Update on Improving Monitoring of Traffic-Related Air Pollution

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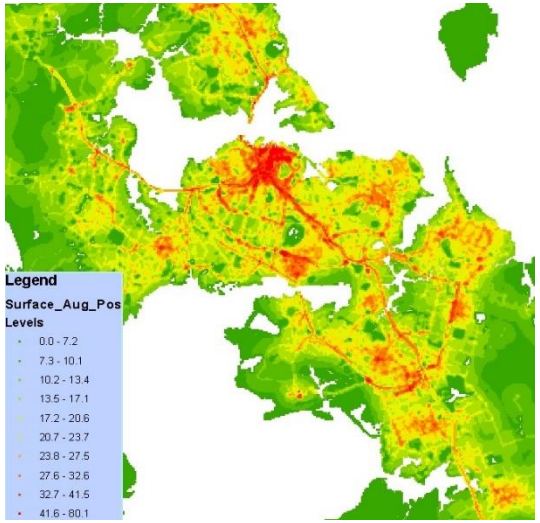
Traffic-Related Air Pollution (TRAP) is a complex mixture

We use NO_2 as a common PROXY measure

Why do we monitor?
Standards and Guidelines relevant to TRAP



Pollutant	Averaging time		Where exceeded?
NO_2	Annual mean	WHO Guideline	Busy roads in urban centres
NO_2	Hourly mean	National Environmental Standard	Rare – busiest roads
CO	8-hr mean	National Environmental Standard	no exceedences recorded in 2 decades

Air pollution a cause of UK girl's death, finds global landmark ruling

By Emma Reynolds, CNN

Updated 1813 GMT (0213 HKT) December 16, 2020

Coroner: Ella Kissi-Debrah died as a result of asthma worsened by exposure to excessive air pollution.

London (CNN) — A 9-year-old girl who died after an asthma attack is thought to be the first person in the world to have air pollution listed as a cause of death in a landmark coroner's ruling.

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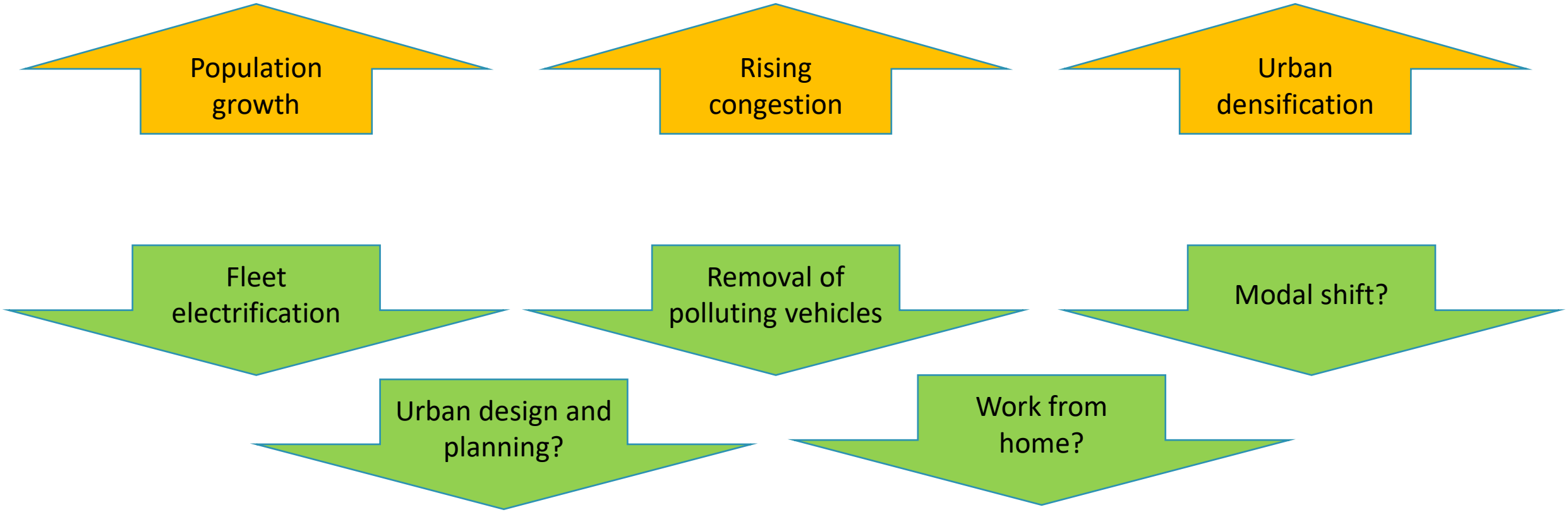
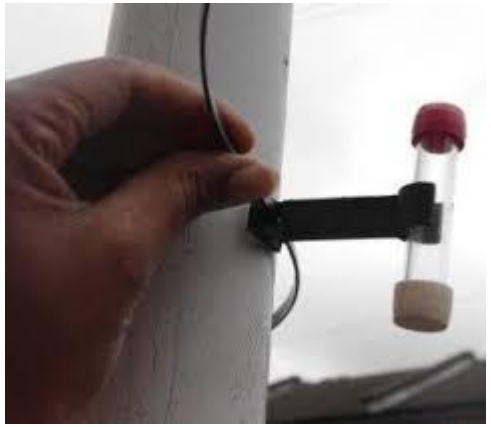
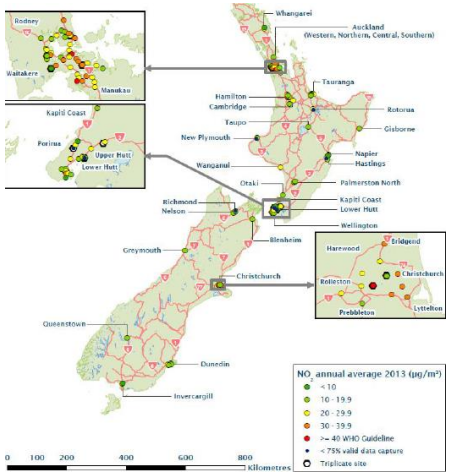
Why ELSE should we monitor?



How do we monitor?

- NO_2
- Monthly data
- 100+ locations (Waka Kotahi)
- WHO Guideline
- Trends and spatial patterns





- NO_2, NO_x, CO and PM
- Hourly data
- <10 locations (Regional Councils)
- National Environmental Standards
- Worst in morning under light winds

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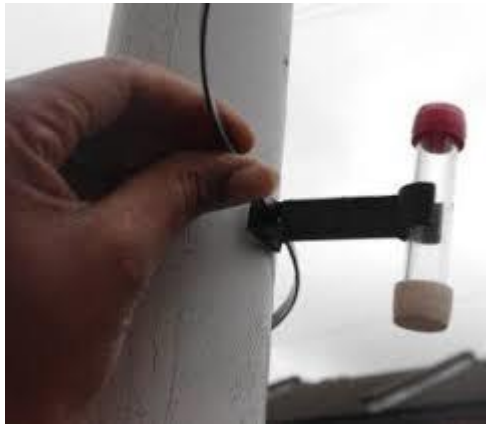
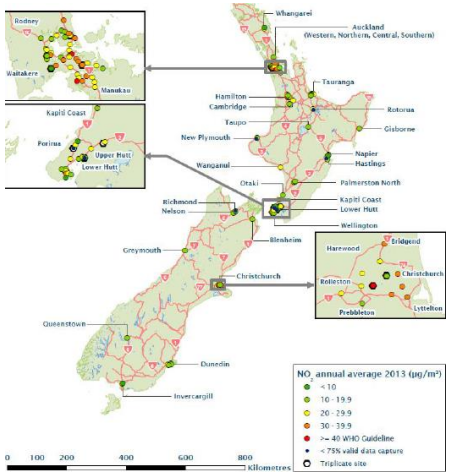
Research questions

- Are these sites representative? (of what?)
- Can we measure more stuff more often in more places?





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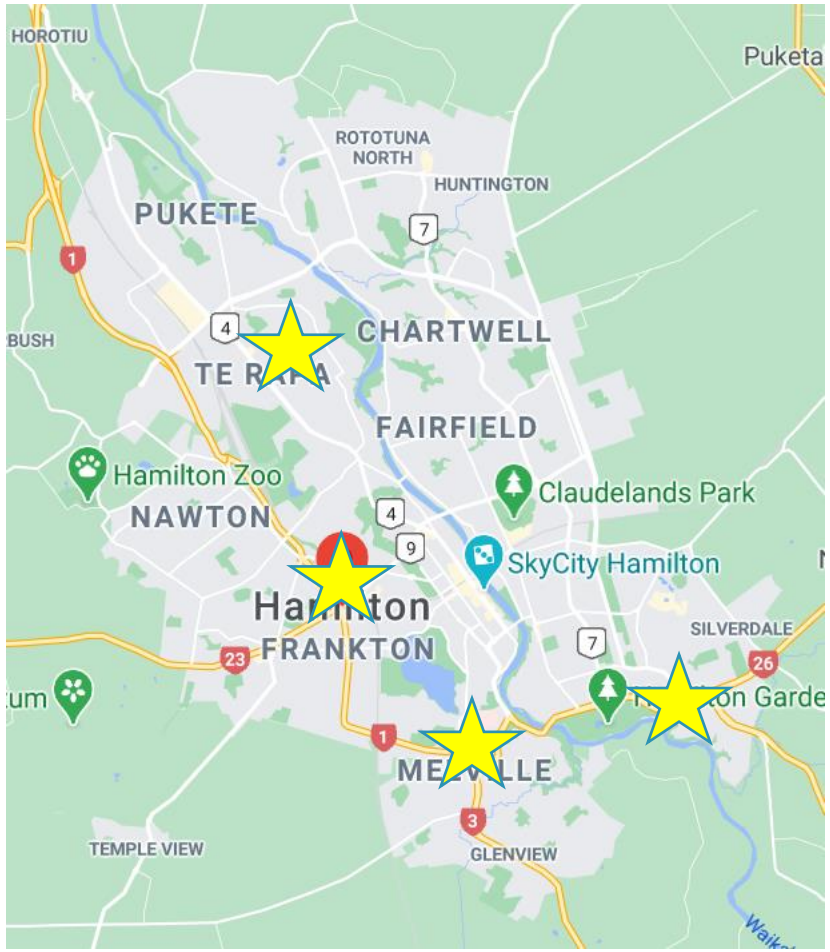
TRAP monitoring relies on a few sites whose representativeness is assumed, or deliberately unrepresentative (peak) sites

(NZTA) National Monitoring Network (NO2)



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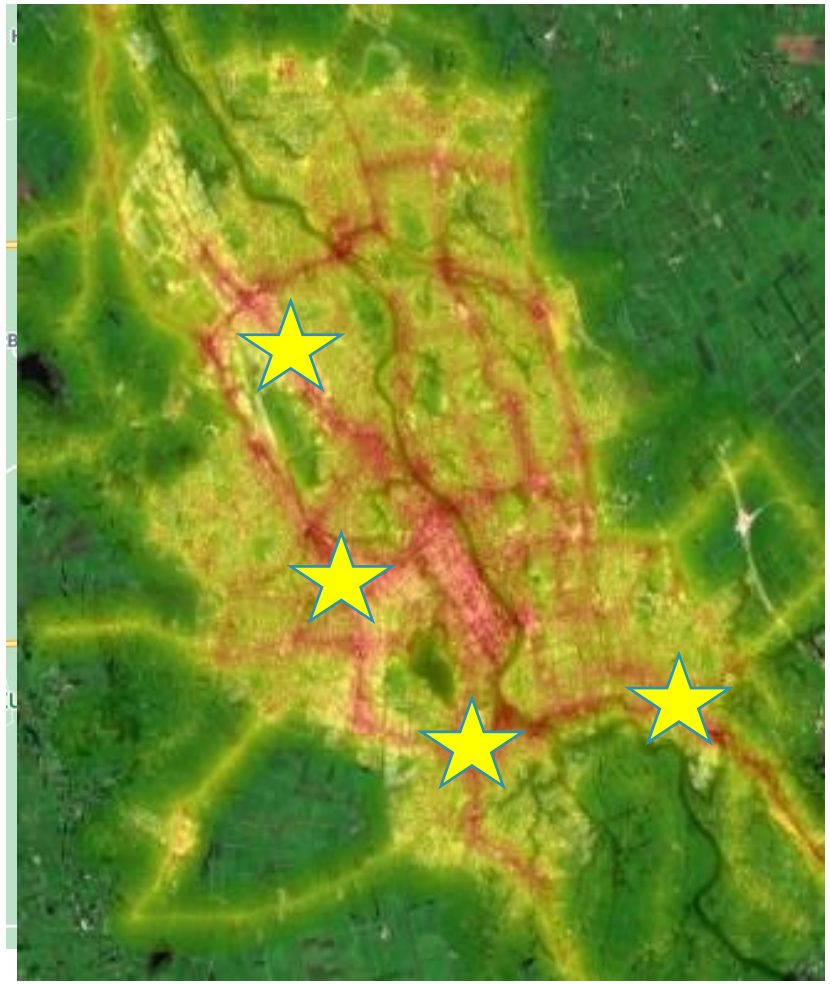
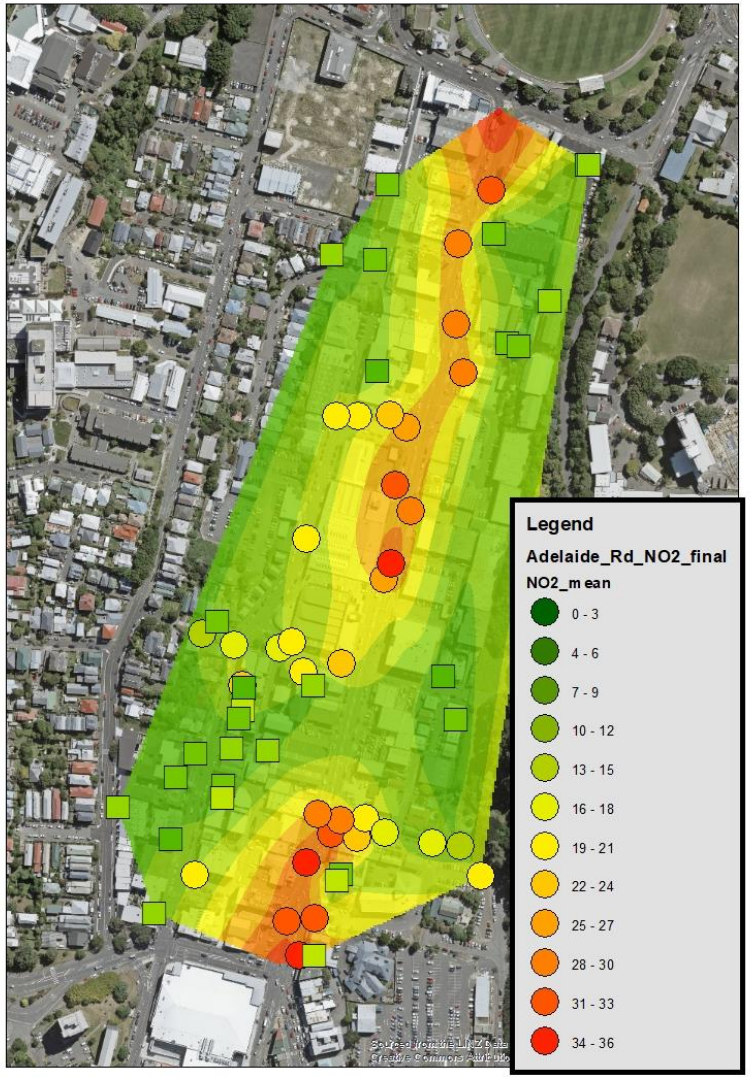
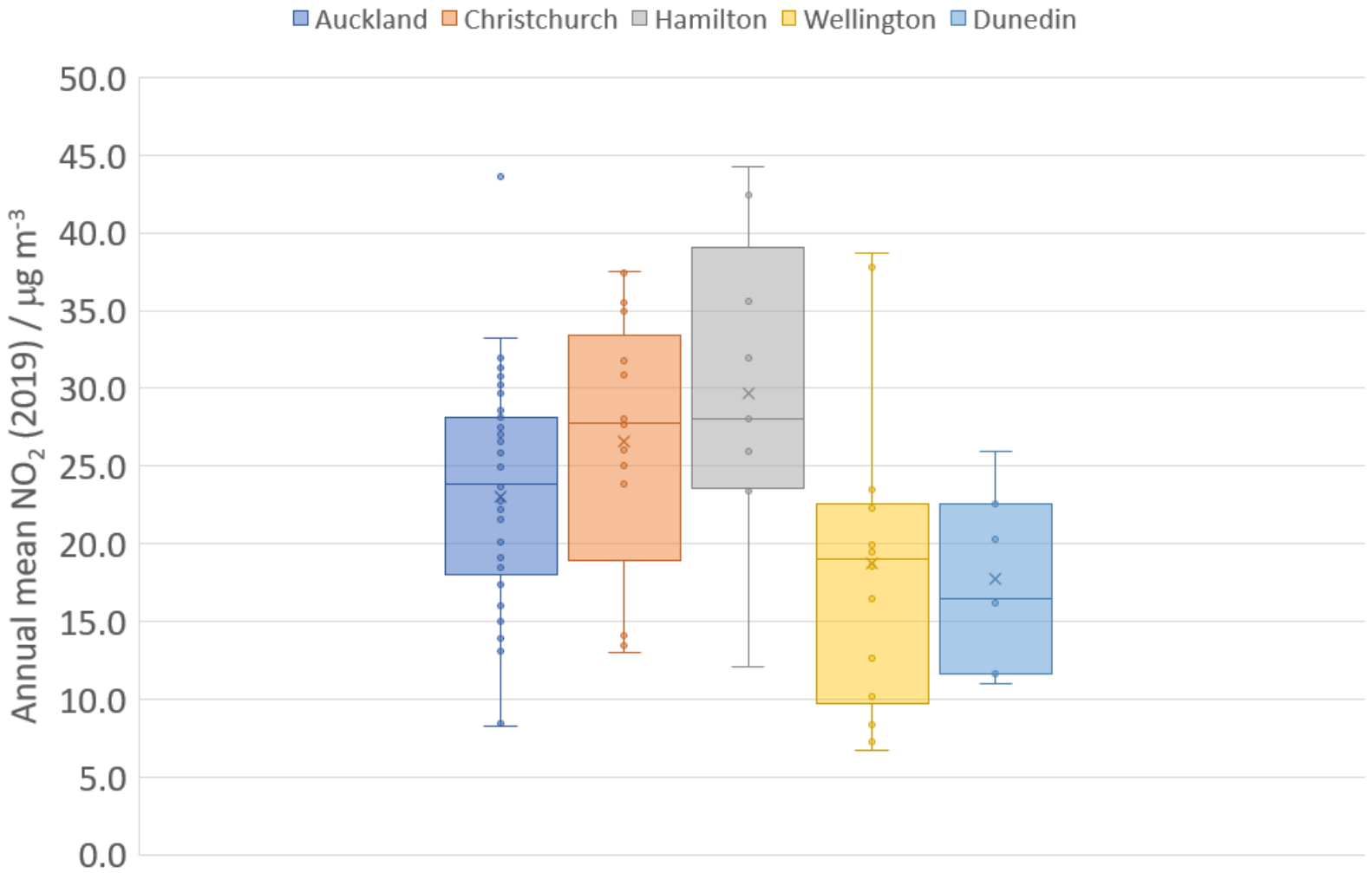
Monitoring and modelling has revealed TRAP has strong gradients and local hot-spots

(NZTA) National Monitoring Network (NO2)





The more roadside/hot-spot sites are monitored, the more biased the data



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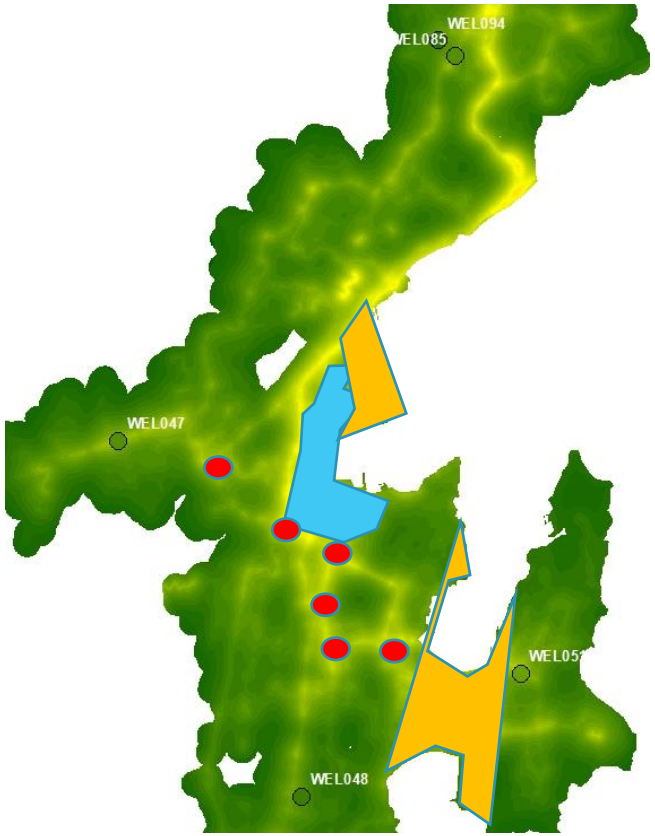
Research goals

- Build approach to

1. Locate and verify representative sites
2. Quantify and predict local “hot-spot” increments

Zones and site representativeness



Urban background

roadside

Traffic dominates
Dispersion and emissions “normal”
(hence modellable)

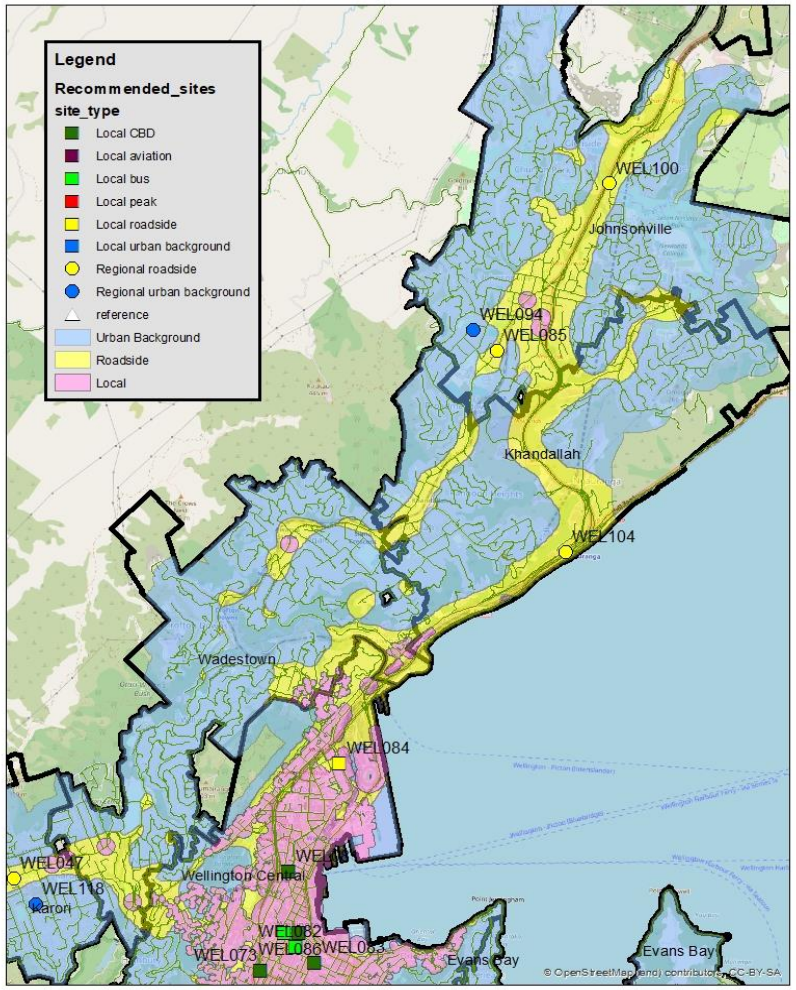
intersections

canyons

ports

Concentrations are locally ELEVATED because dispersion and/or emissions are LOCALLY atypical or non-traffic sources significant

Creating a representative monitoring network



- Define “airsheds” within which concentrations are correlated in long-term
- Minimum one sites per zone per airshed

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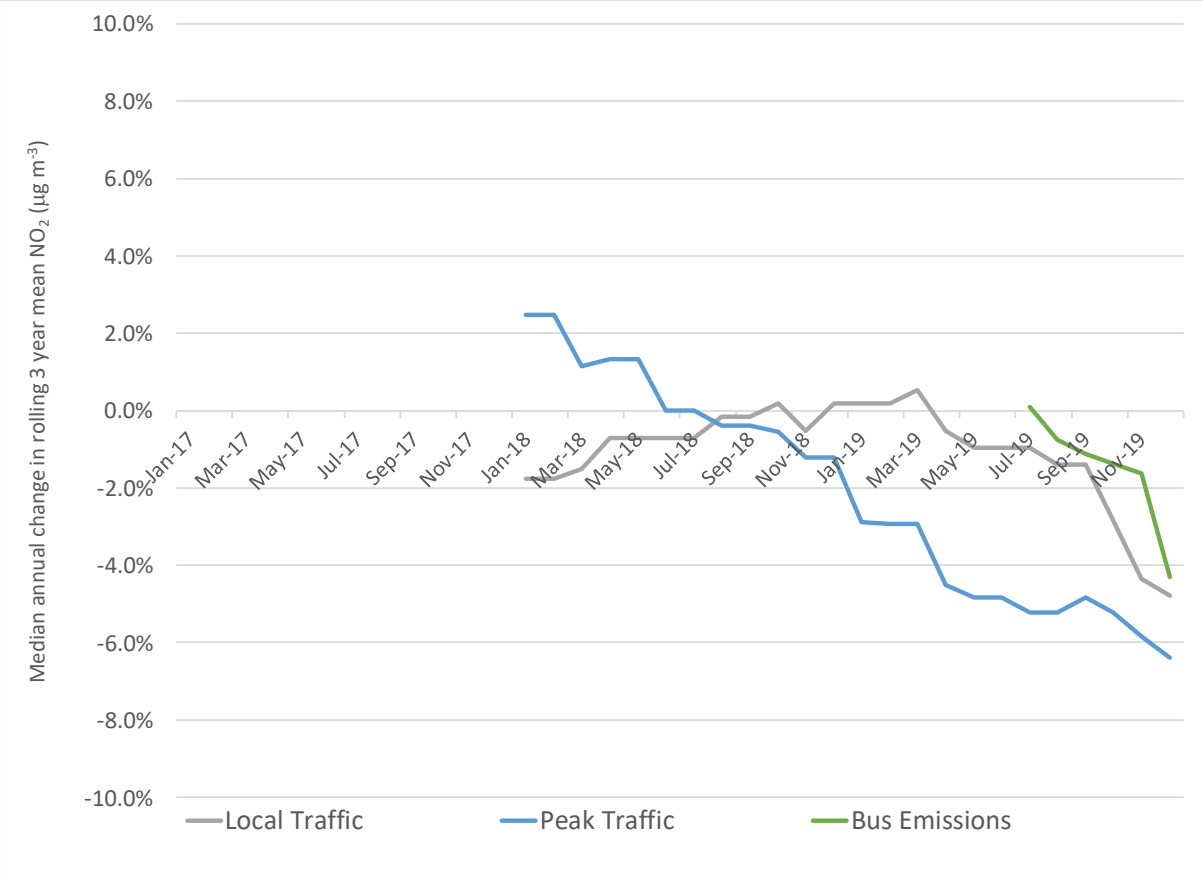
Building Indicators



- Pool data for each zone for each airshed
- 3-year rolling-average to indicate long-term trend

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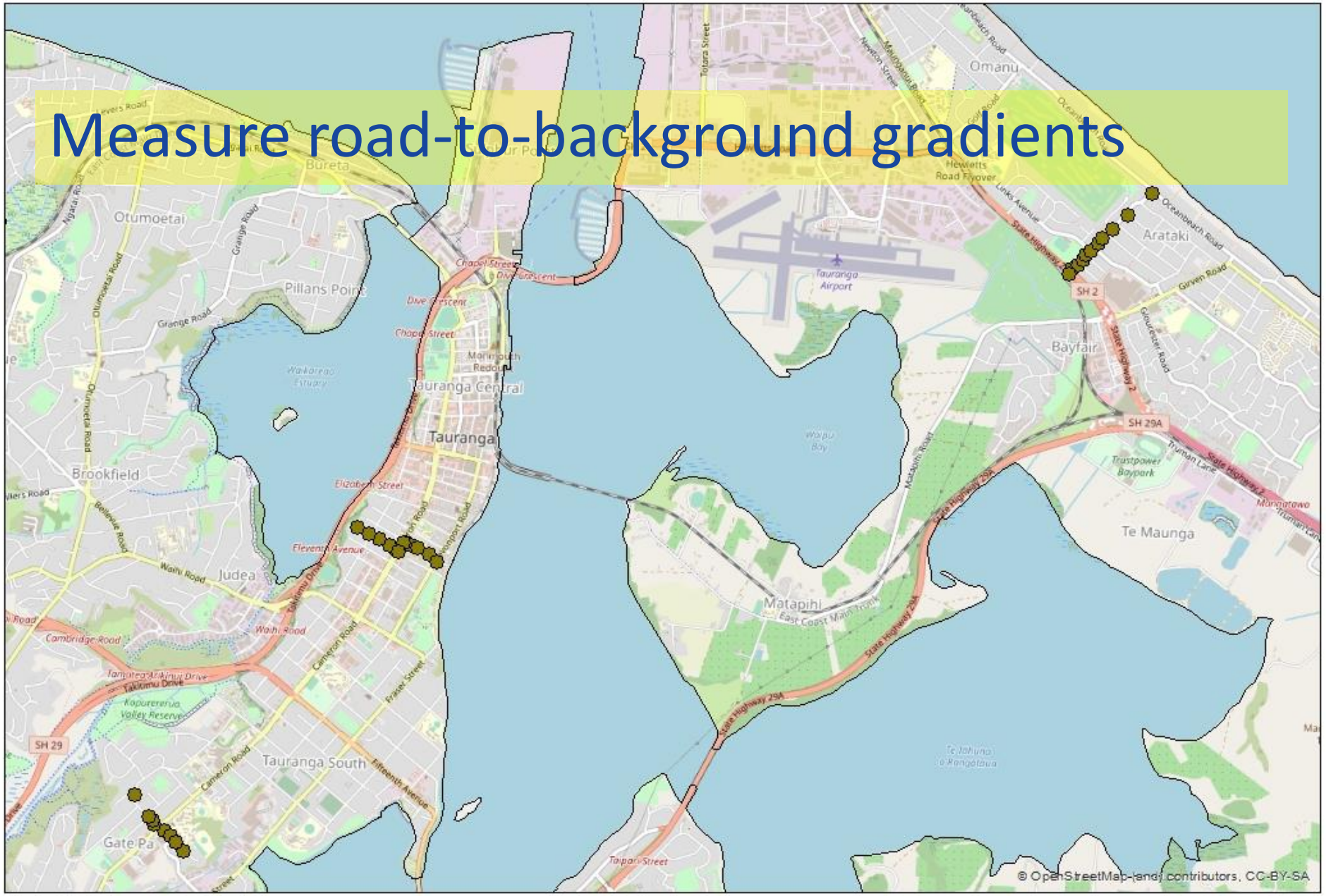
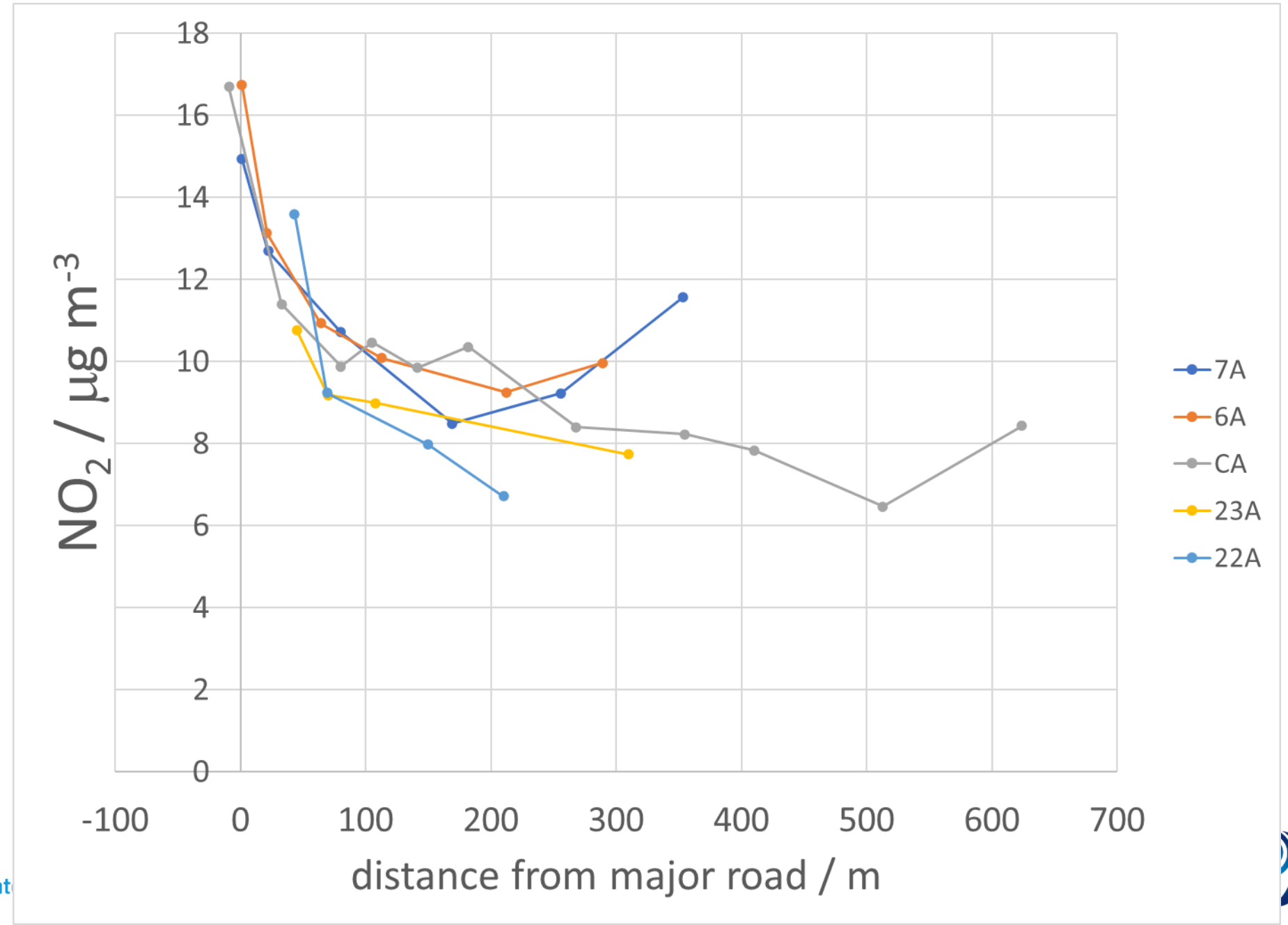
Measure road-to-background gradients





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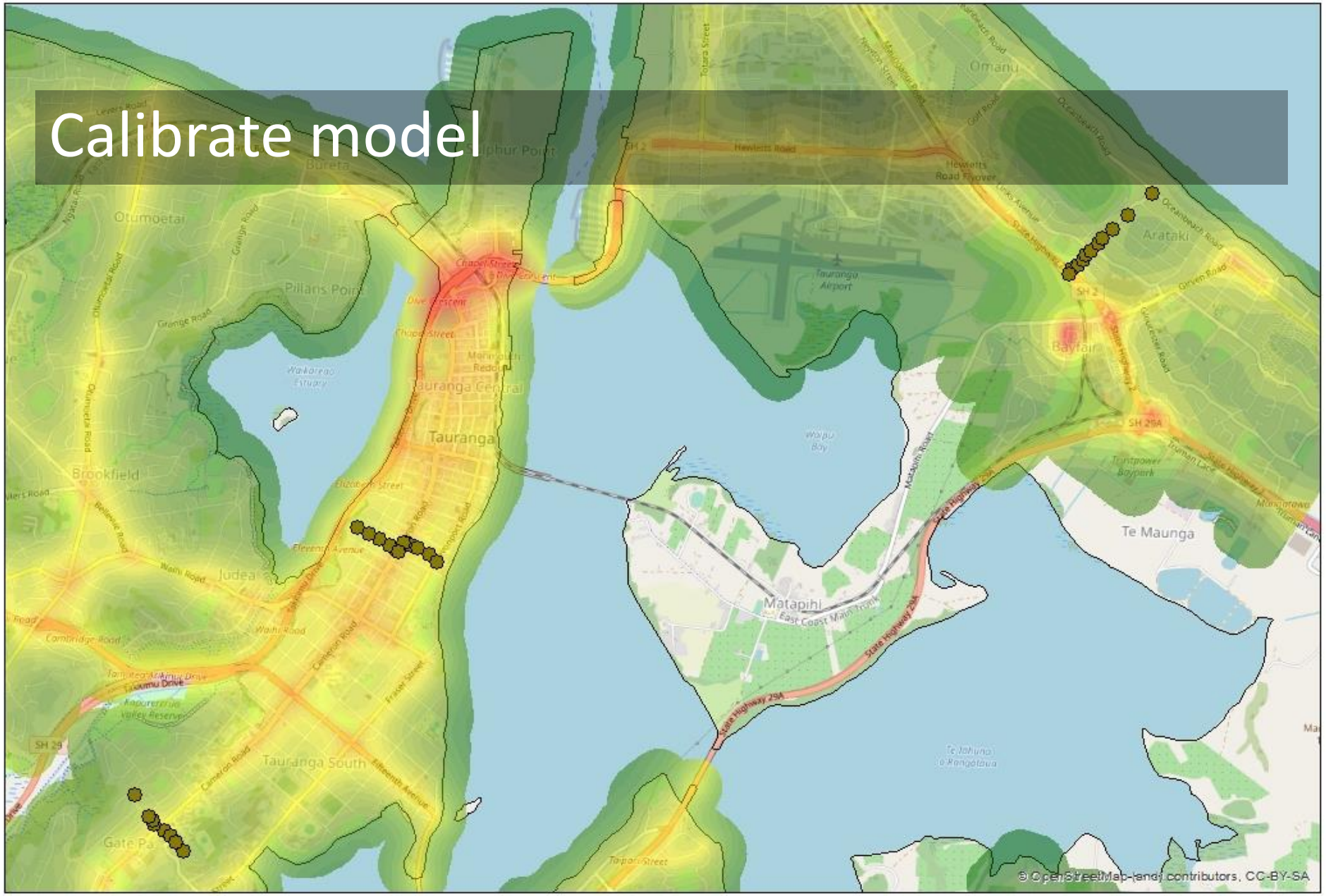
Calibrate model



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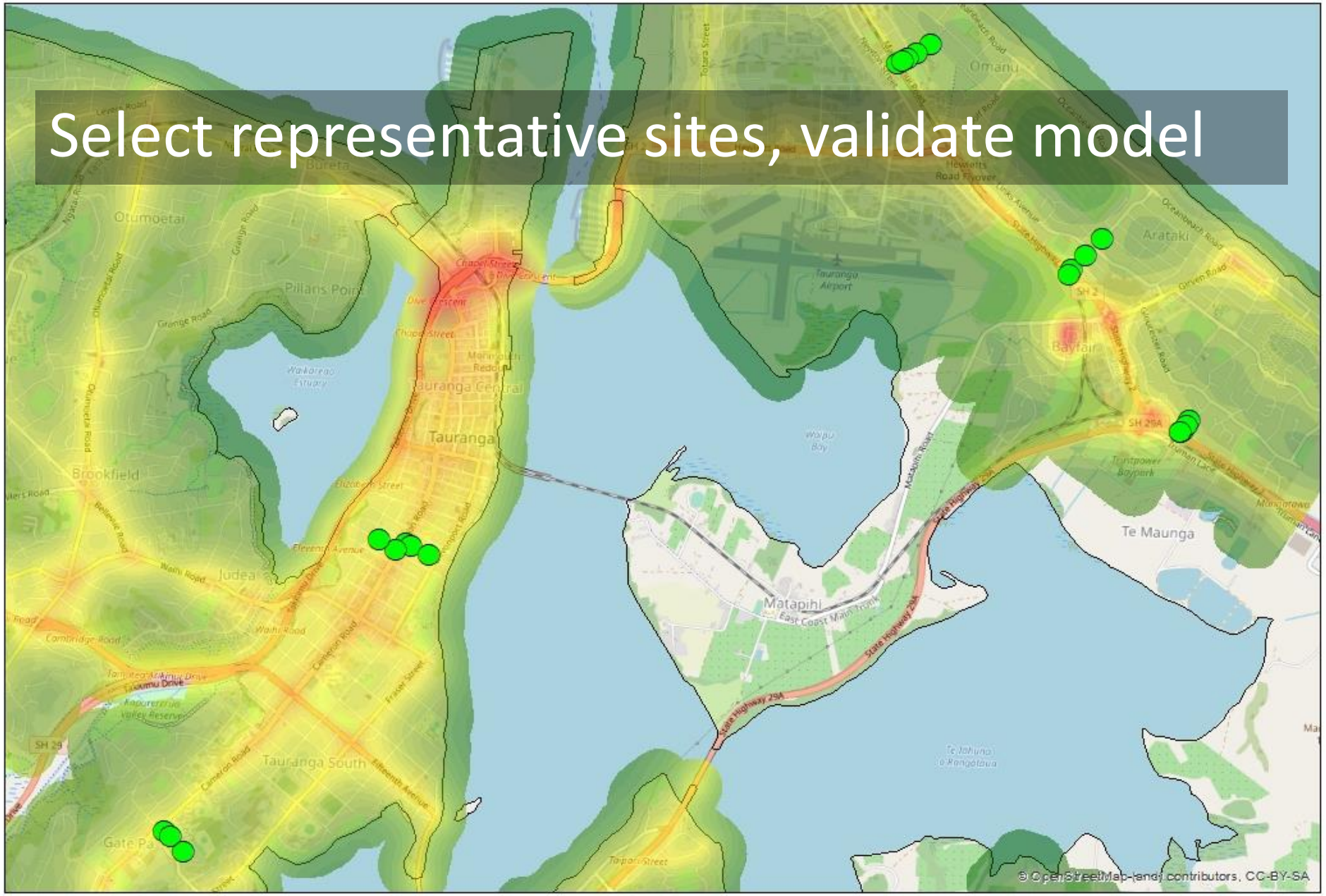
Select representative sites, validate model



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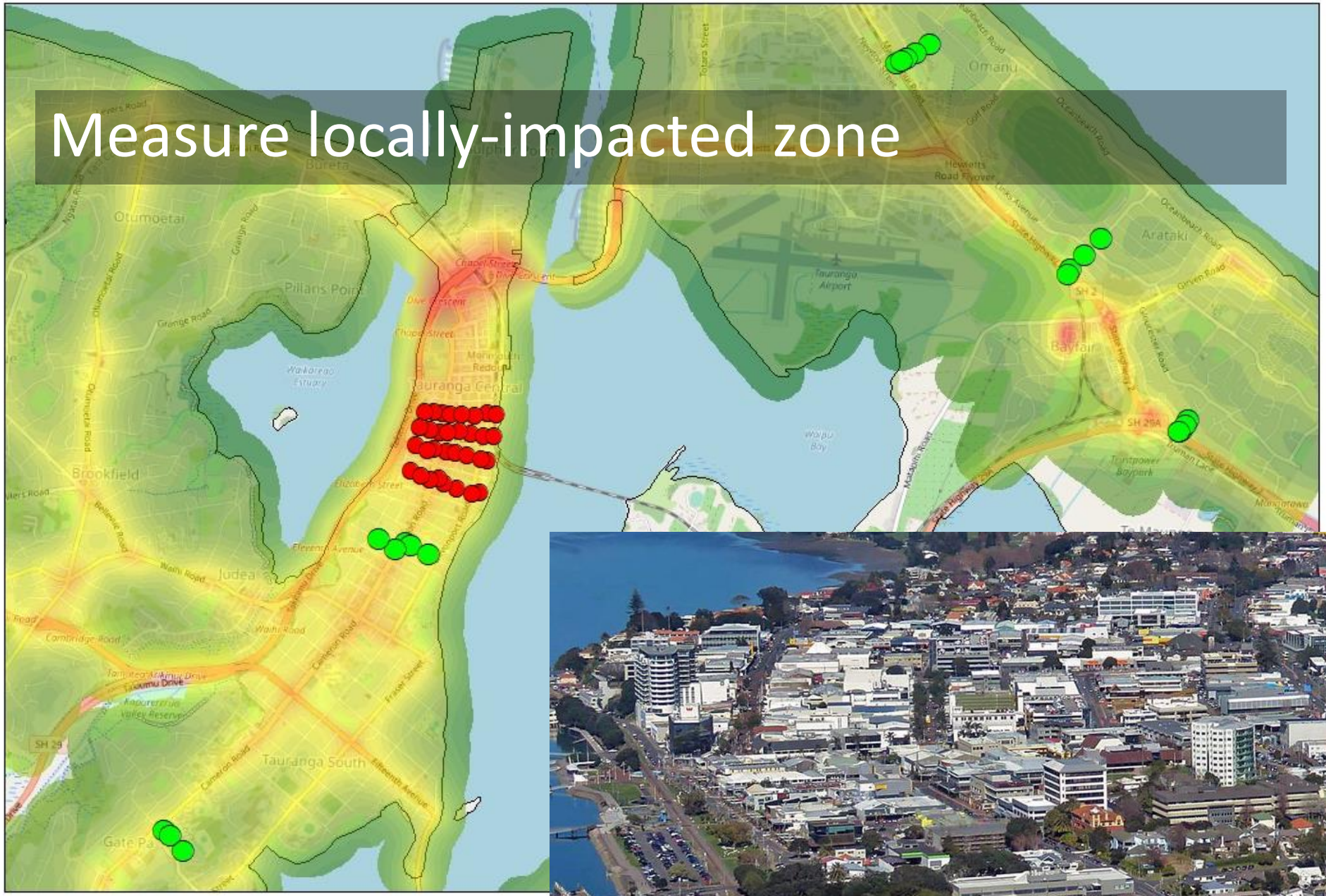
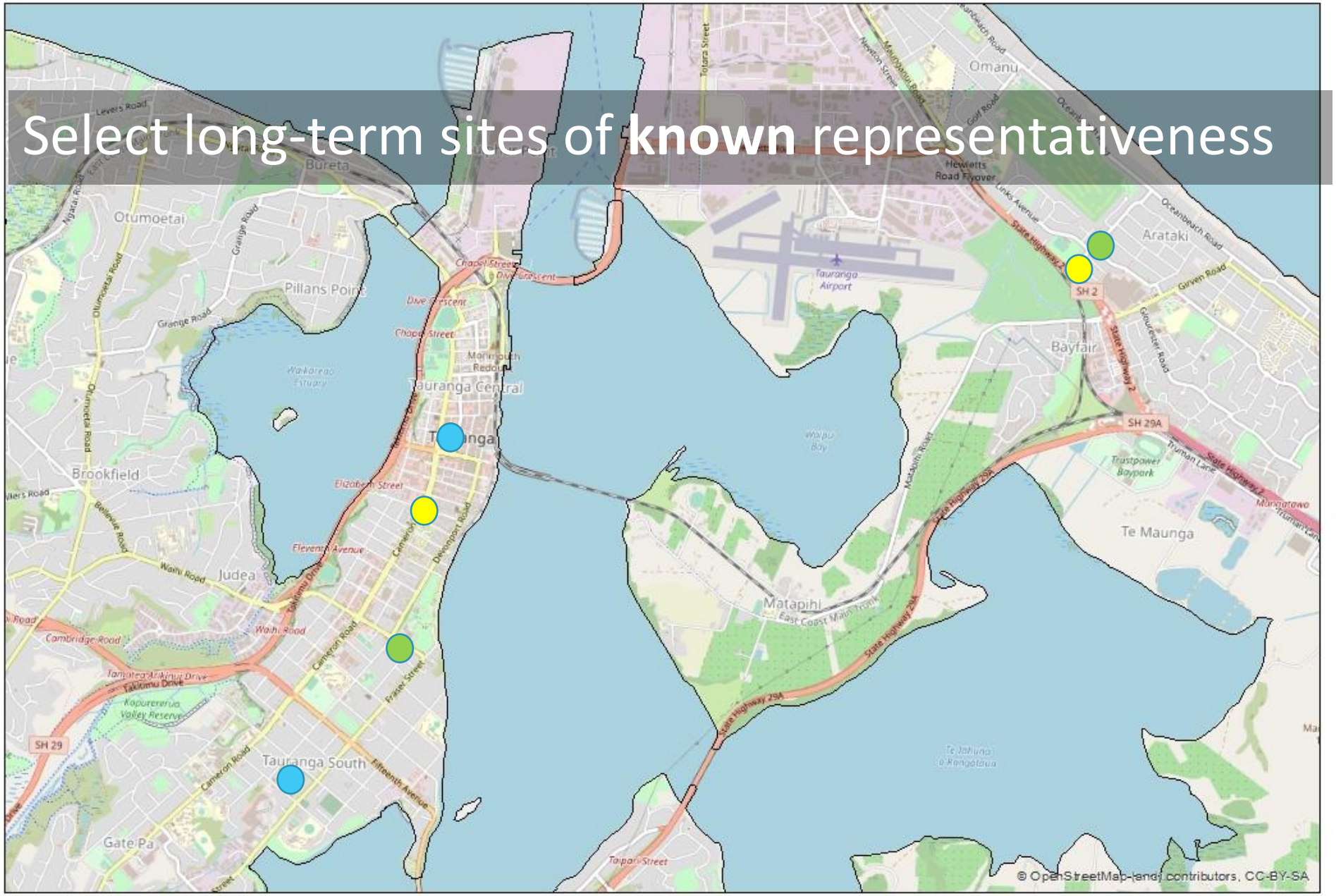
Measure locally-impacted zone



Select long-term sites of **known** representativeness



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Impact of micro-scale topography

Anticipated Outcomes

- Representative monitoring network, data and indicators for Tauranga and Christchurch
- Method that can be reproduced anywhere
- Highly detailed spatial models
- Improved understanding of impacts of urban design features on TRAP

Traffic-Related Air Pollution (TRAP) is a complex mixture

We use NO_2 as a common PROXY measure

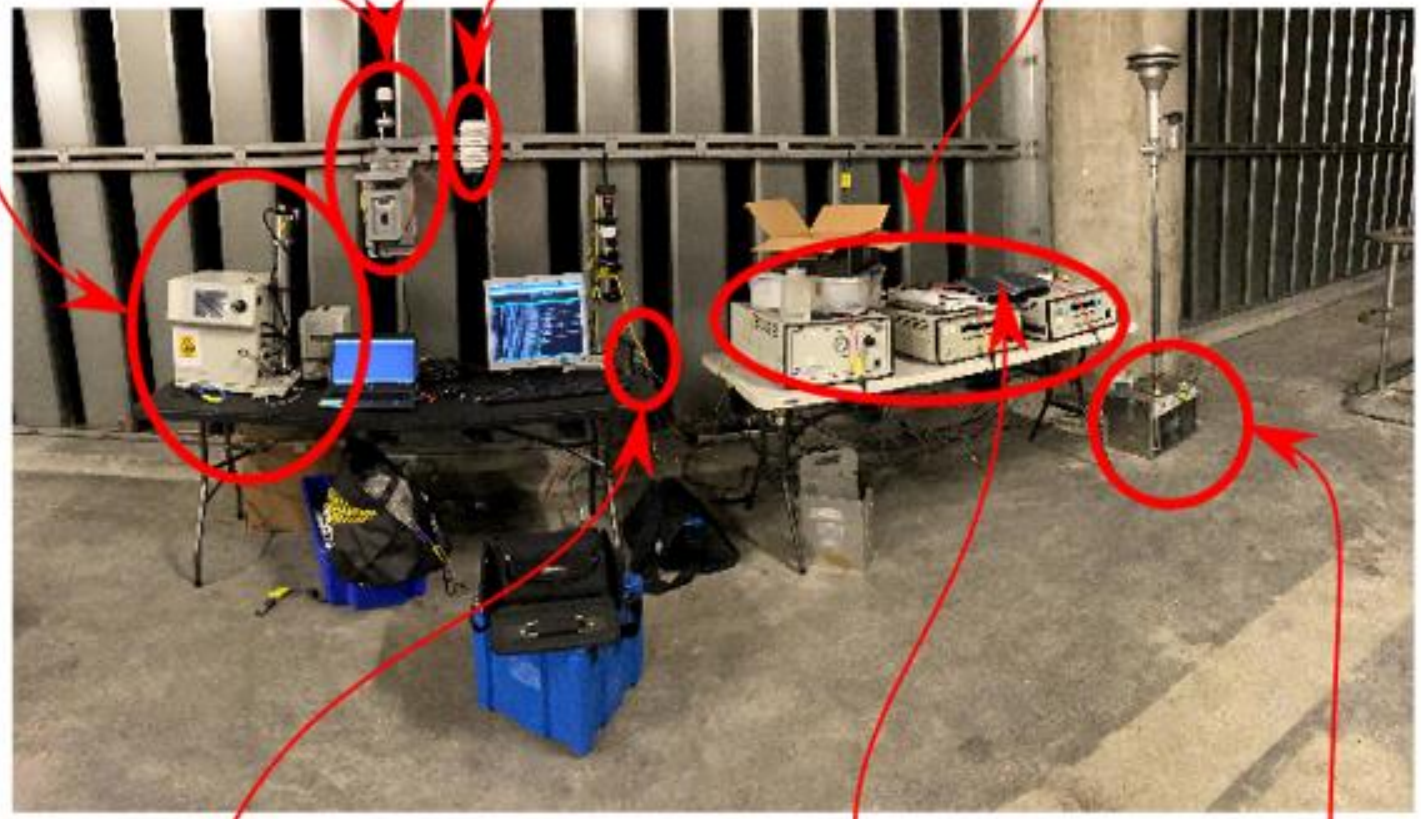
Tunnel setup

Vaisala AQT420

ES642

NOx+Calibrator

SMPS



Electronic Diffusion Tube

SPEC NO2

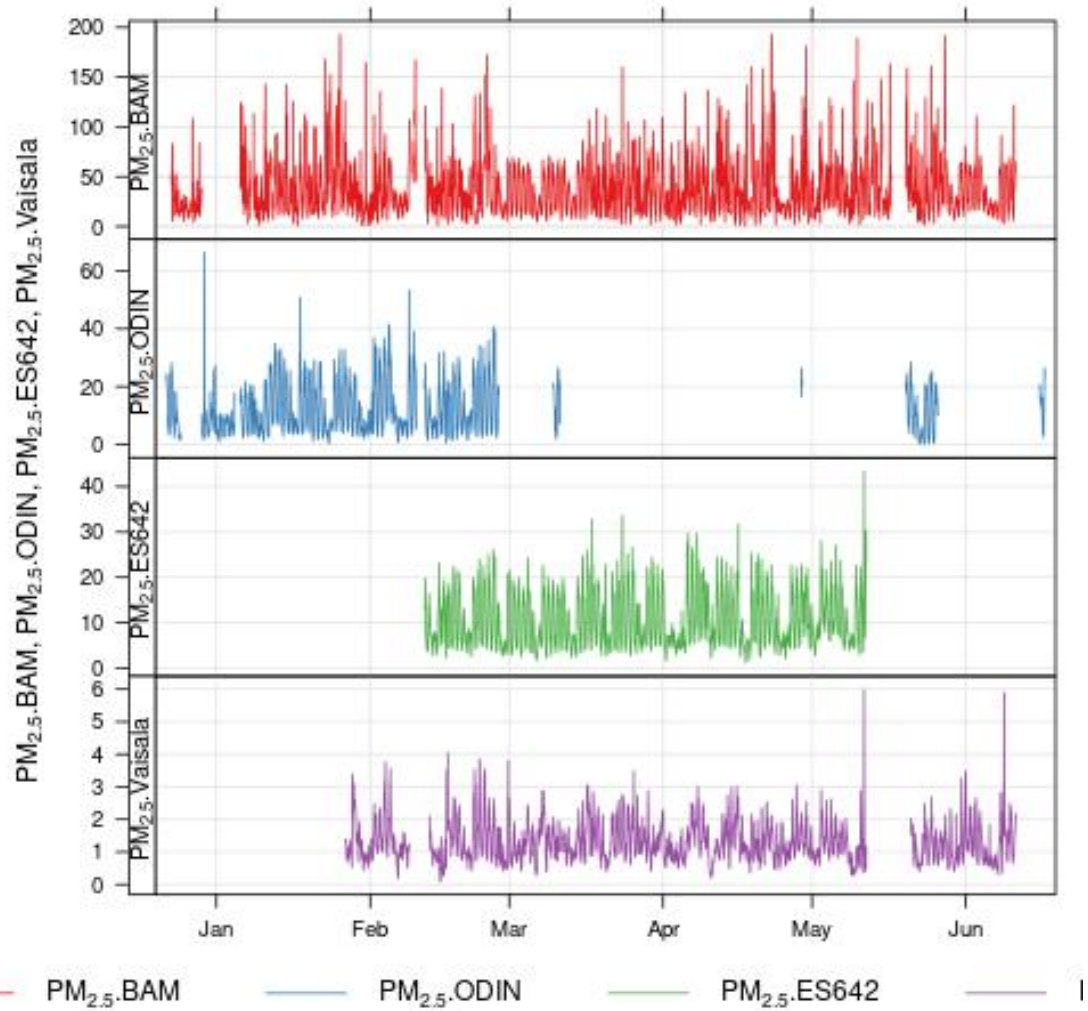
ODIN

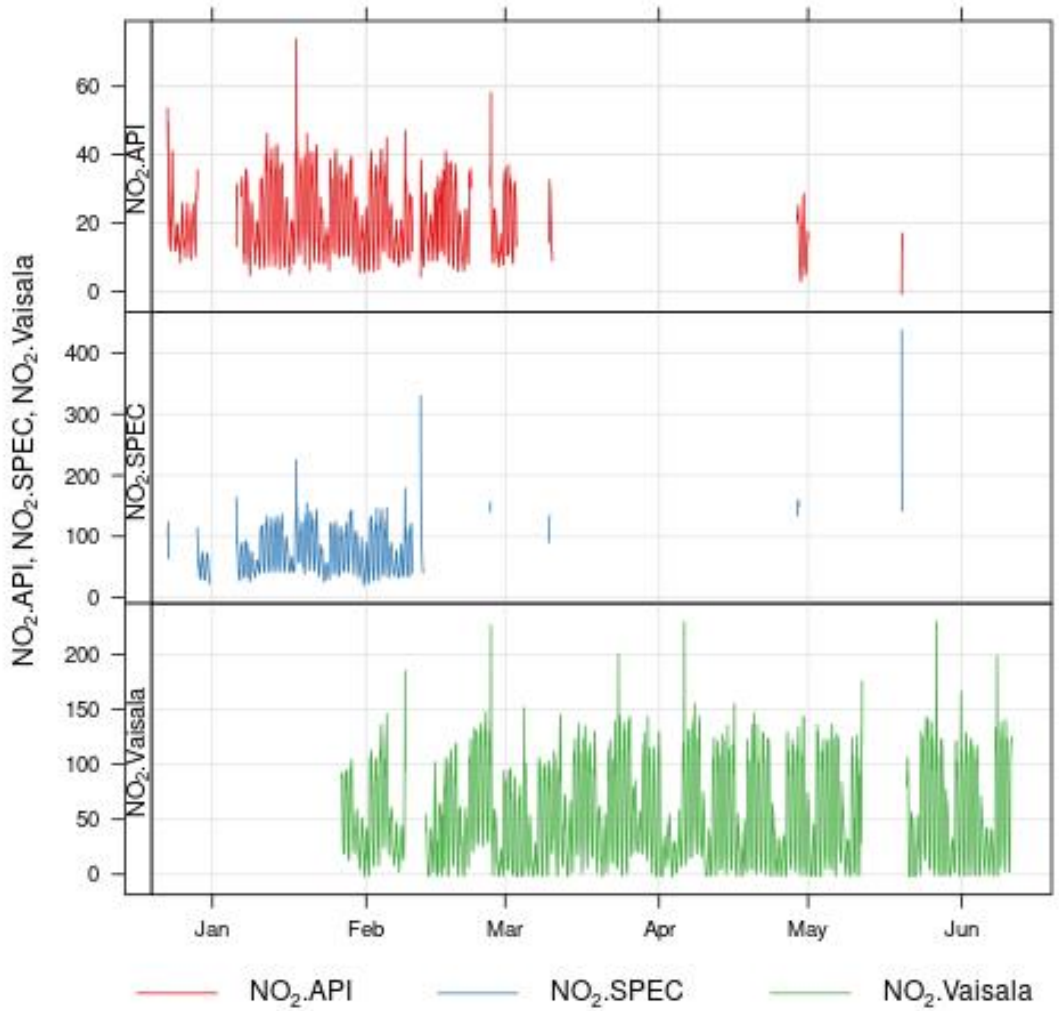
BAM

Instrument details

- **ES642**: On loan from Mote. This device was setup with a PM2.5 inlet and with a logging interval of 1 minute. Data retrieved through Mote's platform.
- **NOx**: A API 200A NOx analyzer. Data was captured directly, once a minute, from the instrument through the RS-232 port.
- **BAM**: Thermo-Fisher FH62C14. **PM2.5** inlet and logged directly to a local computer every minute.
- **Vaisala AQT420**: On loan from Auckland Council. PM2.5, O3, NO2, SO2, CO, PM10, temperature, relative humidity and ambient pressure. It logging to a computer once a minute.
- **SPEC NO2**: Two SPEC DGS-NO2 sensors were connected directly to the logging computer and recorded data every 5 seconds.

Data summaries



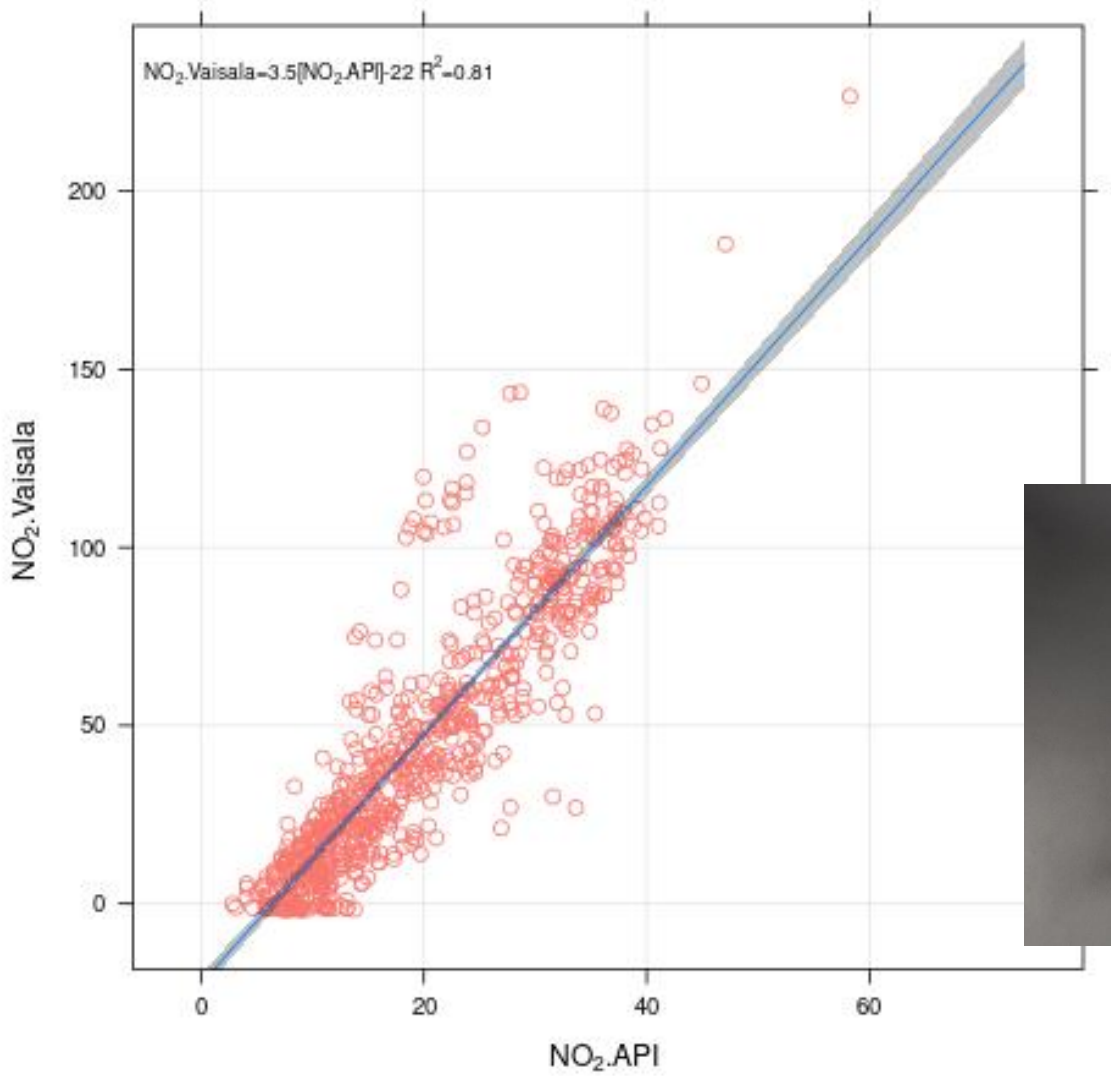


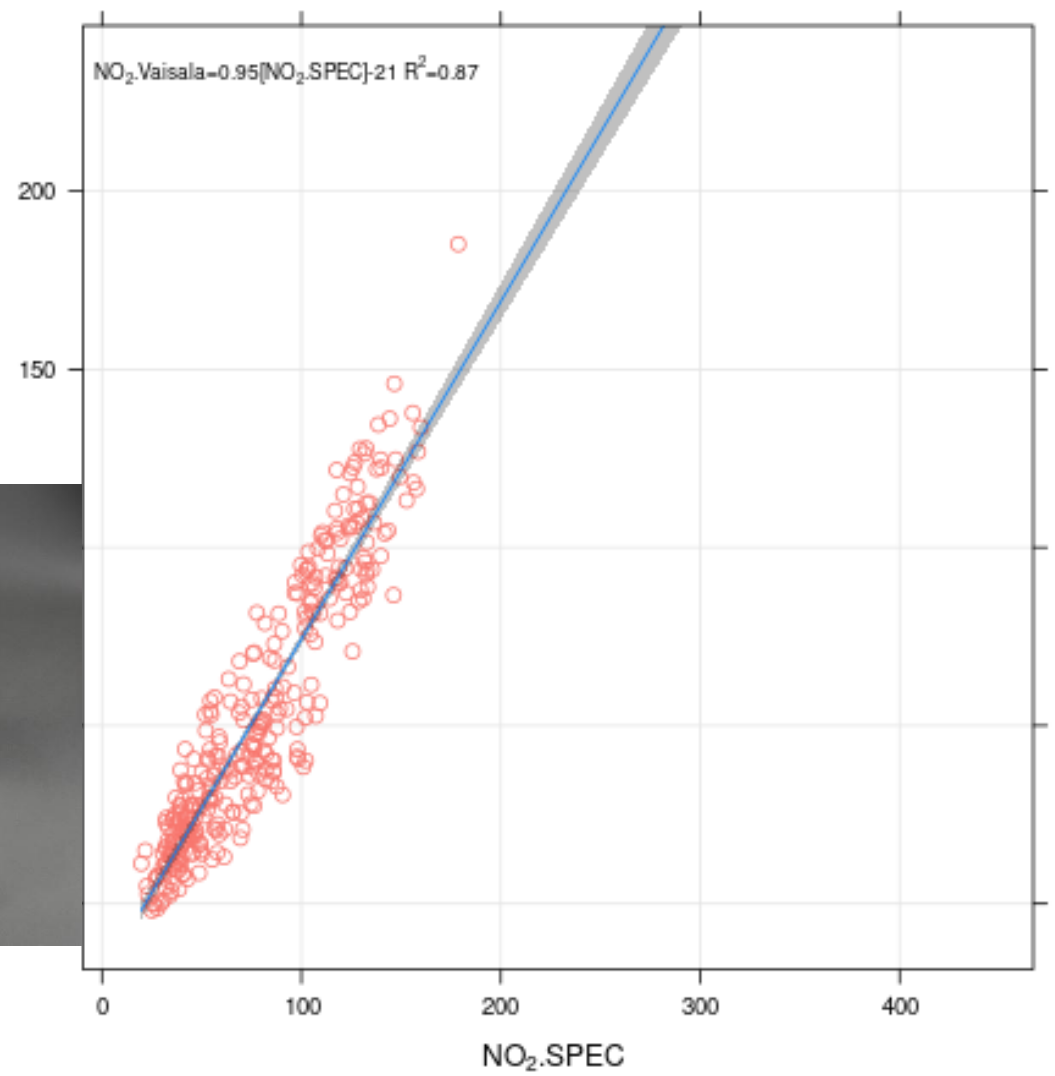
Waterview Tunnel Measurements – Dec 2020 – May 2021

Vaisala AQT420

NO2

SPEC

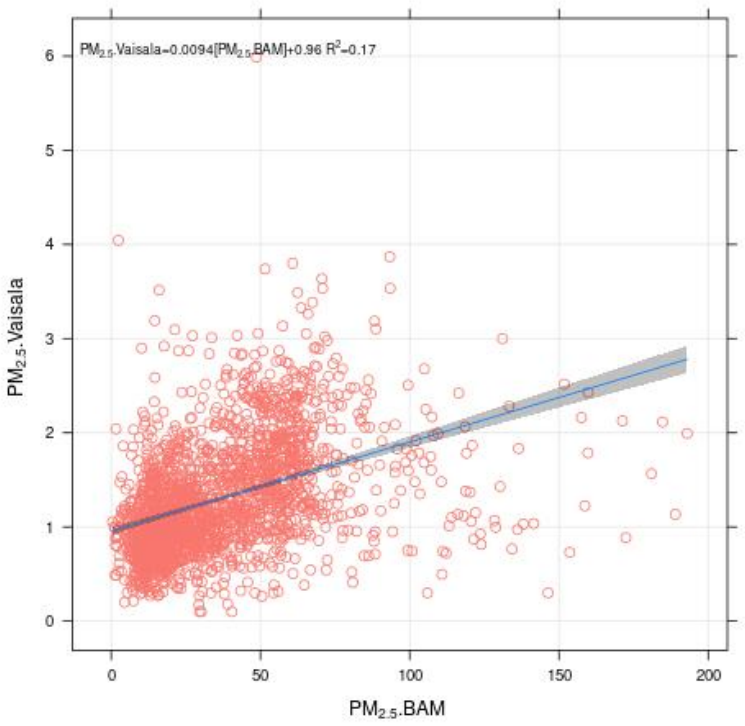




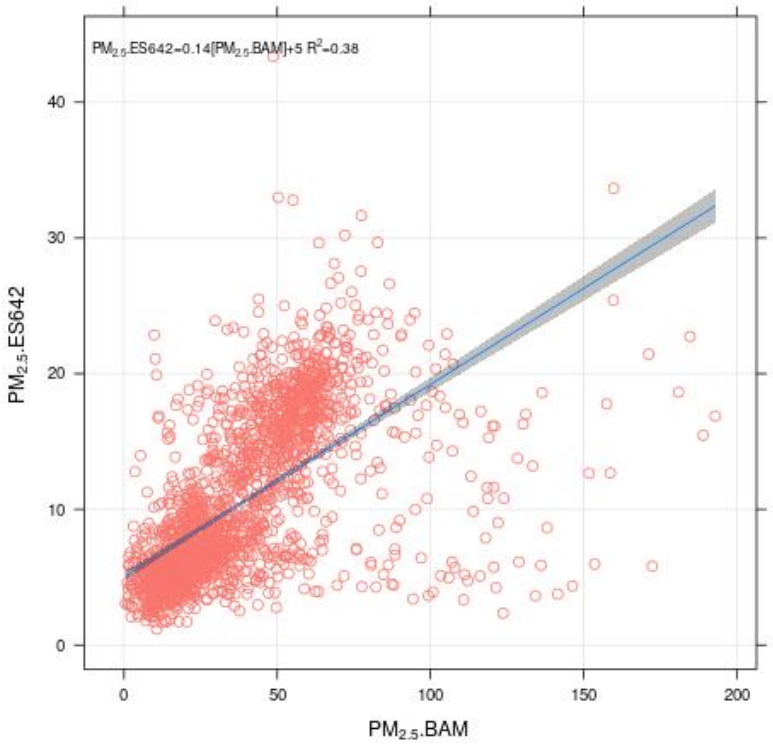
Waterview Tunnel Measurements – Dec 2020 – May 2021

$PM_{2.5}$

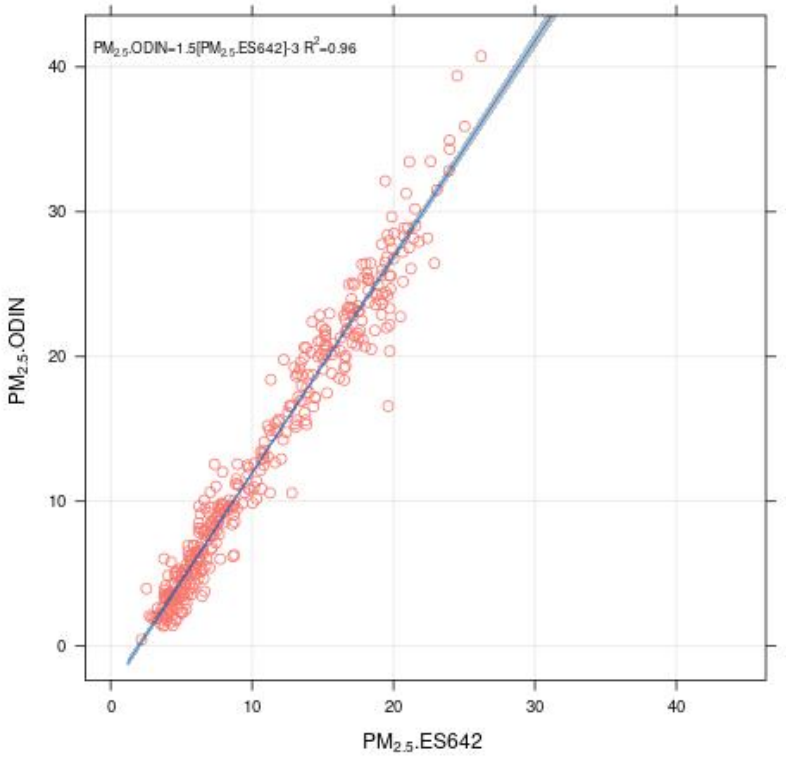
Vaisala AQT420



MetOne ES642



NIWA ODIN



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So?

- No significant degradation of performance of low(er) cost sensors over time
- NO2 sensors (Vaisala and SPEC) overestimate NO2 concentrations by a factor of 3.5 BUT that difference is stable.
- Vaisala's PM2.5 sensor surprisingly underperforms ODIN and ES642 even though they're all optical sensors.

Next steps

- Why do low-cost NO_2 sensors over-read?
- Error analysis
- Long-term performance and maintenance
- Electronic diffusion tubes
- Ambient trials (in planning stage):
  - Auckland motorways
  - Auckland street canyon

Postscript – what about carbon?

- Carbon dioxide – testing soon
- Carbon monoxide – Vaisala AQ420
- Black carbon – difficult, but working on it
- Waterview Tunnel is perfect long-term carbon monitoring site

Acknowledgements

- This work in this presentation was funded by Waka Kotahi and NIWA