A case study to determine the feasibility of using the CNOSSOS model for estimating traffic noise in Australia

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1 Abstract

We demonstrate the feasibility of using the CNOSSOS (Common NOise aSSessment MethOdS) noise modelling framework in Australia. To do this, we implemented the code prepared by Morley *et al.* (2015) using data sources for Bankstown, NSW. We discuss the limitations of the available data in the Australian context and identify enhancements which may be useful if the model were to be applied across Australia.

2 Introduction

Traffic noise is detrimentally linked to several health outcomes (Babisch (2006), Van Kempen & Babisch (2012), Björk *et al.* (2006), Sorensen *et al.* (2012)). Consequently, traffic noise modelling is increasingly important for understanding exposure and the impact on human health.

The aim of this report is to examine the feasibility of extending the CNOSSOS framework as implemented by Morley *et al.* (2015) to an Australian context. In this paper, these authors compare the results achieved using 6 different levels of detailed data, and include code for the least and most detailed models. Our report describes our attempts at getting the low resolution model to run using data for Bankstown, NSW.

We used the code published with this paper, along with data for Bankstown, NSW to demonstrate the CNOSSOS model can feasibly be used in Australia. Included alongside this report, we have created a PostGIS server with access to the source data and scripts which run the analysis. Because some of the datasets are restricted, these are not published in the public domain. Instead they have been made available through the Centre for Air pollution, energy and health Research (CAR) Data Analysis Technology (DAT) platform (http://cardat.github.io/). Access to this can be requested through the CAR data team (car.data@sydney.edu.au).

We highlight a few issues and potential ways in which results may be improved. Primarily there would need to be careful consideration of data inputs, including overcoming any differences in data standards across the states and territories.

Additionally, there are several other papers that could feasibly be used to enhance data inputs into the CNOSSOS code. For example, Morley & Gulliver (2016) describe ways in which traffic flows on minor roads can be modelled. This could improve the CNOSSOS model, which assumes constant hourly rate across all minor roads.

3 Methods

3.1 Implementation of CNOSSOS code from Morley 2015

In Morley *et al.* (2015), a number of different models are described (A through F), which rely on differing levels of detail in the input data. The authors provided code for two of these models in their github repository, located at https://github.com/dwmorley/BioshareCNOSSOS_EU.

As this project was a feasibility study we implemented the lowest resolution model (F), starting from the code in Morley's repository. We then deviated from the original scripts in the following ways:

- Updated deprecated functions
  - ST_Line_Interpolate_Point updated to ST_LineInterpolatePoint
  - ST_Line_Locate_Point updated to ST_LineLocatePoint
- Reorganised SQL scripts so that they were modularised in a logical order catering to code dependencies

When we implemented this model we randomly generated 10 receptor points, and the model estimates the noise at each of the points.

3.2 Software

We implemented this on a PostGIS database (version 2.3 running PostgreSQL 9.6.15 on x86_64-pc-linux-gnu (Ubuntu 9.6.15-1.pgdg16.04+1), compiled by gcc (Ubuntu 5.4.0-6ubuntu1~16.04.11) 5.4.0 20160609, 64-bit) and did the analysis with SQL functions and scripts.

3.3 Data sources

The data sources used for the low resolution code in this study are outlined in Table 1 along with those used by Morley.

Input	Bankstown Data Source	Morley 2015 Data Source
Landcover	NSW State Government of NSW and Office of Environment and Heritage (OEH) (2017)	CORINE 2006 v16 (~100 m precision) European Environment Agency (2015)

Input	Bankstown Data Source	Morley 2015 Data Source
Building heights	PSMA (2019)	1) 50 m grid generalised Landmap LiDAR 2) Constant value according to CORINE urban extent
Road network	Pitney Bowes (2012)	Ordnance Survey, 2015. Meridian 2. (accessed July 2015)
Traffic flow	As for Morley *et al.* (2015)	ESCAPE/UK Department of Transport modelled traffic flow Eeftens *et al.* (2012)
Traffic composition	As for Morley *et al.* (2015)	10% heavy 90% light vehicles as according to CRTN Department of Transport (2013)
Traffic speed	Pitney Bowes (2012)	Local legal maximum limit
Topography	Flat plane (height assumed to be 1m above ground level)	Flat plane (height assumed to be 1m above ground level)
Meteorological data	**wind data** test values Annual average of 2003-2010 **temperature data** downloaded from BoM	UK Met Office air temperature and wind direction Met Office (2015)

3.4 Data category matching

The landcover data used in our feasibility study came from a NSW State Government source and the categories were matched to the CORINE codes used by Morley 2015 model as follows:

LEP Landzoning value	CORINE code	CORINE description
Business Development	121	Industrial or commercial units
Business Park	121	Industrial or commercial units
Enterprise Corridor	121	Industrial or commercial units
General Industrial	121	Industrial or commercial units
Infrastructure	121	Industrial or commercial units
Light Industrial	121	Industrial or commercial units
Primary Production Small Lots	121	Industrial or commercial units
Unzoned land	133	Construction sites
High Density Residential	111	Continuous urban fabric
Medium Density Residential	111	Continuous urban fabric
Local Centre	111	Continuous urban fabric
Mixed Use	111	Continuous urban fabric
Neighbourhood Centre	111	Continuous urban fabric
Low Density Residential	112	Discontinuous urban fabric
National Parks and Nature Reserves	313	Mixed forest
Private Recreation	142	Sport and leisure facilities (Artificial, non-agricultural vegetated areas)
Public Recreation	142	Sport and leisure facilities (Artificial, non-agricultural vegetated areas)
Special Activities	142	Sport and leisure facilities (Artificial, non-agricultural vegetated areas)
Natural Waterways	511	Water courses

4 Results

4.1 Creation of PostGIS server and data sources

We have set up a PostGIS database incorporating the Bankstown data, and along with the SQL scripts and readme in the open source software repos-

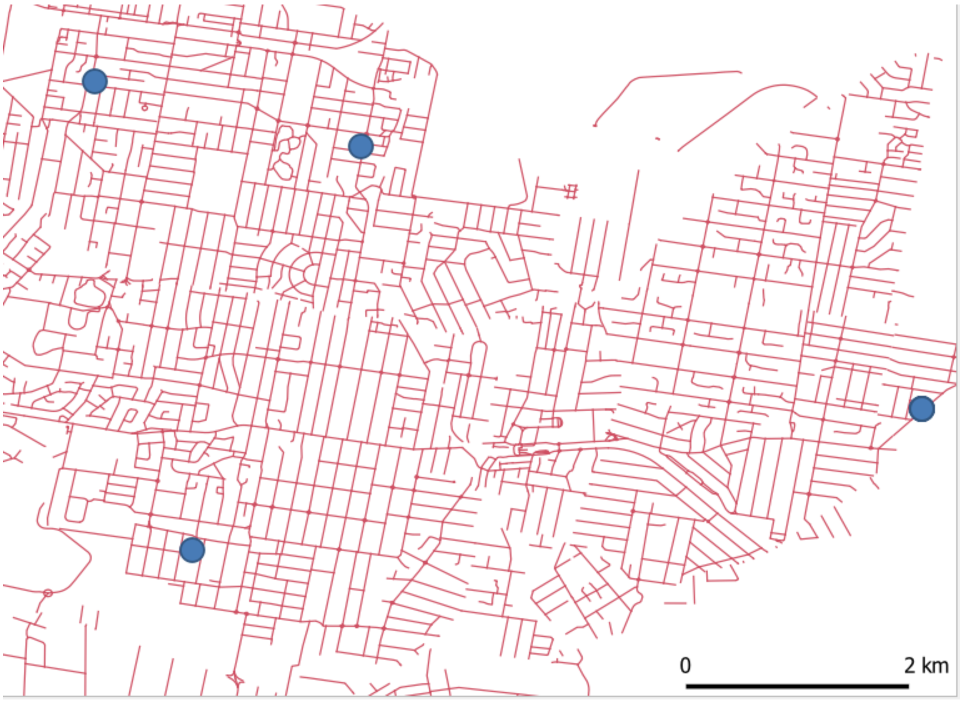

Figure 1: Bankstown roads and with some randomly generated receptor points

itory https://github.com/cardat/CNOSSOS_au_feasibility_report. In the scripts_and_analysis folder can be found the codes to run the low resolution model.

4.2 Data visualisation from QGIS

The data from each of the layers can be visualised through QGIS (https://qgis.org/en/site/). See Fig 1-3 as examples.

4.3 Noise estimates

The analysis results in a table of noise measurements at each receptor point. The results are given it deciBels (dB) and measured using LAeq (A-weighted equivalent continuous sound level). The table includes:

- Information about the receptor point (id, geometry, gps coordinates, optional description).
- Hourly noise averages.
- Noise averages for day, evening and night periods.

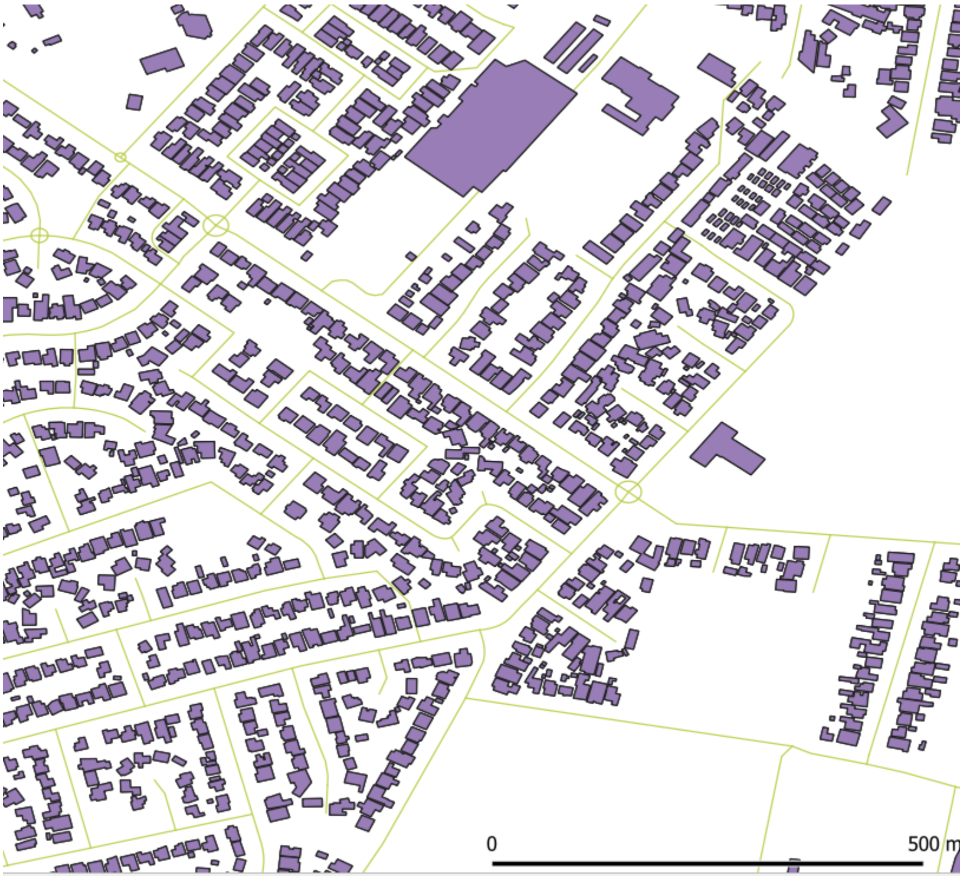

Figure 2: Bankstown roads and building footprints

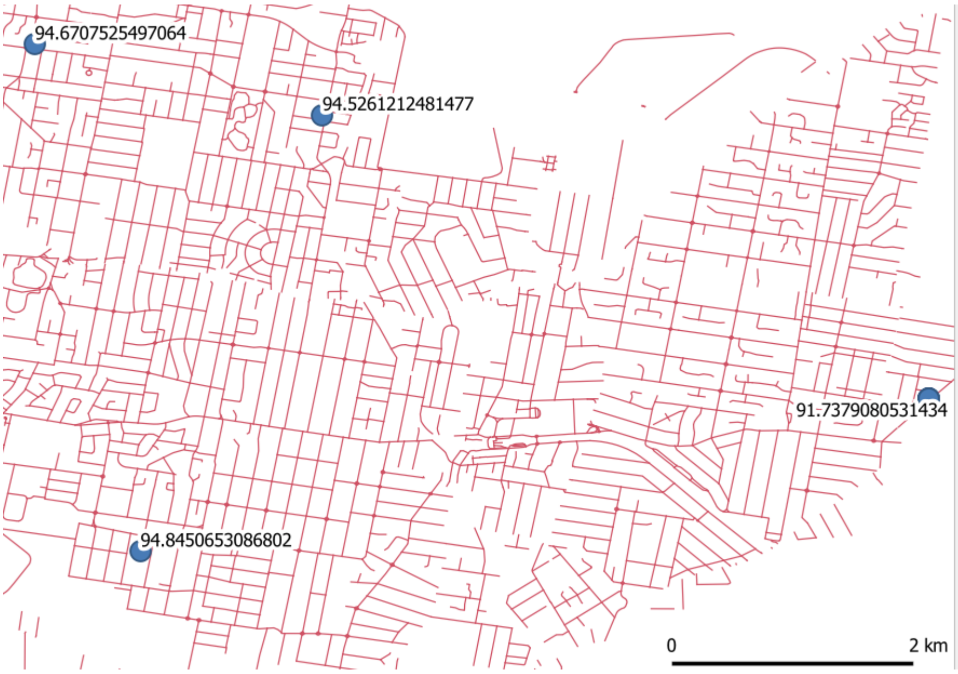

Figure 3: Receptor points and estimated traffic noise at 09:00am

- Noise averages for the 16 hour period 07:00-23:00. A full list of variables can be found in Table 3.

Table 3: Results table variables

Variable name	Description
gid	Unique identifier for the receptor
geom	The point geometry of the receptor
description	An optional description of the receptor
laeq1h_0	The average noise in dB measured using LAeq at 00:00
laeq1h_1	The average noise in dB measured using LAeq at 01:00
laeq1h_2	The average noise in dB measured using LAeq at 02:00
laeq1h_3	The average noise in dB measured using LAeq at 03:00
laeq1h_4	The average noise in dB measured using LAeq at 04:00
laeq1h_5	The average noise in dB measured using LAeq at 05:00
laeq1h_6	The average noise in dB measured using LAeq at 06:00
laeq1h_7	The average noise in dB measured using LAeq at 07:00
laeq1h_8	The average noise in dB measured using LAeq at 08:00
laeq1h_9	The average noise in dB measured using LAeq at 09:00
laeq1h_10	The average noise in dB measured using LAeq at 10:00
laeq1h_11	The average noise in dB measured using LAeq at 11:00

Variable name	Description
laeq1h_12	The average noise in dB measured using LAeq at 12:00
laeq1h_13	The average noise in dB measured using LAeq at 13:00
laeq1h_14	The average noise in dB measured using LAeq at 14:00
laeq1h_15	The average noise in dB measured using LAeq at 15:00
laeq1h_16	The average noise in dB measured using LAeq at 16:00
laeq1h_17	The average noise in dB measured using LAeq at 17:00
laeq1h_18	The average noise in dB measured using LAeq at 18:00
laeq1h_19	The average noise in dB measured using LAeq at 19:00
laeq1h_20	The average noise in dB measured using LAeq at 20:00
laeq1h_21	The average noise in dB measured using LAeq at 21:00
laeq1h_22	The average noise in dB measured using LAeq at 22:00
laeq1h_23	The average noise in dB measured using LAeq at 23:00
lday	The average noise in dB measured using LAeq during the day
leve	The average noise in dB measured using LAeq during the evening
lnight	The average noise in dB measured using LAeq during the night
laeq16	The average noise in dB measured using LAeq for the period of 07:00-23:000
lden	The average noise in dB measured using LAeq for the entire 24 hour period (day, e
st_x	The decimal longitude of the receptor point
st_y	The decimal latitude of the receptor point

Table 4 gives some example output data (truncated to fit to the page)

Table 4: Sample noise averages from analysis at 10 randomly generated receptor points

gid	laeq1h_0	laeq1h_3	laeq1h_6	laeq1h_9	laeq1h_12	laeq1h_15
1	86.07901	83.71443	92.37264	94.84507	95.28852	95.65080
2	85.90470	83.54012	92.19833	94.67075	95.11421	95.47649
3	85.76007	83.39549	92.05369	94.52612	94.96958	95.33186
4	82.97185	80.60727	89.26548	91.73791	92.18137	92.54365
5	82.97185	80.60727	89.26548	91.73791	92.18137	92.54365
6	82.97185	80.60727	89.26548	91.73791	92.18137	92.54365
7	82.97185	80.60727	89.26548	91.73791	92.18137	92.54365
8	82.97185	80.60727	89.26548	91.73791	92.18137	92.54365
9	82.97185	80.60727	89.26548	91.73791	92.18137	92.54365
10	82.97185	80.60727	89.26548	91.73791	92.18137	92.54365

5 Discussion

5.1 Limitations on data

Data availability across Australia can be inconsistent due largely to the extremely diverse population densities. While this means it may not be possible to apply the model in many areas, it is likely that there would be sufficient data to operate the model in areas of interest (i.e. populated regions).

Even where data is available, however, the lack of national standards means that the data may not be measured or represented consistently. These differences mean that matching exercises may be necessary to achieve consistent outcomes from the model.

5.2 Issues and proposed enhancements

In implementing this model we encountered a number of issues with the original code. These included:

- Lack of sample data which made it difficult to ensure new data sources met the requirements of the model. It also made it difficult to debug issues that could have been related to the input data.
- Documentation of code was provided, but it was very minimal and often difficult to understand without detailed knowledge of the accompanying paper.
- There were a couple of deprecated functions which needed to be updated to get the code to run in the more recent version of PostGIS.

If this study were to be further extended, we would recommend a different coding framework for the project.

- Best practice is to have functions defined in individual files rather than in a single SQL file.
- Using an R project to connect and run the scripts would enable more effective scripting, and easier debugging.

This study has not tested for scale and only uses 10 receptor points which are randomly generated. Expanding the results to larger areas could create performance issues.

Using the high resolution model would also improve the accuracy of estimations as it accounts for variables such as elevation. Additionally the model results could be improved through more detailed data inputs.

5.3 Validation of Results

There were no attempts made to validate the results from this experiment, except to check that the results were in the expected range for traffic noise measurements (see Table 4 for sample results).

There was data provided to the Centre for Air pollution, energy and health Research (CAR) for noise readings in various suburbs of Sydney (Penthurst, Oatley, Mt Annan, Bradbury, Woy Woy, Wyoming, Glebe, Ashbury, St Ives, Kellyville, Castle Hill). These data could potentially be used for validating the results achieved in the CNOSSOS model in these regions.

6 Conclusion

It is possible to use the CNOSSOS noise modelling framework in Australia, at least in major cities for which we have data.

There is still significant work that would need to be done to:

- Validate the model against readings from a similar source
- Add realistic data for wind and receptors, rather than the randomly generated numbers and points used in this model (i.e. use real wind data, and generate receptor points 1 metre from the facade of buildings next to the nearest road)
- Map differences in data across states and territories to ensure consistent and comparable results
- Test the performance of the model with large scale data

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