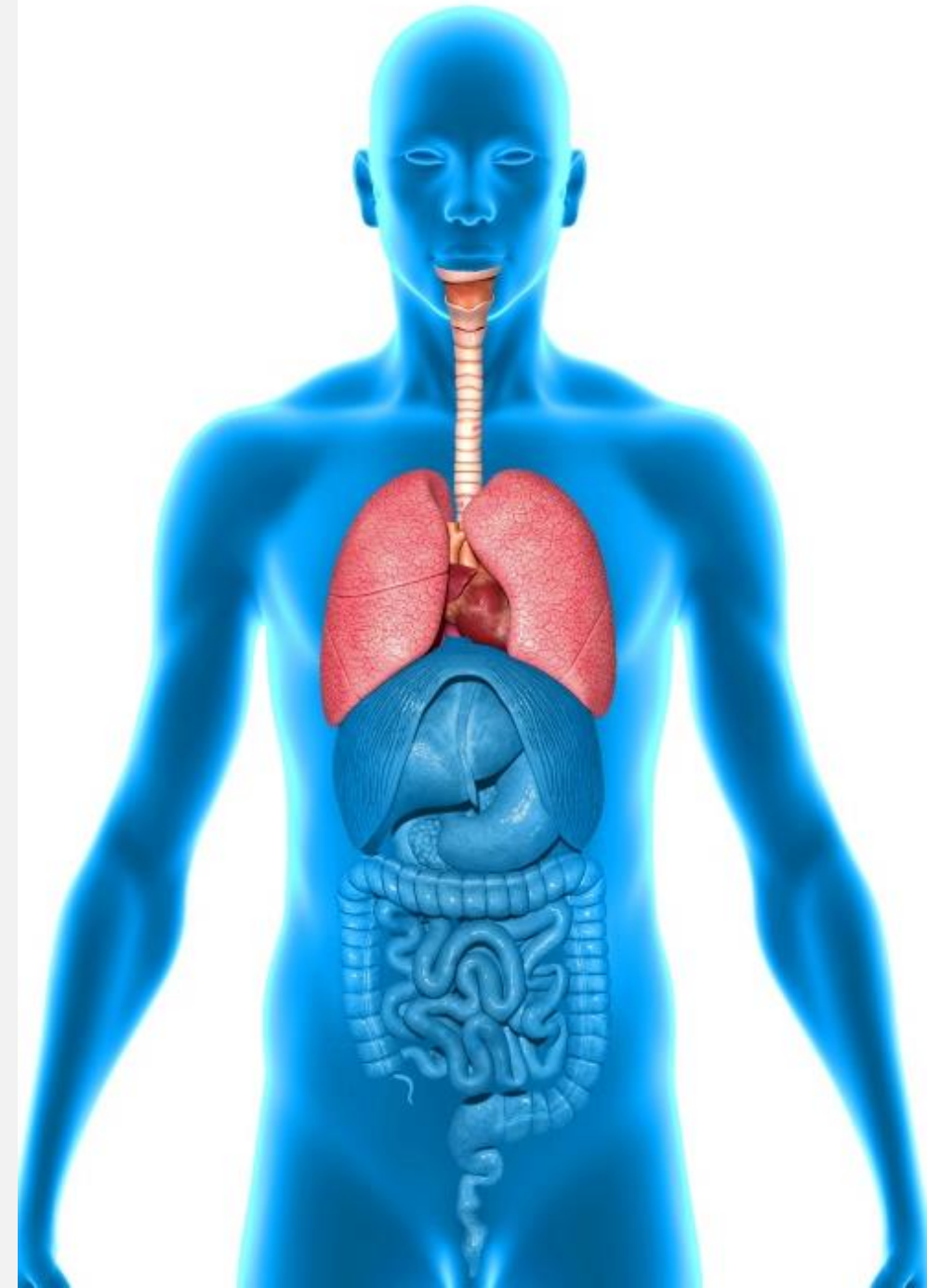
Emerging

- Focus on $PM_{2.5}$ monitoring has made research into $PM_{10-2.5}$ fraction difficult
- But, more evidence emerging of effects independent to $PM_{2.5}$ for example:
 - Association with childhood asthma (Keet et al 2017)
 - Association with cardiovascular admissions (Powell et al 2015)
 - Association with mortality (Chen et al 2019)

current research: road dust

Limited specific studies on road dust

- Studies have confirmed significant association between non-accidental mortality and daily concentration of road dust in Sweden and Canada (Meister et al., 2012, Hong et al., 2017)
- Local factors could be significantly different (spring melt)
- Hong et al., 2017 conclude that acute and chronic health effects remain unclear, which supports the maintenance of PM₁₀ monitoring networks



An anatomical illustration of a human torso, showing the respiratory system (lungs and trachea) in a reddish-pink color, set against a blue-tinted background of the rest of the body. The illustration is semi-transparent, allowing the text to be overlaid.

Health effects

For this study:

- Assume all PM_{10} is equal.
- Consistent with WHO and NZ guidance.
- Consistent with previous work (Bluett *et al.*, 2016)
 - Chronic exposure response functions from Kuschel *et al.*, 2012
- Investigate road dust specific effects:
 - Acute exposure response function from Hong *et al.*, 2017



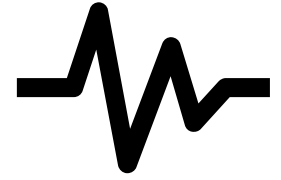
health
effects
assessment

Assumptions and data:

- Calibrated annual emission factor of 223 g per truckVKT
- NZTA screening tool dispersion model
- Distance from houses to road 30m
- FNDC data:
 - Truck VKT for each road
 - Number of houses close to each road

chronic

- non-accidental mortality 7% per 10 $\mu\text{g}/\text{m}^3$ annual PM_{10} (Kuschel, *et al.*, 2012)
- applied to all unsealed roads
- estimate 6 people every 10 years in rural Northland (only)
- \$2.74 million per annum (mortality & morbidity)



acute

Indicative assessment only based on dose response functions from a single Canadian study:

- non-accidental mortality 4.7% per $12 \mu\text{g}/\text{m}^3$ daily PM_{10} (Hong et al., 2017)
- applied to all days of Pipiwai monitoring
- 52% of chronic estimate



Limitations

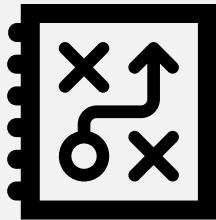


- Based on measurements at one site only
- PM_{10} vs trucks might be different at sites with different meteorology, traffic profile, speed, roading materials...
- Sensitive to assumptions e.g. average distance of houses to road, silt content of road surface, dose response relationships

limitations

Costed

- mortality & morbidity PM_{10}



Not Costed

- accidents caused by lack of road visibility
- reduced productivity of land, crops and livestock,
- increased road and vehicle maintenance
- contamination of drinking water
- reduced amenity due to soiling of houses and property

Recommendations



More monitoring



Improve and extend exposure assessment



Further investigation of dispersion modelling results and emission factors



More thorough economic assessment

The surprising stat from driving in the country

DUSTY ROADS KILL

Imran Ali

Dust from unsealed roads is killing an estimated one Northlander every two years and costing the health sector nearly \$3 million annually, a new study has found.

The study, a first in New Zealand and prepared by Emission Impossible for the Ministry of Health, assessed chronic health impacts and costs of exposure to air pollution from all unsealed roads in Northland.

It showed the national environment standards in Northland were breached 27 times when just one breach was allowed within 12 months.

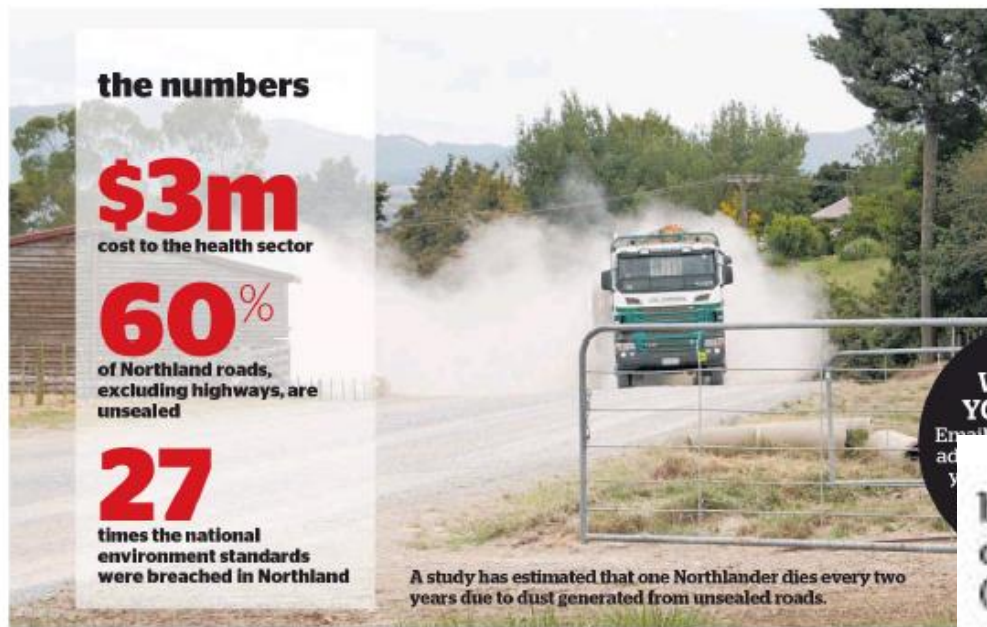
A mixture of extremely small particles and liquid droplets – both organic and inorganic such as dust, pollen, soot, smoke and liquid suspended in air, many of which are hazardous – are taken into consideration when measuring air pollution.

Sixty per cent of Northland's 5880km of roads, excluding 750km of state highways, are unsealed.

Authors of the study estimated the annual cost of health impacts from long-term exposure to dust near all unsealed roads in Northland at \$2.7m, based on cases of premature mortality, cardiovascular, respiratory and hospital admissions, and restricted activity days.

The annual cost of premature mortality was estimated at \$2.72m, cardiovascular hospital admissions \$950, respiratory hospital admissions \$957 and a further \$15,000 for restricted activity days.

The Pipiwai Titoki Advocacy for Community Health and Safety Group



is calling on the Northland Regional Council to carry out more dust monitoring near unsealed roads.

Group spokeswoman Alex Wright, who fought for years to get Wright Rd, where she lives, sealed, said her members knew first-hand how bad air quality was from living next to an unsealed road and fighting for it to be sealed.

The Northland Regional Council said it was meeting its statutory obligations to check air quality and

did more monitoring for dust particles adjacent to unsealed roads than any other council in New Zealand.

"The regional council, the Northland District Health Board and the Whangārei, Far North and Kaipara District Councils recognised some years ago there are both nuisance and potentially health-related problems associated with dust from unsealed roads," NRC Regulatory Services Manager Colin Dall said.

Dall said that, in 2014, Northland Regional Transport Committee which included representatives from four Northland councils and the Zealand Transport Agency – proved the Regional Dust Unsealed Roads Mitigation Framework.

"Under this framework, the regional council monitors dust on unsealed roads and provides monitoring results to the relevant district councils to help them

prioritise sites for dust mitigation measures."

Dall said the NRC carried out the monitoring every summer, when dust issues were typically at their worst, and has monitored a total of 35 roadside sites since 2013.

He said the NRC consulted with district councils to identify potential monitoring sites and contacted nearby property owners to find out if they were prepared to have a dust monitor deployed on their property and provide the power supply required to operate the monitor.

Anil Shetty, public health strategist at the Northland District Health Board, said the latest re-

WHAT DO YOU THINK?

Errol... ac... y

"Northland Public Health have been actively advocating to address dust generated by heavy vehicular (forestry) movements on rural unsealed roads, especially along the unsealed roads with higher population density," Shetty said.

Northland DHB was actively working with community groups affected by unsealed roads, he said, and had made several submissions to the territorial authorities in the region in recent years.



MANATŪ HAUORA

Louise Wickham & Jayne Metcalfe

emission:
impossible^{ltd}