Mapping the Environmental Impact of Land Transport
Stormwater Run-off, Road Traffic Noise and Vehicle Emissions

NZ ESRI Users Conference Transport Special Interest Group Workshop 2019
Sky City, Auckland
12th August 2019

Rob Hannaby
NZ Transport Agency
Lead Advisor – Environment
rob.hannaby@nzta.govt.nz
# Overview

1. Exploring the challenges
2. Case studies

<table>
<thead>
<tr>
<th>Stormwater Run-Off and Roads</th>
<th><img src="image1" alt="Map" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Traffic Noise</td>
<td><img src="image2" alt="Map" /></td>
</tr>
<tr>
<td>Vehicle Emissions</td>
<td><img src="image3" alt="Map" /></td>
</tr>
</tbody>
</table>
# Transport Evidence Base

## Figure 8: Theme Overview – Transport Impacts

### Knowledge needs
Better understanding the size, exposure, valuation, interactions and influences of social, economic, cultural (including transport impacts for Māori as tangata whenua) and environmental impacts as well as the potential effects from mitigations.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Related enabling question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport Impacts</td>
<td></td>
</tr>
</tbody>
</table>

### High-priority initiatives

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Description</th>
<th>Impact</th>
<th>Breadth of applications</th>
<th>Strategic value</th>
<th>Right resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quick wins</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R11.9</td>
<td>Improve environmental impact evaluation around run-off of vehicle pollutants on road</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R11.2</td>
<td>Develop environment impact framework for emissions and infrastructure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other high-priority initiatives</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R11.1</td>
<td>Research into transport emissions profiles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R10.1</td>
<td>Develop health and safety risk profiles and exposures that lead to transport-related harm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Stormwater Run-off and Roads

courses (Our fresh water 2017). Stormwater can contain elevated concentrations of heavy metals (Lewis et al. 2015), coming from vehicles (copper from brake pads and zinc from tyres), metal roofing, and industrial yards (Kannadly & Sutherland, 2008). Wastewater and stormwater can also contain many other pollutants including personal care products, medicines, and plastics that were washed into waterways.

The extent to which stormwater and wastewater pollutes fresh water is determined by how much land is covered by solid surfaces like roofing, asphalt, and concrete. These impervious surfaces reduce the amount of rain that soaks into soils and aquifers, and increase the amount entering the stormwater system.

Our environment is polluted in urban areas

Some of our cities and towns have polluted air, land, and water. This comes from home heating, vehicle use, industry, and disposal of waste, wastewater, and stormwater. Pollution affects ecosystems, health, and use of nature.

Why does this issue matter?

- **Spatial Extent**: It can apply to all cities and towns.
- **Departure from Natural Conditions**: The type and severity of pollution varies from place to place and over time.
- **Irreversibility**: It is challenging to reverse because changing our cities and lifestyles would require significant investment and changes in behaviour.

- **Impacts on What We Value**: There is high risk to human health and cultural well-being, practices, and knowledge because 80 percent of New Zealanders live in urban centres. Fresh water, marine, air, and atmosphere can all be affected.
- **Knowledge Gaps**: Data for all pollutants in urban areas is lacking. Their cumulative impacts on human health, ecosystems, and cultural well-being are not known.
Road Traffic Noise

Traffic noise increases risk of heart attack, researchers find

12:44 PM Monday Jul 11, 2016

Exposure to traffic noise increases the risk of suffering from a heart attack, researchers have found.

Figure 7.1 People affected by transport noise in agglomerations > 250,000 inhabitants (EU-27)

Almost 67 million people (i.e., 55% of the population living in agglomerations with more than 250,000 inhabitants) are exposed to daily road noise levels exceeding 55 dB L_{eq} (the lower benchmark for the combined noise indicator). Daily exposure to railway noise and airport noise in these agglomerations is lower but still significant, with respectively 5.6 and 3.2 million people exposed to levels above 55 dB L_{eq}. With almost 48 million people exposed to levels exceeding 50 dB L_{eq,night} (the lower benchmark for nighttime noise) road noise is also by far the largest source of exposure to nighttime transport noise.

Queen St contains highest levels of black carbon in NZ

Downtown Auckland appears to be serving as a basin for air pollution, including high levels of potentially deadly black carbon.

Annual average nitrogen dioxide concentrations at NZ Transport Agency monitoring sites 2010–16

Note: Dotted line shows WHO long-term guideline; shading shows 95% confidence intervals. No exceedances are displayed due to averaging. Only sites that met data completeness criteria are displayed.

Data source: NZ Transport Agency, National Institute for Water and Atmospheric Research
Challenge and Response

The Challenge

• Transport can create a range of public health, ecological, social and cultural impacts.

• Most impacts are experienced at the local scale but often require a management response at the regional or national level.

• Efficient and effective management requires comprehensive measurement of such impacts in space and time.

• Whilst there are numerous measurement frameworks, there remains the enduring problem of collecting, reporting and analysing such data in a way that enables multiple stakeholders, often working in apparently unrelated disciplines, to understand the relevance of the data to them and any ‘call to action’.

The Response

• Innovative use of Geographical Information Systems (GIS).
5.9 Conclusions from case study

Conclusions from applying the RSS model in the case study area are as follows:

5.9.1.1 Rivers and streams risk assessment

The majority of sub-catchments containing roads are classified in the ‘lowest risk’ category. In contrast, most sub-catchments containing any urban land use are classified as ‘highest risk’ reflecting the fact that loads of copper and zinc are high in relation to stream dilution potential. Loads from non-road impervious surfaces make up the majority of the total metal loads in these sub-catchments.
# Stormwater Run-off

## Overview
- ESRI ArcGIS and MS Excel Road Stormwater Screening (RSS) Model
- Considers relative risk of run-off from Road Traffic and Non-road Urban Contaminants
- Run-off for river reach sub-catchments based River Catchment Classification system
- Output Parameters - Road traffic run-off ‘markers’ - copper and zinc

## Stakeholders and Partners
- NZ Transport Agency
- MWH / Stantec
- NIWA
- Greater Wellington Regional Council

## Current Status
- Basic relative risk model developed
- Case study of run-off risk for Te Awarua-o-Porirua Harbour and Catchment complete

## Next Steps
- Improve efficiency of sourcing and process model input data, including development of national geodatabase.
- Further validation work – additional case studies
- Improve functionality and user interface
- Map national risk

## Further Information
- [https://www.nzta.govt.nz/resources/research/reports/585/](https://www.nzta.govt.nz/resources/research/reports/585/)
Vehicle Emissions

Another way to look at vehicle emissions

Tool Inputs

Road Asset Information

Digital Elevation Model

Regional

National

Local

A digital elevation model (DEM) was used as an underlay to the road network to automatically calculate road gradients. The gradient has a turbidity value calculated in 10 meters steps along the road network, but this distance can be adjusted in the future depending on the requirements.

Vehicle Emissions Prediction Model (VEPM 3.5)

Vehicle emissions factors used are generated from VEPM 3.5 and provide emission rates in grams per kilometer appropriate to the various road classes. The emission factor is automatically selected based on the individual road's mean speed, gradient and their grades.

Auckland Road Transport 2017 NOx emissions by Statistical Area 1

Notes: Major roads include motorways, regional national, arterial, regional and high volume.
# Vehicle Emissions

| **Overview** | • ESRI ArcGIS Feature Manipulation Engine (FME) software model  
• Emissions factors based on NZ Vehicle Emission Prediction Model  
• Years Modelled – 2016, 2017, 2018  
• Output Parameters - Greenhouse Gases (CO2) and Harmful Air Pollutants (CO, NOx, PM, etc)  
• LV and HV split; petrol, diesel and electric/hybrid split |
| **Stakeholders and Partners** | • NZ Transport Agency  
• Jacobs  
• Transport Environment Knowledge Hub |
| **Current Status** | • Vehicle emissions mapped across NZ State highways and local road networks from 2016 and being updated yearly. |
| **Next Steps** | • Map concentrations and exposure to harmful air pollutants  
• Further validation work – to include comparison against regional and national greenhouse gas and harmful air pollutant inventories and monitoring data  
• Development of a ‘future state’ model for scenario testing of interventions |
Road Traffic Noise

STATE HIGHWAY NOISE MAPPING – AUCKLAND MOTORWAYS CASE STUDY
Rob Hannaby, NZ Transport Agency, New Zealand
Stephen Chiles, NZ Transport Agency, New Zealand
Chris Worts, NZ Transport Agency, New Zealand
James Whittock, Marshall Day Acoustics, New Zealand
Andy Haigh, Beeca, New Zealand

ABSTRACT
The NZ Transport Agency initiated a strategic noise mapping exercise in 2009. The aim was to generate noise maps covering the 220 km of motorway network in Auckland, which could then be used to inform and identify priority areas for noise mitigation.

The 2009 exercise was repeated and refined in 2012 to address a number of short comings, in particular the limited geographical coverage of the maps due to incomplete input data, as well as output inconsistencies associated with the mapping methodology. Careful project planning and data management enabled the efficiency of the 2012 mapping process to be enhanced and streamlined. Ultimately a complete set of maps have been generated for the Auckland motorway network by 2012.

This paper explores the benefits realized from the noise map, highlighting the benefits of optimising the use of spreadsheets in geoprocessing and the importance of quality data management. The information provided by the maps is now being used to target road traffic noise sources in Auckland.

National Land Transport (Road) Noise Map
2019 Project Report

AECOM
Road Traffic Noise

National

Population exposed to >53 Lden (WHO)
- 0 - 9999
- 10,000 - 29,999
- 30,000 - 49,999
- >50,000

- Northland Region
  - 19,705
- Auckland Region
  - 235,832
- Waikato Region
  - 41,854
- Taranaki Region
  - 25,729
- Nelson Region
  - 5,128
- Tasman Region
  - 4,881
- West Coast Region
  - 4,187
- Southland Region
  - 7,246
- Otago Region
  - 33,940
- Canterbury Region
  - 73,021
- Bay of Plenty Region
  - 23,377
- Gisborne Region
  - 9,149
- Hawke’s Bay Region
  - 16,288
- Manawatu-Wanganui Region
  - 23,121
- Wellington Region
  - 58,660

Local

Corridor/Grid
Road traffic noise modelling

National noise mapping 2018/19
First national noise map for New Zealand
Includes state highways, regional
and arterial roads

- 15,000+ km² TERRAIN
- 14,000+ km ROADS
- 1,600,000+ BUILDINGS
- 3,000+ BRIDGES
- 88+ km NOISE BARRIERS
# Road Traffic Noise

| Overview | • ESRI ArcGIS and Soundplan Model  
| State highways, regional and arterial roads  
| Year modelled – 2017 (traffic) and 2013 (population)  
| Output Parameter – L_{Aeq(24hr)} (and others) |
| Stakeholders and Partners | • NZ Transport Agency  
| AECOM  
| Chiles Ltd |
| Current Status | • Completed 2019  
| Used to inform noise mitigation business case development |
| Next Steps | • Annual updates  
| Update population exposure estimates with 2018 census  
| Refinements to input data sets (topography, building footprints and heights, noise barriers, building use, etc) |
Summary

- Smart use of GIS platform(s) informed by robust science to enable cross-sector collaboration in order to minimise the impact of transport-related environmental harms.

- Designed to:
  - support strategic and tactical interventions
  - monitor and report spatial and temporal trends at national, regional and local levels
  - inform scenario testing and economic appraisal
Thank You

QUESTIONS?

Rob Hannaby
NZ Transport Agency
Lead Advisor – Environment
rob.hannaby@nzta.govt.nz