

HUMAN EXPOSURE TO HARMFUL CONTAMINANTS FROM VEHICLES

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Keywords: harmful emissions, reporting, trends, exposure

1. Introduction

The New Zealand Transport Agency (the Agency) is developing its evidence base to respond to the New Zealand Government Policy Statement (GPS) on Land Transport 2018, Environment Strategic Priority. The GPS includes reporting measures for the national land transport objective of:

'a land transport system that reduces greenhouse gas emissions, as well as adverse effects on the local environment and public health'

Harmful effects of contaminants from vehicles on human health range from breathing problems to premature death of susceptible people. It was found that 22% of all social costs from anthropogenic air pollution are attributed to motor vehicles. More than 256 people in New Zealand are estimated to die prematurely every year due to emissions from motor vehicles (Kuschel et al. 2012).

The Agency has invested in tools to support reporting for the GPS measures. Reporting requires estimating the tonnes of greenhouse gas emissions and harmful emissions; and predicting exposure to harmful air pollutants from land transport. Applications also include tracking progress over time with the Transport Outcomes Framework outcomes for 'healthy & safe people' and 'environmental sustainability' developed by the Ministry of Transport (2018).

The new tools for estimating exposure to harmful emissions have been built up from the Agency's investment in the National Vehicle Emissions Database (NVED). The NVED is an automated tool that calculates and maps both harmful air pollutants and carbon dioxide emissions. The potentially harmful contaminants estimated within the tool are nitrogen dioxide (NO₂), oxides of nitrogen (NO_x), carbon monoxide (CO), and particulate matter as PM₁₀ and PM_{2.5}. The exposure estimate component of the work is focused on NO₂, PM₁₀ and PM_{2.5}.

The tool estimates emissions from all public roads throughout New Zealand and is being updated on an annual basis to monitor and report on trends.

This paper explores the add-ons to the NVED tool to enable reporting of transport emissions, which are being used to inform and shape transport strategic interventions to reduce the adverse impacts of

greenhouse gases and harmful emissions from transport.

2. Recent Developments

The tool inputs relate to road asset information obtained from the Agency and local authority road asset management systems: traffic counts, fleet profile and average speed. The tool takes gradient data and uses the Vehicle Emissions Prediction Model (VEPM) to calculate emissions in grams per kilometre of road.

Further developments of the calculation tool have been staged with add-ons to the NVED incorporating:

1. Conversion of emissions to roadside concentration and raster graphics
2. An estimator to identify dwellings located along the roadside
3. Estimates of the spatial distribution of background concentrations
4. Addition of road concentrations to background concentrations combined with population to estimate human exposure to harmful contaminants.

Converting emissions data to concentrations has been enabled using the UK Highway Agency's Design Manual for Roads and Bridges (DMRB) methodology, which was used to predict annual average NO_x as µg/m³.

NIWA has updated the NO_x to NO₂ conversion ratio empirical equation for NO_x to NO₂ near roads from the *Good Practice Guide for Assessing Discharges to Air from Land Transport* (MfE, 2008) using the latest available monitoring data.

The tool has incorporated updated background concentrations for NO₂, which are used to estimate cumulative concentrations combined with road contributions. NO₂ background updates have been provided by NIWA from their National Model of NO₂ from Road Traffic. Updated background data sets for PM₁₀ and PM_{2.5} are still under development.

Jacobs has developed a dwelling estimator that automates a process for identifying a dwelling count with distance from the road. Meshblock population data is applied to the dwellings in each meshblock.

3. Outputs

The NVED maps the emissions for state highway and local roads nationally. The NVED is now available for the years 2016, 2017 and 2018; so trend data is emerging. Due to the automation provided within the NVED, it is relatively simple to back cast and update the data sets, such as when a new version of VEPM is released.

The NVED outputs can be readily separated out for reporting and analysis such as emissions by heavy vehicle or light vehicle; or diesel, petrol and hybrids. Reports for different spatial areas can also easily be generated to produce emissions such as by region or district, urban areas or airshed.

Figure 1 is an example of a pollutant concentration output showing the concentration gradient with distance from the road.

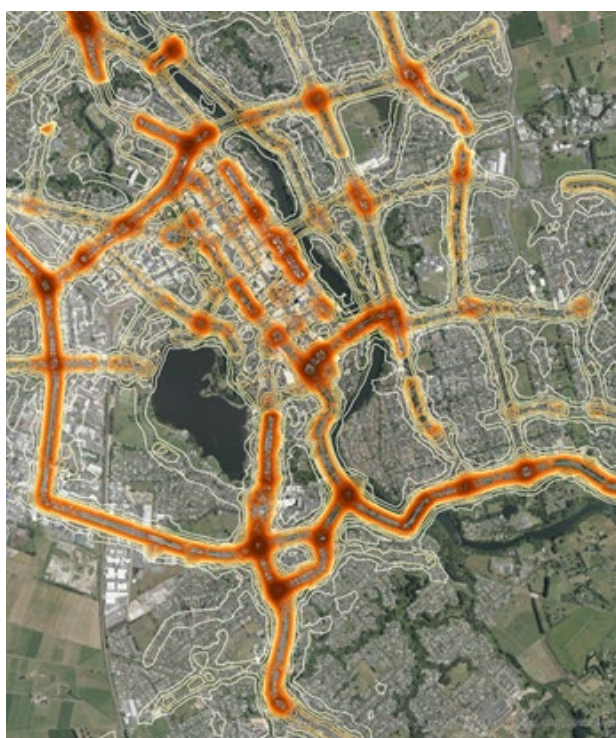


Figure 1. Example pollutant concentration output

The dispersion algorithm is applied to a series of receptor points out to 200 metres for all roads. Concentrations at intersections are combined in accordance with the UK's DMRB screening methodology. Spatial interpolation is then applied to receptor points to produce emission concentration contours and a raster-based emission concentration output.

4. Next Steps

The Agency has a programme of ongoing work to further develop, validate and apply the emission estimation tool to assist in managing emissions from land transport. The tool achieves this by providing a baseline, predicting the impacts of interventions to

inform policy, and tracking progress aimed at reducing emissions.

Validation of the NVED includes comparing emission estimates with equivalent data from territorial authority air emission inventories. In addition, predicted pollutant concentrations from the NVED (road traffic contribution) will be compared with monitoring data appropriate for road traffic contributions.

Pollutant concentration maps with human exposure are in progress and will provide annual mean concentration estimates for NO₂. The Agency's intention is that exposure maps will be a representation of the number of people exposed to elevated road transport-related air pollution. This will be extended in time to include PM₁₀ and PM_{2.5}.

Critically, the NVED tool and add-ons will enable the Agency to achieve annual reporting for the GPS measures:

1. Tonnes of greenhouse gas and harmful emissions emitted per year from land transport.
2. The number of people living close to transport infrastructure who are exposed to elevated concentrations of land transport-related air pollution.

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