

ROAD DUST

PM₁₀ and Health Effects





- 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

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







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







% valid data

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



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



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



I-hour PM™ I Jun 2017 – 31 May 2018	Concentration (µg/m ³)
Maximum	1,101
Minimum	0
Standard deviation	44
95 th percentile	200
95 th percentile	69
70 th percentile	18
Number of hours > 150 μ g/m ³	124 (1.4%)



Average of Daily PM10

PM₁₀ highest on days when rainfall <Imm per day



Daily rainfall 🛛 🔫





Average PM₁₀ concentration: trucks per day

modelled vs measured

US EPA emission factors + NZTA screening dispersion model

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

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 PM₁₀ vs Measured PM₁₀ at Pipiwai on days with less than 1mm rain



Modelled vs measured

- "Calibrated" emission factor
- Average modelled $PM_{10} =$ average measured PM_{10}
- Model still underestimates . maximum PM₁₀

MODELLED VS MEASURED

Annual emission factor estimated based on days of rain

	Road	AADT (heavy)	(Calibrated) Modelled annual PM10	Background annual PM10	Modelled annual PM10 (including background)	Measured annual PM10 Pipiwai Road	
		vehicles/day	(µg/m³)				
1	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

Source: Review of evidence on health aspects of air pollution (WHO, 2013)



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





Health effects

For this study:

- Assume all PM₁₀ 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 truck VKT
- 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 μg/m³ annual PM₁₀ (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 μg/m³ daily PM₁₀ (Hong et al., 2017)
- applied to all days of Pipiwai monitoring
- 52% of chronic estimate



Limitations

- Based on measurements at one site only
- PM₁₀ 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 PM₁₀



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





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

ust 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 the numbers





times the national environment standards were breached in Northland

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

Group spokeswoman Alex Wright, who fought for years to get Wright Rd, where she lives, sealed, said her land District Health Board and the

members knew first-hand how bad Whangārei, Far North and Kaipara air quality was from living next to an District Councils recognised some unsealed road and fighting for it to years ago there are both nuísance and be sealed. potentially health-related problems

The Northland Regional Council associated with dust from unsealed said it was meeting its statutory roads,* NRC Regulatory Services obligations to check air quality and Manager Colin Dall said.

did more monitoring for dust Dall said that, in 2014, Northla Regional Transport Committe particles adjacent to unsealed roads than any other council in New Zeawhich included representatives

A study has estimated that one Northlander dies every two

years due to dust generated from unsealed roads.

"The regional council, the North-

Zealand Transport Agency proved the Regional Dust Unsealed Roads Mitigation Fr work.

"Under this framework, the gional council monitors dust unsealed roads and provides monitoring results to the rele district councils to help ther

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

WHAT DO

YOU THINK?

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

"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 populafour Northland councils and the tion 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

Nothern Advocate, 24 July 2019



MANATŪ HAUORA

thank you

Louise Wickham & Jayne Metcalfe

