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 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

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 LEP Land Zoning 2010 NSW State Government of NSW and Office of Environment and Heritage (OEH) (2017)	CORINE 2006 v16 (~100 m precision) European Environment Agency (2015)
Building heights	Geoscape GeoScape vector data of building PSMA (2019)	1) 50 m grid generalised Landmap LiDAR 2) Constant value according to CORINE urban extent
Road network	StreetPro Navigation 2012 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	StreetPro Navigation 2012 Pitney Bowes (2012)	Local legal maximum limit
Topography	Flat plane	Flat plane
Meteorological data	**wind data** test values made **temperature data** downloaded from BoM	up | Annual average of 2003-2010 | UK Met Office air temperature and wind direction Met Office (2015)

3.4 Data mapping

The Topograpy data used in our feasibility study was mapped to the CORINE codes used by the CNOSSOS 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

LEP Landzoning value	CORINE code	CORINE description
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

A full list of the CORINE Land Cover nomenclature conversion to Land Cover Classification system codes can be found here http://dd.eionet.europa.eu/vocabulary/landcover/clc

4 Results

4.1 Creation of PostGIS server and data sources

As a deliverable we have set up a PostGIS (version 9.6.15) database with several schemas for the source data, and a public schema for the CNOSSOS tables and code. This database incorporates the Bankstown data, and along with the SQL scripts and readme in the scripts_and_analysis folder in this repository can be used to run the low resolution model.

4.2 Data visualisation from QGIS

The data from each of the layers can be visualised through QGIS. Below are some examples of data used in this report.

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 mapping exercises may be necessary to achieve consistent outcomes from the model.

Figure 1: Bankstown roads and ten randomly generated receptor points

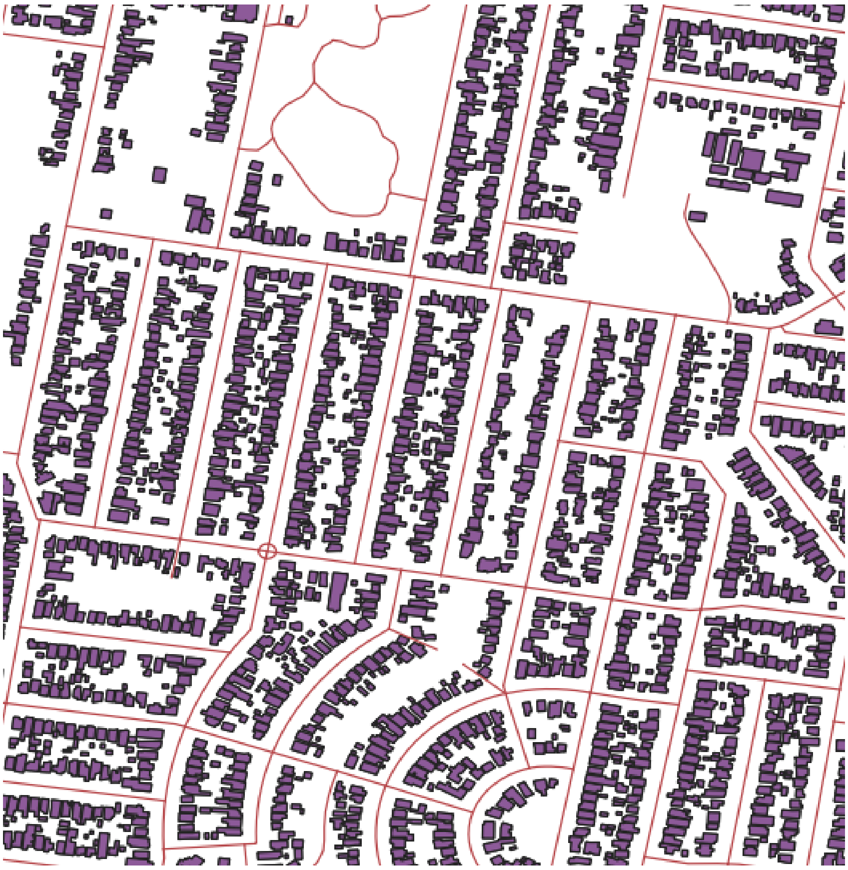

Figure 2: Bankstown roads and ten randomly generated receptor points

5.2 Issues and proposed enhancements

In implementing this model we encountered a number of issues with the orginal 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 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 IT 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 result in poor performance.

Additionally the model results could be improved through better 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.

There was data provided to the Centre for Air pollution, energy and health Research (CAR) for noise readings from the top of buildings in various suburbs of Sydney (Penthurst, Oatley, Mt Annan, Bradbury, Woy Woy, Wyoming, Glebe, Ashbury, St Ives, Kellyville, Castle Hill). These data however were not appropriate for validating the results achieved in the CNOSSOS model, as the protocols under which they were collected were different and they did not cover the same geographic regions.

If this project were to be continued it would be important to find or collect data to validate the results from the model.

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 realist 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

7 Acknowledgments

The work by Ivan Hanigan and Christy Geromboux was funded by the Clean Air and Urban Landscapes (CAUL) hub of the Australian Government's National and Environmental Science Programme (NESP).Financial support was also provided by the Centre for Air pollution, energy and health Research (CAR, http://www.car-cre.org.au) an Australian National Health and Medical Research Council (NHMRC) Centre of Research Excellence; and the Air Pollution, Traffic Exposures and Mortality and Morbidity in Older Australians (APTEMA) Study.

This research is undertaken with the assistance of resources from the Collaborative Environment for Scholarly Analysis and Synthesis (CoESRA; https :// coesr a.tern.org.au).

With thanks to our colleages Bridget Beesley, Steve van der Hoorn and Jane Heyworth in University of Western Australia, who provided support and advice on getting the orginal code to run.

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