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SUPPLEMENTAL DATA

Spatial Analysis Methods

The second part of this study uses a spatial lens to examine the alignment of active transport and urban forestry policies in the City of Melbourne (CoM). Geographic Information System (GIS) analysis is a useful tool for triangulating findings that involve a spatial component. Steinberg and Steinberg (2006) define spatial analysis as an exploration of the relationships within and between data in space, which provides the ability to define common geographies and their characteristics as they relate to other information that has been collected. This spatial analysis therefore has two key benefits. Firstly, it offers an alternative method of answering the research question, by providing a geographically grounded evidence base for examining the alignment of active transport and urban forestry policies in the CoM. Secondly, the results from this analysis are triangulated with findings from the policy analysis, to facilitate a deeper understanding of how policy relates to built form outcomes. Since this study is concerned with urban planning and determinants of health that relate to the built environment, analysing spatial variables allows for a more holistic understanding of infrastructure alignment.

To answer the research question, *how are City of Melbourne's Transport Strategy and Urban Forest Strategy aligned to achieve common public health goals*, existing formalised bicycle lanes are compared against tree canopy. The percentage surface area of each bicycle lane which is covered by tree canopy is calculated to determine the extent to which each segment of bicycle lane is aligned with canopy coverage. This analysis also generates insights on the areas of the cycling network with the highest and lowest canopy coverage.

Data Selection and Processing

All spatial data processing and analysis tasks were performed using a combination of ArcGIS Pro (version 2.9.32739) and ArcGIS Desktop (version 10.8.28388). Aerial imagery was sourced from the Esri World Imagery (Esri) and Nearmap.

Existing and proposed bicycle lanes

The shapefile for '*Bicycle routes, including informal, on-road and off-road routes*' (bicycle routes) within the CoM were available via the CoM's Open Data portal (City of Melbourne Open Data Team, 2016a). The bicycle routes shapefile contained metadata that was useful to inform the spatial analysis (Table S1).

Table S1. *Relevant metadata within the bicycle routes shapefile*

Metadata field name	Description	Purpose within this study
Type	Provides information on the type of bicycle lane (on-road, off-road or informal)	Bicycle lane typology was used to estimate bicycle lane widths and convert linework to polygons by generating buffer areas for each bicycle lane
Direction	Provides information on directionality (both directions or one way)	Used to verify whether cycling lanes were located on one side or both sides of the road
Status	Provides information on whether the bicycle lane is existing or proposed (blank value indicates existing infrastructure)	Used to categorise bicycle lanes into 'existing' and 'proposed'

Since the bicycle routes shapefile contained lines that ran through the centre of each road, further data processing was necessary to generate more accurate bicycle lane alignments within the road reserve. This was executed manually using the 'edit vertices' function in ArcGIS Pro (Figure S1).

Figure S1*. Example of conversion from centreline (yellow) to approximate bicycle lane alignments (grey)*

The '*Road segments, with surface type*' shapefile was obtained from the CoM Open Data website (City of Melbourne Open Data Team, 2016b) and used as a comparative layer to estimate the alignment of bicycle lanes where aerial imagery was not clear (Figure S2).

***Figure S2**. Example of the use of the road segments layer (purple) to improve accuracy of bicycle lane alignments. Bicycle lanes (grey) were aligned to the edges of road reserves where aerial imagery was unclear.*

Each bicycle lane was categorised using metadata contained within the bicycle routes shapefile. This was cross-referenced with recent CoM publications, including the *Transport Strategy 2030* and capital works updates published on the CoM's website (City of Melbourne, 2023). There were some minor discrepancies between the bicycle routes data and what was observed on Esri aerial imagery, where bicycle lanes were identified as 'proposed' in the metadata but were constructed in the aerial imagery. This was resolved using a combination of CoM capital works updates and higher resolution Nearmap satellite imagery.

Subsequently, a buffer was applied to each bicycle lane to generate indicative widths and surface areas for each bicycle lane (Figure A3). Widths were estimated using a combination of CoM bicycle lane guidelines (City of Melbourne, 2019) and aerial imagery (Table S2).

***Table S2.** Categories of bicycle lanes, with corresponding estimated widths and sources of information*

Bicycle lane category	Estimated width	Source
Informal	1.5m	Bike Lane Guidelines states that existing 'simple' bike lanes are roughly 1.5m wide.
Existing protected	2m	Bike Lane Guidelines provides a range of 1.5m-1.8m for single chevron separated bicycle lanes, and 1.5m-4.0m for double chevron bicycle lanes (City of Melbourne, 2019, p. 21). 2m was assumed as an average width.
Existing on-road	1.5m	Bike Lane Guidelines provides a range of 1.5m-1.8m for single chevron separated bicycle lanes.
Existing off-road	3m	Bike Lane Guidelines provides a range of 1.8m-3.0m for kerbside physically separated bicycle lanes.

		3m was assumed based on a sample of existing off-road bicycle lanes measured using aerial imagery.
Existing slow zone	3m	Bike Lane Guidelines provides a range of 1.8m-3.0m for kerbside physically separated bicycle lanes. 3m was assumed based on a sample of existing slow zones measured using aerial imagery.
Proposed protected	2m	Bike Lane Guidelines provides a range of 1.5m-1.8m for single chevron separated bicycle lanes, and 1.5m-4.0m for double chevron bicycle lanes (City of Melbourne, 2019, p. 21). 2m was assumed as an average width.
Proposed slow zone	3m	Bike Lane Guidelines provides a range of 1.8m-3.0m for kerbside physically separated bicycle lanes. 3m was assumed based on a sample of existing slow zones measured using aerial imagery.

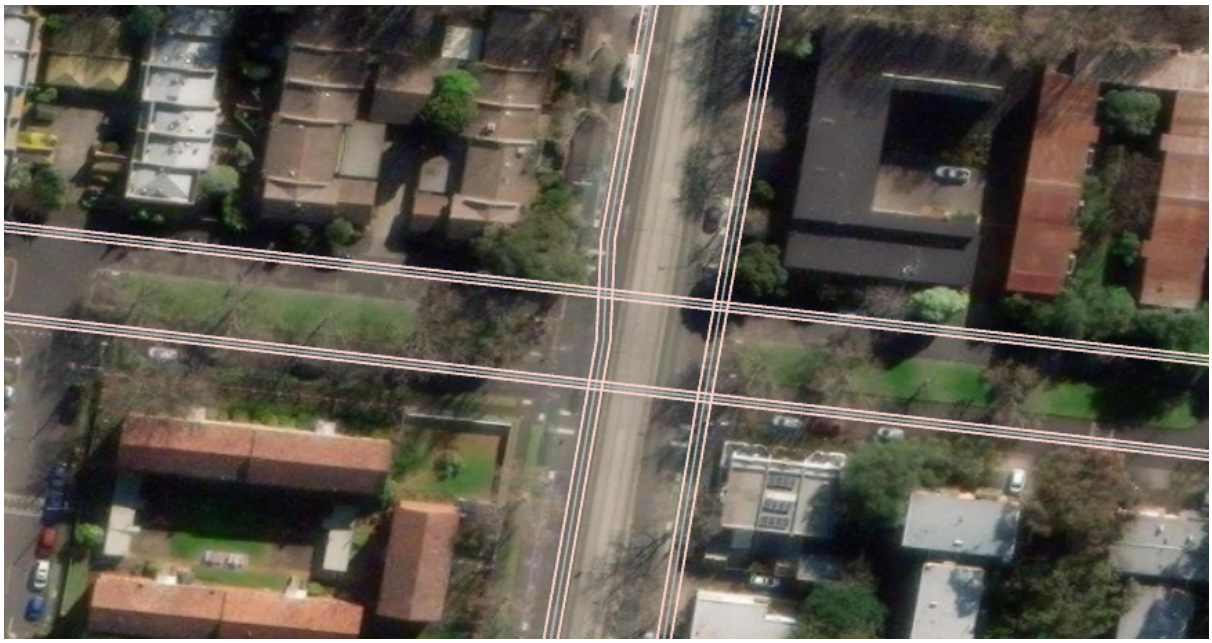

***Figure S3**. Example of buffered bicycle lanes (pink)*

Buffers were converted to polygons using the 'Feature to Polygon' tool in ArcGIS (Figure S4). A new shapefile was generated, which contained individual bicycle lane polygons. Each bicycle lane was given a unique ID number starting from 0, with a total of 527 unique polygons.

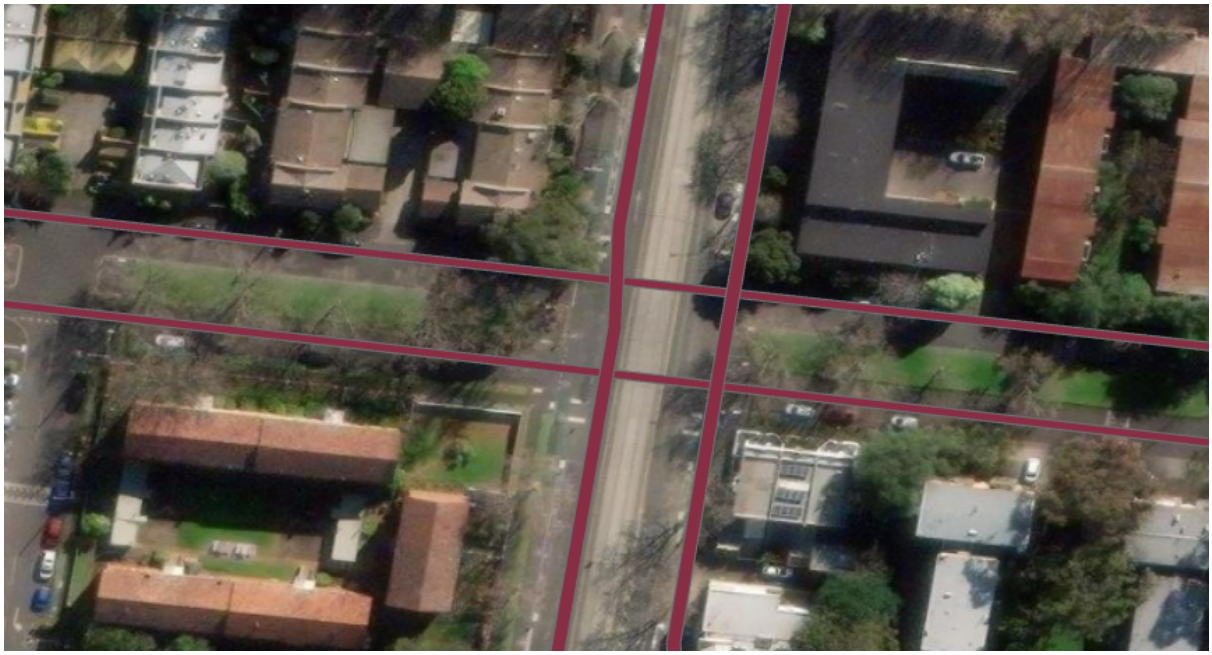

Figure S4. *Example of bicycle lane polygons generated using buffer linework*

Tree Canopy

Tree canopy data was obtained from CoM Open Data (City of Melbourne Open Data Team, 2021). The most recently published dataset, '*Tree Canopies 2021 (Urban Forest)*' was utilised for this study. No further data processing was undertaken for tree canopy shapefiles.

Spatial Analysis Method

The 'Tabulate Intersection' tool within ArcGIS was used to generate the percentage of total area that each bicycle lane polygon intersected with tree canopy polygons (Figure S5). The 'Tabulate Intersection' tool broadly works by defining two parameters, Input Zone Features and Input Class Features. A summary of input parameters is provided in Table A3.

Figure S5. *Example of intersecting polygons. The 'Tabulate Intersection' tool is used to calculate the percentage of total area of each bicycle lane (red) that intersects with tree canopy (yellow).*

Table A3. *Description of parameters and input data used for this study*

Parameter	Definition	Input data
Input Zone Features	The features used to identify zones	Bicycle lane polygons
Zone Fields	The attribute field or fields that will be used to define zones	Bicycle lane polygon IDs. This is necessary to calculate the percentage of canopy coverage over each individual bicycle lane, rather than the bicycle lane polygon layer as a whole.
Input Class Features	The features used to identify classes	Tree Canopy. Input class features were not defined as there was no need to differentiate between different fields within the tree canopy layer.
Output Units	Percentage	-

The 'Tabulate Intersection' tool generated an output table (Figure S6) which contained the following outputs:

Intersecting area (square metres). This is the area within each bicycle lane polygon that is intersected by tree canopy polygons.

Percentage of each bicycle lane that is intersected by tree canopy (%). This enables comparison between bicycle lanes of different total areas.

	OBJECTID *	AREA	PERCENTAGE
1	1	401.55836	25.067861
2	2	20.788617	3.693798
3	3	38.513933	5.013916
4	4	28.917425	3.750916
5	5	1128.978173	92.030601
6	6	187.445397	18.729956
7	7	1008.862579	32.521596
8	8	2925.571396	72.912943
9	9	1359.52002	66.452834
10	10	950.873096	73.582482
11	11	544.898081	31.79409
12	12	46.182146	13.9346
13	13	289.748633	13.460282
14	14	897.872462	33.40208

***Figure S6**. Example of output table generated using the Tabulate Intersection tool*

The output table was joined to the bicycle lane polygon shapefile using the unique bicycle lane polygon IDs as the common field. This enabled each individual bicycle lane polygon to be linked to the corresponding percentage within the output table.

References

City of Melbourne. (2019). *Bicycle Lane Design Guidelines*. Accessed 28 July 2024. Retrieved from https://www.melbourne.vic.gov.au/cycling-lanes-and-routes

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