TOOLS FOR ASSESSING EXPOSURE TO LAND TRANSPORT EMISSIONS

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PART TWO | IMPACTS

2.2 AIR QUALITY

OBJECTIVES

A1 Understand the contribution of vehicle traffic to air quality.

A2 Ensure new state highway projects do not directly cause national environmental standards for ambient air quality to be exceeded.

A3 Contribute to reducing emissions where the state highway network is a significant source of exceedances of national ambient air quality standards.

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The “Roadside Corridor”

Zone up to 200 m along major roads
Up to 2 times more traffic air pollution
Up to 2 times rates of childhood asthma (US/EU studies)
Existing assessment tools

Roadside Corridor Model (RCM)
- Model hourly winds for 2 years

- Prevailing winds give different results on each side of road
Rotate the road and repeat
Results: parameterised power law

Annual mean concentration per unit emission = $A \times distance^{-B}$

$A$ and $B$ depend on
- time of day
- road orientation
- Local climate
RCM Conclusions

• Different wind climate leads to ~1/3 more roadside dispersion in WTN than AKL
• Road orientation makes up to
  – ~25 % difference in Auckland
  – ~40 % difference in Wellington
• Cross-road difference (at 20 m) up to
  – 39 % in Auckland
  – 36 % in Wellington
• Morning peak dispersion proportionally weaker in AKL than WTN
Using Roadside Corridor Model to define corridor widths for Auckland

<table>
<thead>
<tr>
<th>AADT</th>
<th>Corridor width</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,000</td>
<td>25 m</td>
</tr>
<tr>
<td>40,000</td>
<td>50 m</td>
</tr>
<tr>
<td>100,000</td>
<td>200 m</td>
</tr>
</tbody>
</table>
Using RCM to compare scenarios: SH20
(Population-weighted) exposure to an Auckland motorway

Scenario 1: PM$_{10}$ without WRR

Scenario 2: PM$_{10}$ with WRR

NZTA Research Report 451

Taihoru Nukurangi
Population Exposure Distributions

Distribution of population experiencing differences in exposure between scenarios 1 and 2

NZTA Research Report 451
Contribution of commuting to daily inhaled dose of airborne particles

- Home: 34.8%
- Commuting: 25.5%
- Office: 26.8%
- Lunchtime: 2.4%
- Cooking: 10.5%
Monitoring in-car exposure
Typical mapped time series

Direction of travel

Particle Number Concentrations:
- 2168 - 5790
- 9791 - 9740
- 9231 - 15329
- 15261 - 23250
- 22560 - 22100
- 32100 - 40100
- 40160 - 60000
- 65600 - 76000
- 76900 - 118000
- 119000 - 264000

Particle Number Concentrations:
- 3110 - 5170
- 5171 - 7240
- 7241 - 9650
- 9530 - 13000
- 13001 - 16000
- 16001 - 21000
- 21001 - 25000
- 25001 - 30000
- 30001 - 36000
- 36001 - 30700
- 30701 - 45500

NIWA
Taihor Nukurangi
Key features #1: encounters with “gross emitters”

- 3 minutes behind bus doubled journey exposure
Key features #2: importance of intersections

Vehicle in front accelerating

Polluted air trapped in car for 4 km
Effect of ventilation

Right: effect of ventilation and speed on Air Exchange Rate (AER) in two cars

Left: effect of AER on infiltration of pollution into cabin
Summary of results

1. In-car concentrations usually lower than on-road, but higher than roadside
2. Can be very high if behind gross emitter
3. Higher in-car than for cyclist (cabin traps pollutants) – see also NZTA Research Report 457
4. Highest in-car pollution
   a) on motorways,
   b) Stop-start town centre driving
   c) Queen Street, Auckland (deep street canyon)
The NZTA project ends here...

...but the research goes on!
Observational corroboration
NZTA-co-funded project 2010-12
Multiple traffic sources: Traffic Impact Model (ongoing R&D)
Terrace Tunnel in-car model study

\[
\frac{dN(t)}{dt} = (A \nu(t) + B)(N_{\text{out}}(t - t_{\text{lag}}) - N(t)) - kN(t)
\]
Thanks for your attention

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Extra slides
4 ventilation settings (same vehicle, same journey)

![Graph showing journey mean N/cm³ for different ventilation settings: normal, high fan, open window, recirculate. The graph includes data for internal (int) and external (ext) environments.](NIWA-Avondale & back)