Creating a Road Network Analysis Layer with Travel Time Estimates using Open-source Data

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Data available at: http://www.geohealth.canterbury.ac.nz/data/nzogps_240215_nal1.gdb.zip
Report available at: http://www.geohealth.canterbury.ac.nz/working/beere2016.pdf

A main focus of health geography research is assessing the impacts of environmental exposures on health. Exposures, in this instance, are anything in the environment that has the potential to negatively affect or positively contribute to health outcomes. Access to fast food outlets and obesity (Pearce *et al*. 2009), gambling opportunities and gambling behaviours (Pearce *et al*. 2008), alcohol availability and crime (Day *et al*. 2012), greenspace access and mental health (Nutsford *et al*. 2013), and traffic pollution exposure by mode of transport (Kingham *et al*. 2013) are examples of the type of research conducted by health geographers. Exposures are often modelled by determining proximity via a road network, such as measuring access to health services (Beere and Brabyn 2006; Brabyn and Beere 2006).

Distance alone is not always the most appropriate measure as the time required to travel two equal distances may vary. Travel time arguably provides a more consistent basis for comparing exposures, however, the creation and maintenance of a GIS road network with travel time attributes is resource-intensive. Proprietary New Zealand road network data with associated travel time estimates exist, but these are relatively expensive, which puts them beyond the means of many researchers and organisations. Building on the work of Brabyn and Skelly (2002), this paper discusses the methods used to produce an open-source road network analysis dataset with travel time as a resistance attribute. The intention is to produce a publicly accessible network analysis dataset suitable for modelling relationships relevant to health geography, and that can be updated relatively efficiently.

Data

Open-source national road network datasets are available from three sources in New Zealand: Land Information New Zealand (LINZ), Open Street Maps (OSM), and the New Zealand Open GPS project (NZOGPS). When Brabyn and Skelly (2002) developed their method, the LINZ dataset was the only freely available road data. The LINZ data are primarily for display purposes for the New Zealand Topographic Map series. This data have a number of connectivity issues (highway on-ramps and off-ramps in particular), which make its use for analysis impracticable. The LINZ data also do not contain bridge/tunnel data, which is necessary in order to avoid erroneous intersection connectivity being created where an overpass or underpass occurs. For example, where a bridge feature intersects with a non-connected road passing underneath it, Brabyn and Skelly's (2002) method produces an intersection where none exists.

Length, surface type (sealed/unsealed), highway status, number of lanes (<2/>=2), one-way roads, sinuosity (bendiness), and urban/rural were required to replicate Brabyn and Skelly's (2002) approach. Table 1 outlines the variables within each of the three available datasets.[1]

Table 1: Variables required for determining estimated speed

Attribute	LINZ	OSM	NZOGPS
Length	Yes	Yes	Yes
Surface Type	Yes	**No**	Yes
Highway	Yes	Yes	Yes
Number of lanes	Yes	**No**	**No**
One-way roads	Yes	Yes	Yes
Sinuosity	**No**	**No**	**No**
Urban/Rural	**No**	**No**	**No**

The absence of information about surface type ruled out the use of the OSM data. While the NZOGPS did not have information on the number of lanes, it was possible to derive a proxy using its "type" attribute field and assigning roads with the attribute 3, 4, and 5 (arterial roads) as >=2 lanes. As the NZOGPS data does not contain bridge attributes, this was obtained from the OSM data. To incorporate one-way geometries, line features representing one-way roads must be digitised consistently in the direction that traffic is permitted to move. While both the LINZ and OSM data contained one-way attributes, the digitising direction was inconsistent. The NZOGPS data had consistent one-way direction geometries and associated attributes. It is important to note that both the OSM and NZOGPS data contain estimated speed variables, but preliminary tests

[1] A full list of relevant attribute table variables, with their data source origin, is listed in the appendix.

were divergent from both ground-truthed data, Google Maps estimates, and from the original Brabyn and Skelly (2002) method. As a result, the existing estimated speed variables were not considered.

Method

The first step involved removing all data from the NZOGPS road network that were designated as "notforcar". To derive the sinuosity values, the NZOGPS data was, in its raw form, converted into a network analysis layer in ArcGIS. This was done to take advantage of the Dissolve Network tool, which removes any intersections with a valency of two. The result created a network with a single line feature between intersections (defined as a junction where three or more lines meet). Doing so was necessary as the intention was to improve upon the approach Brabyn and Skelly (2002) used to determine sinuosity. Brabyn and Skelly's (2002) approach was to divide the road network layer into 500m lengths, then calculate the sinuosity on these lengths. Sinuosity, in this instance, is defined as the ratio between the total length of each 500m segment of road relative to the distance between the start and end point of each segment. Dividing the entire network in this way is necessary as longer line segments tend to distort sinuosity values (Figure 1). Further, calculating sinuosity on lines with highly variable lengths means the resulting values are not comparable.

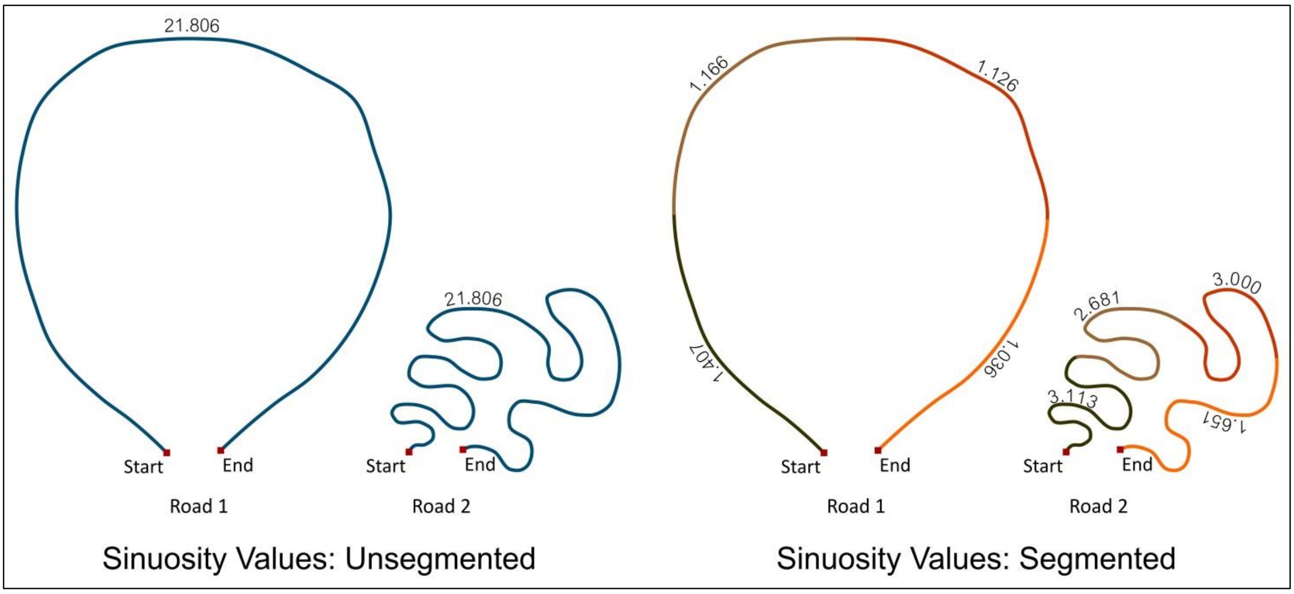

Figure 1: As their start/end distance is the same, both 'Road 1' and 'Road 2' are 2,000m and have the same sinuosity over their total length. By dividing roads into smaller segments, a more nuanced sinuosity index is created

Unless the length of a line feature is exactly divisible by 500, however, the method used by Brabyn and Skelly (2002) results in short 'artefact' line segments. In these cases, short lengths are more likely to be 'straight' and receive a low sinuosity score. This is an issue when that length may have been part of a curve in a road. To avoid creating artefact lengths, each 'intersection to intersection' feature was divided into 'as close to' 500m lengths as possible.

First, the closest divisible value to 500 was calculated for each line feature. Second, a point layer was created to split each feature in the road network based on the values outputted in the previous step. This point layer was generated via the Query Table functionality of ArcGIS. To generate the Query Table, a macro was used in Microsoft Excel to generate extra rows based on the number of divisions each line was going to be split. Based on the line features unique ID, the cumulative distance each point was to be plotted along each line was calculated (Table 2).

Table 2: Example of Query Table used to plot points for splitting road network line features

Feature ID	Split Length	Cumulative Point Location
58	478.02	478.02
58	478.02	956.05
58	478.02	1434.07
58	478.02	1912.10
58	478.02	2390.12
59	475.03	475.03
59	475.03	950.06
103	340.52	340.52
121	401.16	401.16
121	401.16	802.33
127	443.45	443.45
131	485.44	485.44
131	485.44	970.88
131	485.44	1456.32
131	485.44	1941.76
131	485.44	2427.20
138	409.00	409.00
143	336.87	336.87
147	404.53	404.53
152	554.13	554.13
152	554.13	1108.25
154	437.04	437.04
154	437.04	874.08

Using both the unique ID and cumulative distance variable, a point layer was created via the Query Table, and this was used to split the road network. Third, sinuosity was calculated for each road segment. Fourth, using a Spatial Join in ArcGIS, the original NZOGPS attributes were joined to the sinuosity layer. While this created variability in the lengths of road being assigned sinuosity values, it was deemed a better approach as it avoided the production of extra <500m line features.[2]

LINZ topographic data were used to determine which roads were urban or rural. Defining 'urban', is highly problematic (Taloci, 1998), as illustrated by the three different datasets in Figure 2. Brabyn and Skelly (2002) used the Land Cover Database (LCDB) to define urban and rural roads. The level of detail in the LCDB data, however, means that internal polygon holes (donuts) result in some urban roads being classified as rural. These internal holes can be filled, but the LCDB also tended to exclude some areas that had 'urban' characteristics that could potentially affect travel speeds, such as tourist attractions or resorts.

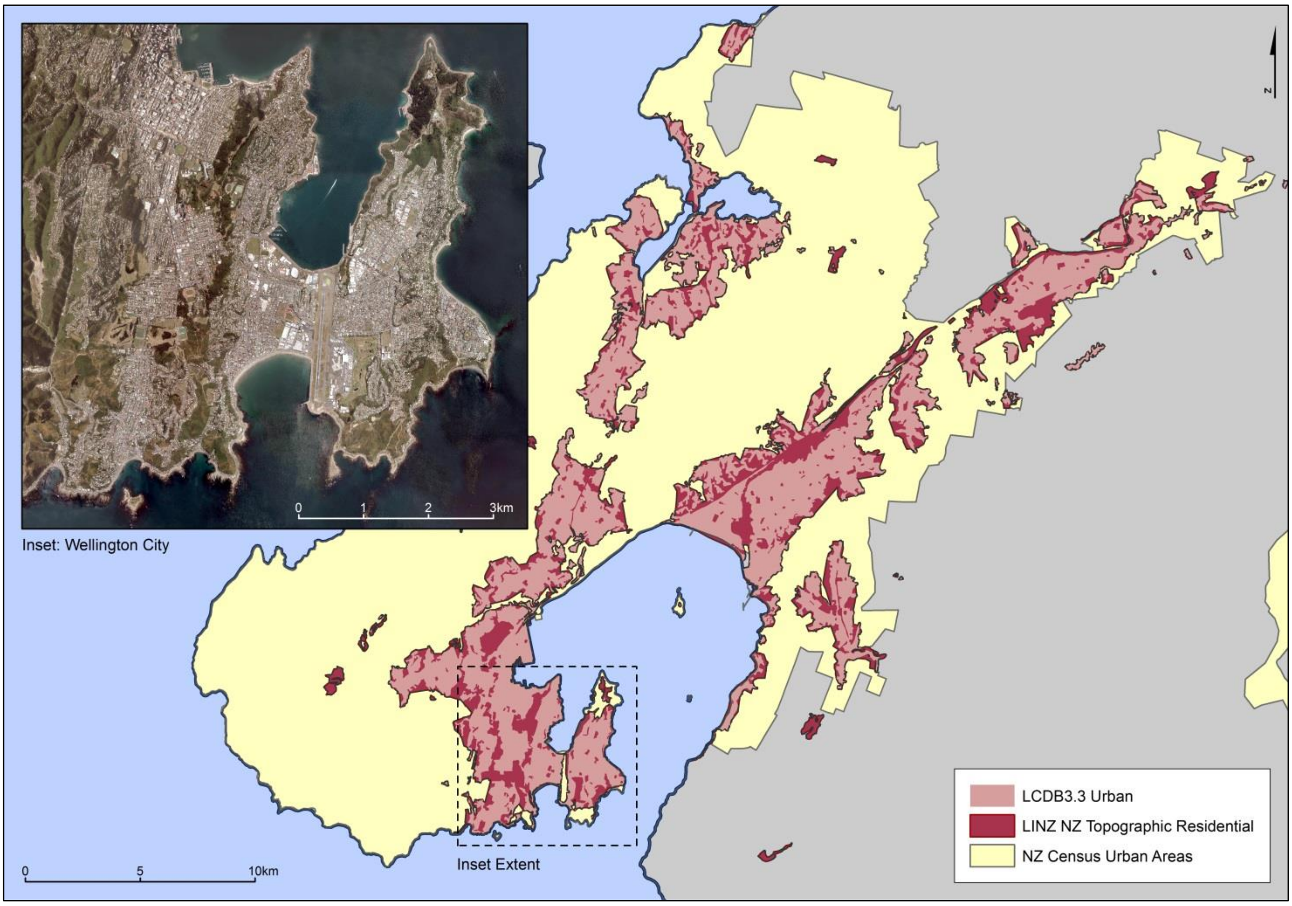

Figure 2: Comparison of three urban extent datasets: Wellington region

[2] Existing 'intersection to intersection' features in the original NZOGPS data were <500m, and these features tended to be in urban areas and have a sinuosity value of 1. Sinuosity was calculated for both the <500m features, and the features that were split.

The geometry and connectivity of the resulting output was then ‘cleaned’ using the model developed by Glennon (2011). Unconnected lines remained after this process, mainly due to roads that were under construction and yet to be connected to the road network. As the status of these roads could not be confirmed, these unconnected lines were removed.

The “type” field in the NZOGPS data provided variables to define highways, number of lanes, and surface type. Roads of “type” 1 and 2 were assigned a value of 1 in the binary “highway” field. To generate a proxy for the number of lanes variable employed by Brabyn and Skelly (2002), roads of “type” 3, 4, and 5 were assigned a value of 1 in a binary field “arterial”. A “surface” field was created and roads of “type” 10 were assigned a value of 1 to denote unsealed/metalled roads, and 0 for sealed.[3] Using the parameters in (Table 3), each road segment was assigned an estimated speed value, and from this estimated travel time in decimal minutes was calculated.

Table 3: Parameters for assigning travel speed estimates (from Brabyn and Skelly 2002)

Road Type	Estimated Average Speed
Urban highway	80km/hr
Non-urban, >=two lanes, sealed, straight roads (<1.2 ratio)	80km/hr
Non-urban, one lane, sealed, straight roads (<1.2 ratio)	70km/hr
Non-urban, >=two lanes, sealed, bendy roads (>=1.2 ratio)	60km/hr
Metalled straight roads	50km/hr
Non-urban, one lane, sealed, bendy roads (>=1.2 ratio)	40km/hr
Sealed urban roads	30km/hr
Metalled bendy roads (>=1.2 ratio)	30km/hr

In order to allow end-users/researchers to incorporate the population of offshore islands in their analysis, ferry routes were digitised and added to the road network layer. Ferry travel times were manually added as the time resistance. Connecting offshore islands to the mainland also serves to avoid issues that arise when network analysis search tolerances allow ‘island hopping’ to occur (Figure 3). Using the Create Network Analysis tool in ArcGIS, a new analysis layer was created, with estimated time, length, and one-way variables used to defined analysis attributes.

[3] A full list of existent and derived variables in the NZOGPS network analysis layer are included in the appendix.

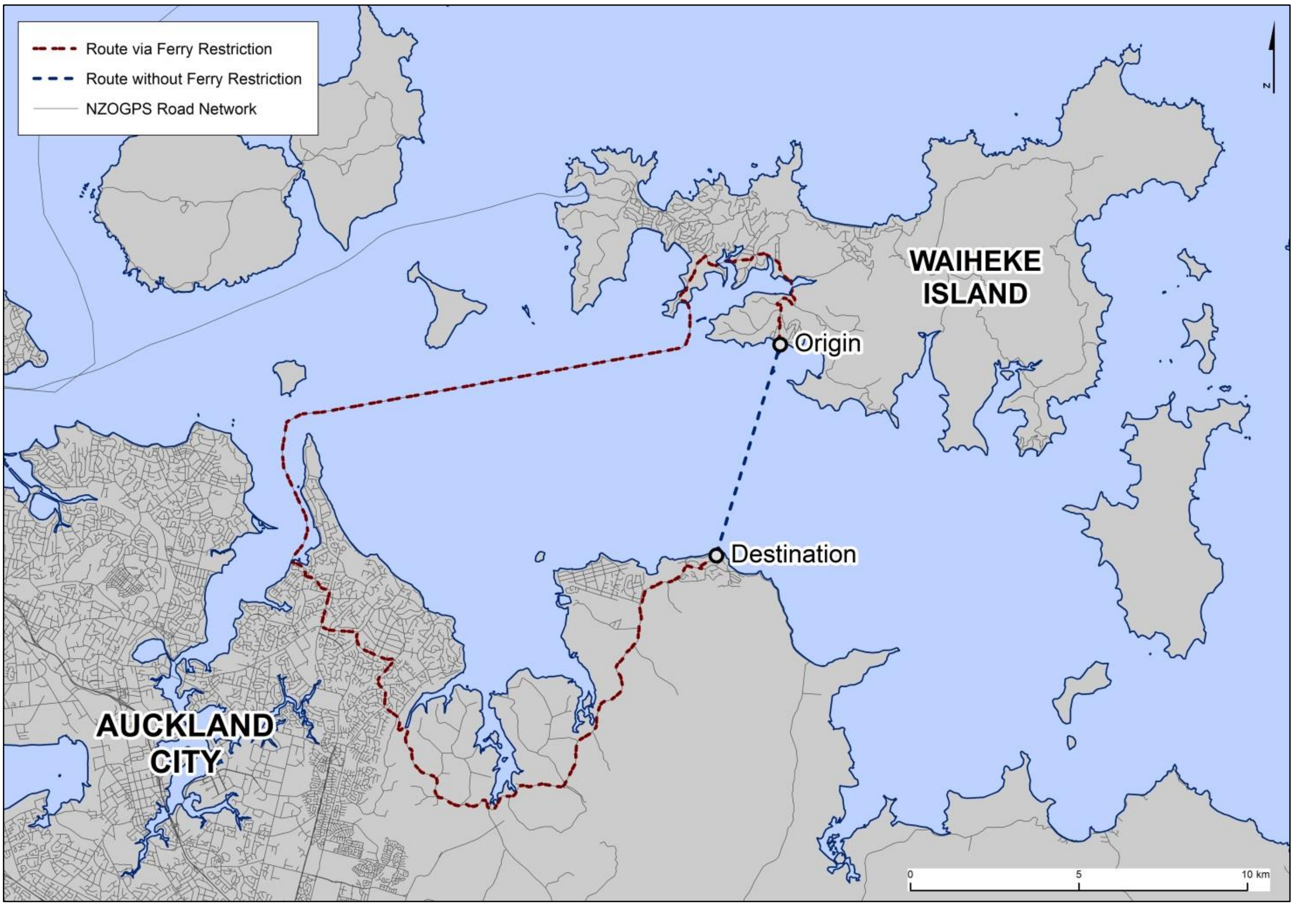

Figure 3: Example of network analysis layer origin/destination result with and without ferry route restrictions

Validation

As a means to check the estimates produced by the model, 67 routes were created using Google Maps, the geometries of which were exported as kml files. The 67 Google Maps routes were then replicated in the road network analysis layer. As the Google Maps routes did not align with the NZOGPS layer, the kml files were first converted to points using the Vertices to Points tool in ArcGIS. Second, the ArcGIS Near function was then used to determine the closest network analysis layer junctions that the Google Maps route points corresponded to. Third, new point versions of the 67 Google Maps routes were generated using the xy coordinate variables outputted from the Near tool. Due to some of the original Google Maps route vertices being in closer proximity to side road junctions and opposing lanes in the network analysis layer, each had to be manually checked for accuracy (see Figure 4). Fourth, the Make Route Layer tool in ArcGIS was used to calculate travel time estimates to compare against the Google Maps estimates.

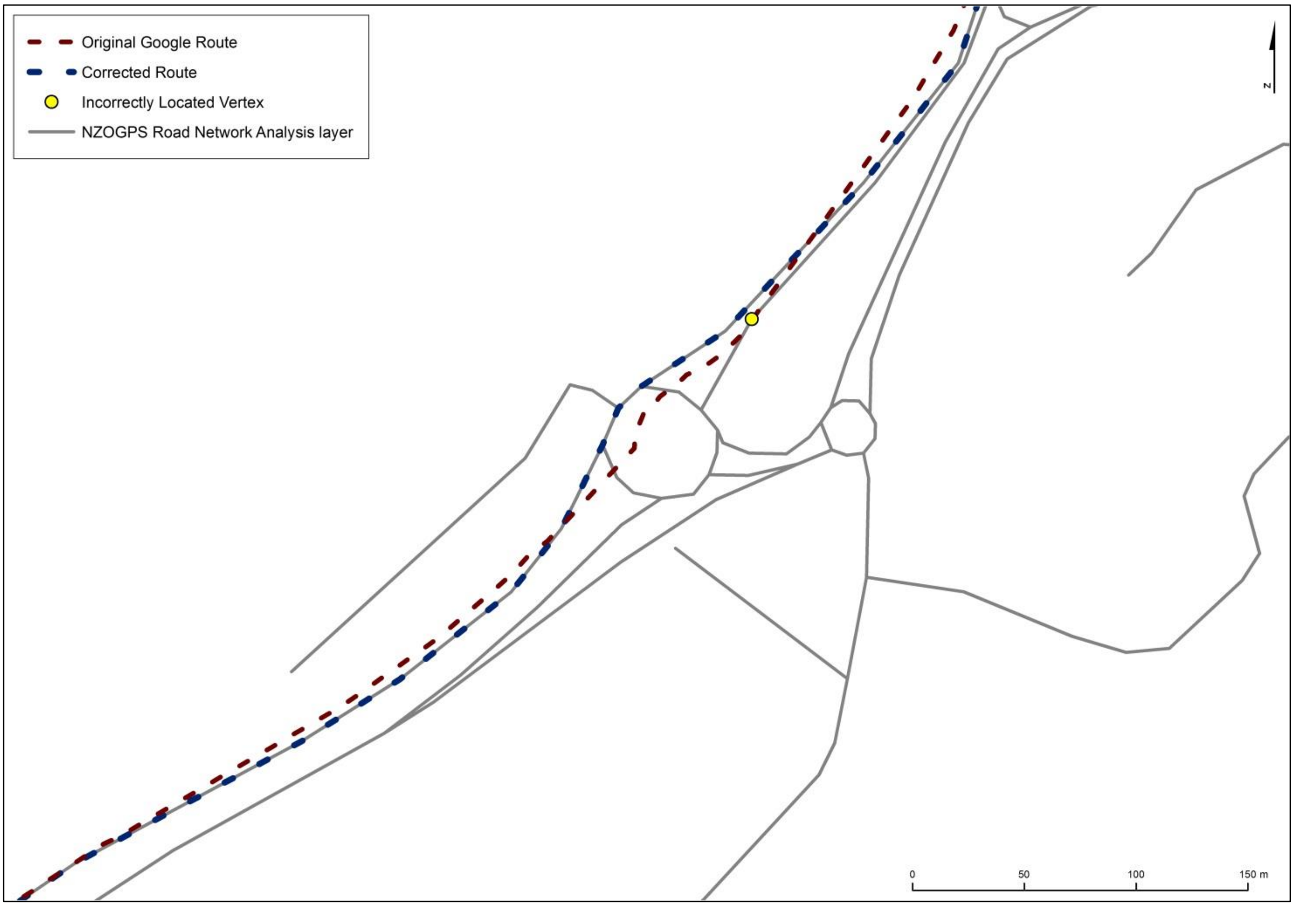

Figure 4: Example of misaligned routes, and incorrectly located vertices

The 67 Google Maps routes were selected at random, but were weighted to ensure <10, <20, <30, and <60 minute time brackets were well-represented (n=34). Health service provision or environmental exposure research conducted in the GeoHealth Laboratory often has a focus on travel times <60, so it was important to ensure estimates were representative at this scale. In part, this reflects the metrics used to determine what constitutes 'accessible' in relation to health services (see Beere and Brabyn, 2006; Brabyn and Beere 2006). For the purposes of consistency across the entire network, >60 minute routes were also analysed. As the NZOGPS network analysis layer did not incorporate intersections, time of day, or congestion as resistances, the 'without traffic' Google Maps travel time estimates were used. Pearson correlation and paired t-test analysis were conducted in R to compare the two estimate datasets.

Results

The estimates from both Google Maps, and the road network analysis layer, are shown in Table 4. Paired t-test analysis for all modelled routes (n=67) returned a mean of the differences of -6.41 (p-value <0.001) and a coefficient of 0.998. For the routes <60 minutes, the coefficient was 0.986, and the mean of the differences was -0.364 but this was not significant.

Table 4: Travel time estimates from Google Maps and the NZOGPS-based road network analysis layer

Route	Google Minutes	Model Minutes	Google km	Model km	Time Difference	Time Difference as Percentage of Google Estimate
Dominion Road to Ward Street, Kaitaia	3.00	2.50	1.20	1.25	-0.50	-16.82
24 Bidwill Street to 1 Daniell Street, Wellington	4.00	3.36	1.60	1.68	-0.64	-15.88
Duncan Street to Toko Street, Rotorua	4.00	4.68	2.30	2.34	0.68	17.01
Galaxy Drive to Brighton Terrace, Auckland	4.00	3.56	1.90	1.78	-0.44	-11.02
Selwyn Street to Buckley Road, Auckland	5.00	5.83	2.90	2.92	0.83	16.68
15 Bryndwr Road to 4 Grassmere Street, Christchurch	7.00	7.34	3.90	3.67	0.34	4.91
Lovatt Crescent to Russell Road, Whangarei	7.00	5.47	3.10	3.06	-1.53	-21.84
Waimea Road to Weka Street, Nelson	7.00	9.05	4.50	4.53	2.05	29.32
Balloch Street to Cook Street, Hamilton	8.00	7.31	3.70	3.66	-0.69	-8.58
Boyce Avenue to Bentleigh Avenue, Auckland	8.00	6.64	3.80	3.32	-1.36	-16.98
Wills Street to Kinsman Street, Dunedin	10.00	9.56	4.80	4.78	-0.44	-4.37
3 Treasure Grove to 12 Aitken Street, Wellington	12.00	9.30	6.40	6.56	-2.70	-22.54
Christchurch to Belfast, Canterbury	15.00	14.56	10.30	10.26	-0.44	-2.95
5 Stafford Street to 5 Wrights Hill Road, Wellington	16.00	15.74	7.80	7.87	-0.26	-1.64
Derwent Crescent to Arundel Street, Auckland	16.00	22.31	11.00	11.15	6.31	39.44
3 Rex Street to 25 Fleete Street, Christchurch	17.00	19.82	9.90	9.91	2.82	16.57
Kennington to Wallacetown, Southland	17.00	14.74	19.20	19.33	-2.26	-13.30
Baffles Crescent to Baverstock, Hamilton	18.00	18.26	13.60	13.72	0.26	1.42
Wellington to Porirua, Wellington	19.00	20.07	20.40	20.57	1.07	5.65
Victoria Road to Port Chalmers, Otago	21.00	18.81	16.90	17.11	-2.19	-10.41
Cliffs Road to Braeview Crescent, Dunedin	22.00	23.09	11.50	11.54	1.09	4.95
Cornfoot Street, Whanganui to Whangaehu	22.00	26.26	24.20	24.18	4.26	19.37
1 Dinton Street to 10 Marine Parade, Christchurch	25.00	27.13	18.80	18.83	2.13	8.50
Grieve Road, Te Teko to Wairaka Road, Whakatane	25.00	26.50	28.60	28.86	1.50	5.99
Vanguard St, Nelson to Aranui Road, Mapua	28.00	30.01	30.70	30.82	2.01	7.18
Splitt Avenue, Hamilton to Huntly	32.00	30.07	36.80	36.87	-1.93	-6.03
Etherton Drive to Glover Road, Auckland	35.00	42.50	28.90	29.32	7.50	21.44
Martinborough to Masterton	36.00	35.25	43.00	43.04	-0.75	-2.09
Winton to Edendale	40.00	40.41	53.40	53.62	0.41	1.03
Thames to Tairua	41.00	39.33	49.00	49.44	-1.67	-4.06
Martinborough to Upper Hutt	46.00	41.24	48.20	48.65	-4.76	-10.34
Tauranga to Lichfield	51.00	54.81	70.10	70.12	3.81	7.47
Hamilton to Lichfield	56.00	58.14	73.00	73.17	2.14	3.83
Wanaka to Queenstown	58.00	53.73	67.20	67.36	-4.27	-7.37
Christchurch to Ashburton	66.00	73.00	88.70	88.87	7.00	10.61
Tuturumuri to Masterton	67.00	63.65	74.20	74.20	-3.35	-5.01
Piha to Tui Vale Road, Auckland	69.00	76.31	61.70	61.97	7.31	10.60
Hokitika to Arthur's Pass	73.00	75.14	99.60	99.84	2.14	2.94
Gore to Milton	77.00	73.07	96.70	96.96	-3.93	-5.10
Matamata to Otakiri	92.00	96.84	127.00	127.55	4.84	5.26
Christchurch to Hanmer Springs	99.00	107.15	133.00	133.57	8.15	8.23
Palmerston North to Herbertville	100.00	98.22	119.00	121.28	-1.78	-1.78
Wellington to Palmerston North	110.00	113.61	141.00	140.75	3.61	3.28
Auckland to Whangarei	116.00	123.03	158.00	157.96	7.03	6.06
Tuturumuri to Paraparaumu	117.00	109.25	129.00	129.76	-7.75	-6.63
Christchurch to Timaru	121.00	130.37	165.00	164.95	9.37	7.75
Kumeu to Dargaville	130.00	130.12	171.00	170.75	0.12	0.09
Stratford to Tihiroa	152.00	165.95	218.00	218.76	13.95	9.18
Gisborne to Potaka	166.00	152.06	198.00	198.21	-13.94	-8.40
Christchurch to Oamaru	179.00	195.51	250.00	250.18	16.51	9.22
Picton to Takaka	192.00	184.27	237.00	237.80	-7.73	-4.03
Christchurch to Twizel	195.00	222.32	285.00	285.90	27.32	14.01
Charleston to Takaka	227.00	227.65	292.00	292.57	0.65	0.28
Wellington to Napier	231.00	245.65	315.00	315.23	14.65	6.34
Christchurch to Westport	241.00	257.58	332.00	332.26	16.58	6.88
Paparoa to Cape Reinga	242.00	241.92	318.00	318.50	-0.08	-0.03
Christchurch to Picton	243.00	262.13	337.00	337.12	19.13	7.87

Route	Google Minutes	Model Minutes	Google km	Model km	Time Difference	Time Difference as Percentage of Google Estimate
Christchurch to Dunedin	255.00	277.28	361.00	361.60	22.28	8.74
Christchurch to Nelson	294.00	325.97	415.00	415.79	31.97	10.87
Coromandel to Opononi	328.00	324.84	427.00	427.82	-3.16	-0.96
Christchurch to Queenstown	329.00	371.47	484.00	484.71	42.47	12.91
Karamea to Haast	391.00	394.77	513.00	514.41	3.77	0.97
Christchurch to Invercargill	397.00	432.48	566.00	566.73	35.48	8.94
Opunake to Gisborne	439.00	459.98	591.00	592.87	20.98	4.78
Wellington to Auckland	446.00	494.80	643.00	644.00	48.80	10.94
Whangarei to Gisborne	463.00	504.93	640.00	641.10	41.93	9.06
Picton to Invercargill	628.00	681.08	896.00	897.21	53.08	8.45

Relative to the Google Maps estimates, the road network analysis layer both overestimated (n=42) and underestimated (n=25) route times. The majority of underestimates occurred below the 20th percentile, and were relatively evenly distributed above the 20th percentile for the overestimates. Most overestimates occurred above the 80th percentile. The average overestimate time was 11.87 minutes, and the average was -2.74 minutes for underestimates. When broken down by quintiles, underestimates were relatively similar, apart from the 61%-80% range, which was over double that of the next highest mean (Table 5). For the overestimates, these were relatively similar below the 60th percentile, but showed a large increase above this.

Table 5: Comparisons of over and underestimates by quintile

Time Quintile	Underestimate		Overestimate	
	Average of Difference Minutes	Count	Average of Difference Minutes	Count
1 (Shortest)	-0.90	10	2.04	5
2	-2.13	3	2.51	9
3	-3.12	6	3.95	7
4	-7.80	4	9.63	9
5 (Longest)	-1.62	2	29.26	12

The largest difference in distance, expressed as a percentage of the original distance, was 5.15% over a 1.6km distance (80m), followed by 3.97% over a 1.2km distance (50m). All other differences in distances between Google Maps and NZOGPS routes were less than +/-2% of the original Google Maps distance. More variation was observed in the differences between travel time estimates (Table 4). No distinct linear trend was observed in the time difference percentage relative to the Google Maps travel time estimate. Larger percentage difference discrepancies did tend to occur for the shorter routes, but this was not statistically significant.

Discussion

The goal of this project was to produce a road network analysis layer suitable for conducting social epidemiology research involving spatial and travel time relationships, such as access to health services. Due to the variability of network travel via private motor vehicles (time of day, unexpected congestion, road works, accident events), without detailed network flow data, producing an accurate representation rarely translates to 'real world' experiences. For the purposes of this project, however, it was important to provide some context in which to benchmark results. The intention was to see how well the network analysis layer based on NZOGPS and OSM attributes and NZOGPS geometries aligned with a commonly used metric such as Google Maps.

While both Google Maps and the NZOGPS network analysis layer estimates are contestable, it was pleasing that equivalent route times were closely aligned. Even with the model both underestimating and overestimating travel times, the range within which the estimates fell (difference of means=-6.41, p-value <0.001; coefficient=0.998) meant that a satisfactory estimate metric had been produced. Satisfactory, in this instance, refers to an 'intuitive' representation of travel time through the New Zealand road network.

Google Maps time estimates were rounded to the nearest minute, so this is likely to have resulted in inflated discrepancies between estimates. This is particularly true for shorter routes. Further, variation in the distances between the two models may have also contributed to some variability. These differences for the most part were within -/+2% of the original Google Maps route, and resulted from simplified or divergent geometries (Figure 4). For this reason, the author is satisfied that the routes were close enough in distance for the purposes of comparison.

Acquiring the latest NZOGPS geometries for network analysis layer is possible via the NZOGPS portal at https://github.com/NZOGPS/nzopengps. Instructions on how to download and convert the raw NZOGPS data for ArcGIS can be accessed at http://gwprojects.org/forum/viewtopic.php?f=3&t=348.

I would like to acknowledge the generous help of Gary Turner from the New Zealand Open GPS Project for your help in accessing data and advice in converting files.

References

Beere, P., and Brabyn, L., (2006). Providing the evidence: Geographic accessibility of maternity units in New Zealand. *New Zealand Geographer*, *62*(2), pp. 135-143.

Brabyn, L., and Beere, P., (2006). Population access to hospital emergency departments and the impacts of health reform in New Zealand. *Health Informatics Journal*, *12*(3), pp. 227-237.

Brabyn, L., and Skelly, C., (2002). Modeling population access to New Zealand public hospitals. *International Journal of Health Geographics*, 1(3). http://www.ij-healthgeographics.com/content/1/1/3

Day P., Breetzke G., Kingham S., and Campbell M., (2012). Close proximity to alcohol outlets is associated with increased serious violent crime in New Zealand. *Australian and New Zealand Journal of Public Health*, 36(1) , pp. 48-54. doi: 10.1111/j.1753-6405.2012.00827.x

Glennon, R., (2011). Cleaning up line data with geoprocessing. https://blogs.esri.com/esri/arcgis/2011/11/15/cleaning-up-line-data-with-geoprocessing/. Accessed 26 April 2016.

Kingham S., Longley I., Salmond J., Pattinson W., and Shrestha K., (2013). Variations in exposure to traffic pollution while travelling by different modes in a low density, less congested city. *Environmental Pollution*, 181, pp. 211-218. http://dx.doi.org/10.1016/j.envpol.2013.06.030

Nutsford D., Pearson A., and Kingham S., (2013). An ecological study investigating the association between access to urban green space and mental health. *Public Health*, 127 (11), pp. 1005-1011. http://dx.doi.org/10.1016/j.puhe.2013.08.016

Pearce J., Hiscock R., Blakely T., and Witten K., (2009). A national study of the association between neighbourhood access to fast food outlets and the diet and weight of local residents. *Health and Place*, 15(1), pp. 193-197.

Pearce J., Mason K., Hiscock R., and Day P., (2008). A national study of neighbourhood access to gambling opportunities and individual gambling behaviour. *Journal of Epidemiology and Community Health*, 62(10), pp. 862-868.

Taloci, C., (1998). Rural-urban interactions: a guide to the literature. *Environment and Urbanization*, 10(1), pp. 147-166.

Appendix

List of Open Street Map road variables

Field Name	Type	Description	Variables
FID	Integer	Unique numeric system ID	
Shape	String	Artibrary system variable	Polyline
osm_id	Integer	Unique numeric ID	
name	String	Road names	
ref	String	State/regional highway code	
type	String	Route type	abandoned, bridle-way, construction, crossing, cycle-way, footway, footwaypath, living_street, motorway, motorway_link, paper, path, path-disabled, path;track, pedestrian, platform, primary, primary_link, proposed, race-way, residential, rest_area, road, secondary, secondary_link, service, steps, subway, tertiary, tertiary_link, tidal_path, track, traffic_signals, trunk, trunk_link, turning_circle, unclassified, unclassified_lin, undefined, unknown, unmarked_route, unsurfaced
one-way	binary	One-way roads	0 (no), 1 (Yes)
bridge	binary	Bridges	0 (no), 1 (Yes)
tunnel	binary	Tunnels	0 (no), 1 (Yes)
maxspeed	Integer	Legal speed limits. Not comprehensive/missing data	0, 3, 5, 8, 10, 15, 20, 25, 30, 40, 50, 56, 60, 70, 72, 80, 90, 93, 100

List of LINZ road data variables

Field Name	Type	Description	Variables
FID	Integer	Unique numeric system ID	
Shape	String	Artibrary system variable	Polyline
name_ascii	String	Road name (ASCII format)	
macronated	String	Text data after July 2012 in UTF-8 format. If your system is not UTF-8 compliant, you will need to use this attribute, which has had any macronated vowels removed.	y, n
name	String	Road name	
hway_num	Integer	State highway number	
rna_sufi	Integer	This is a unique identifying number given to the Electoral/Landonline Road Centreline ID. It replaces the name_ID attribute in earlier Topo Road Centreline layers. This will enable users a direct link via the IDs to the NZ Road Centre Line (Electoral) layer.	
lane_count	Integer	Number of road lanes	1, 2, 3, 4, 5, 6, 7, 8, {blank}
way_count	String	One way roads	one-way, {blank}
status	String	Road construction status	under construction, {blank}
surface	String	Road surface type	sealed, metalled, unmetalled

NZOpenGPS road data variables

Field Name	Type	Description	Variables
type	Integer	Numeric code for road types. 1-2 Highways, 3-6 vechicle roads, 7 access/service lanes, 8 arterial road access, 9,11 on/off ramps, 10 unsealed roads	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 20, 22, 24, 26, 27, 28, 31, 41
label	String	Road name, type	
descr	String	State highway description	
city	String	City name	
region	String	Regional council area	
country	String		new zealand~[0x1d]nz
one-way	Binary	One-way roads	0 (no), 1 (yes)
toll	Binary	Toll road status	1 (no), 1 (yes)
speed	Integer	The speed limit attribute does not refer to legal speed limits. It may be interpreted as an attempt at capturing the 'actual' speed a car would travel on a given road, but actually relates to the routing systems used by in-car GPS units so that trip-routing is optimised. For example, a road with speed bumps may be classified as having a speed attribute of 1 (20km/h) so that it is distinct from adjacent roads of category 2 or 3 (40km/h and 60km/h, respectively), even if these are not the legal speed limits for these sections of the road network.	0 = 5km/h 1 = 20km/h 2 = 40km/h 3 = 60km/h 4 = 80km/h 5 = 100km/h 6 = 110km/h 7 = no limit
class	Integer	Road type classification	0 = Residential 1 = Collector 2 = Arterial 3 = Principal HW 4 = Major HW
roadid	Integer	Unique road identity number	
level	Integer	?	0
endlevel	Integer	?	0,1
notforemer	Binary	Road not accessible to emergency service vehicles	0 (no), 1 (yes)
notfordeli	Binary	Road not accessible to delivery vehicles	0 (no), 1 (yes)
notforcar	Binary	Road not accessible to private motor vehicles	0 (no), 1 (yes)
notforbus	Binary	Road not accessible to buses	0 (no), 1 (yes)
not fortaxi	Binary	Road not accessible to taxis	0 (no), 1 (yes)
notforpede	Binary	Road not accessible to pedestrians	0 (no), 1 (yes)
notforbicy	Binary	Road not accessible to bicycles	0 (no), 1 (yes)
notfortruc	Binary	Road not accessible to heavy transport vehicles	0 (no), 1 (yes)

Road network analysis metadata

Field Name	Type	Description	Variables
OBJECTID	Object ID	System-generated	Unique
Shape*	Geometry	System-generated	Polyline
TARGET_FID	Long	Unique ID for features split for sinuosity calculation	Unique
FID_nzogps_Corrected	Long	ID for feature outputs from network dissolve	Non-unique 2-198722
type	Integer	Numeric code for road types. 1-2 Highways, 3-6 vechicle roads, 7 access/service lanes, 8 arterial road access, 9,11 on/off ramps, 10 unsealed roads	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 20, 22, 24, 26, 27, 28, 31, 41
label	String	Road name, type	
descr	String	State highway description	
label3	String	State highway description	
city	String	City name	
region	String	Regional council area	
country	String		new zealand~[0x1d]nz
one-way	Binary	One-way roads	0 (no), 1 (yes)
toll	Binary	Toll road status	1 (no), 1 (yes)
speed	Integer	The speed limit attribute does not refer to legal speed limits. It may be interpreted as an attempt at capturing the 'actual' speed a car would travel on a given road, but actually relates to the routing systems used by in-car GPS units so that trip-routing is optimised. For example, a road with speed bumps may be classified as having a speed attribute of 1 (20km/h) so that it is distinct from adjacent roads of category 2 or 3 (40km/h and 60km/h, respectively), even if these are not the legal speed limits for these sections of the road network.	0 = 5km/h 1 = 20km/h 2 = 40km/h 3 = 60km/h 4 = 80km/h 5 = 100km/h 6 = 110km/h 7 = no limit
class	Integer	Road type classification	0 = Residential 1 = Collector 2 = Arterial 3 = Principal HW 4 = Major HW
roadid	Integer	Unique road identity number	
level	Integer	?	0
endlevel	Integer	?	0,1
notforemer	Binary	Road not accessible to emergency service vehicles	0 (no), 1 (yes)
notfordeli	Binary	Road not accessible to delivery vehicles	0 (no), 1 (yes)
notforcar	Binary	Road not accessible to private motor vehicles	0 (no), 1 (yes)

Field Name	Type	Description	Variables
notforbus	Binary	Road not accessible to buses	0 (no), 1 (yes)
not fortaxi	Binary	Road not accessible to taxis	0 (no), 1 (yes)
notforpede	Binary	Road not accessible to pedestrians	0 (no), 1 (yes)
notforbicy	Binary	Road not accessible to bicycles	0 (no), 1 (yes)
notfortruc	Binary	Road not accessible to heavy transport vehicles	0 (no), 1 (yes)
road_class	String	Text version of NZOGPS "roadclass" field, from the NZOGPS metadata. This field also used to label bridges/underpassess that were identified from OSM. Column 12 characters long	ArterialOT = Arterial Overpass/Tunnel ArterialT = Arterial Tunnel ArterialU = Arterial Underpass Collector = Collector CollectorB = Collector Bridge CollectorOT = Collector Overpass/Tunnel CollectorT = Collector Tunnel CollectorU = Collector Underpass Major HWTU = Major Highway Tunnel/Underpass Major HWU = Major Highway Underpass Major HW = Major Highway Major HWB = Major Highway Bridge Major HWBU = Major Highway Bridge/Underpass Major HWT = Major Highway Tunnel Major HWU = Major Highway Underpass Principal BU = Principal Highway Bridge/Underpass Principal B = Principal Highway Bridge Principal HT = Principal Highway Tunnel Principal HU = Principal Highway Underpass Principal HW = Principal Highway Principal OT = Principal Highway Overpass/Tunnel ResidentiaBU = Residential Street Bridge/Underpass Residential = Residential Street ResidentialB = Residential Street Bridge ResidentialT = Residential Street Tunnel ResidentialU = Residential Street Underpass ResidentiaOT = Residential Street Overpass/Tunnel
one-way_char	String	Text version of NZOGPS "one-way" field. Used for one-way restrictions compatible with ArcGIS	Null = two-way F = one-way
Urban_Rural	Binary	Urban/rural definition based on NZTopo "Residential Areas" dataset	0 = rural 1 = urban

Field Name	Type	Description	Variables
sinuosity	Double	Ratio of total length divided by the distance between the start and end vertices.	1 = straight <1.2 = not 'bendy' >=1.2 = 'bendy'
road_name	String	Capitalised and cleaned version of the NZOGPS "label" field, from the NZOGPS	
highway	Binary	Binary variable to identify highways derived from the NZOGPS "type" field	0 = not highway 1 = highway
surface	Binary	Binary variable to identify metalled/unsealed roads derived from the NZOGPS "type" field	0 = metalled/unsealed 1 = sealed
arterial	Binary	Binary variable to identify arterial roads derived from the NZOGPS "type" field. This is a proxy for >=two-lane roads that are not highways	0 = not arterial 1 = arterial
estimated_speed	Integer	Estimated speed in km/h based on Brabyn and Skelly (2002)	30, 40, 50, 60, 70, 80
estimated_travel_time	Double	Estimated travel time based on "estimated_speed" and "Shape_Length"	Non Urban Arterial Bendy Non Urban Arterial Straight Non Urban Bendy Non Urban Straight Residential Unsealed Bendy Unsealed Straight Urban Highway
class_types	String	Text version of "estimated_speed" field	30 = Residential 30 = Unsealed Bendy 40 = Non Urban Bendy 50 = Unsealed Straight 60 = Non Urban Arterial Bendy 70 = Non Urban Straight 80 = Non Urban Arterial Straight 80 = Urban Highway
Shape_Length	Double	System-generated	