Distribution of Green Space, Bikeways, and Wealth in the City of Vancouver

GEOB 270 Final Project
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Abstract

This project report analyses the relationship between green space, bikeways, and wealth per census tract in the City of Vancouver. Three choropleth maps were produced in order to visualise the relationship between these variables. The first map shows the percent of green space per census tract, the second map shows the percent of bikeways normalised to road distance per census tract, and the third map shows the distribution of income for populations aged 15 and over per census tract. The premise is that, since access to green spaces and bikeways are important for human well-being, widespread and evenly distributed bikeways and green spaces incentivize people to ride their bicycles and spend time outside, and this generally increases their quality of life. This project report will attempt to analyse whether there is any relationship between access to bikeways and green spaces with wealth. The report includes the project description, methodology used to create the maps, a table of the dataset, discussion and results, error and uncertainty, further research and recommendations, and an appendix where the maps can be found.

Project Description

Access to green spaces and bikeways is important for human well-being. Widespread and evenly distributed bikeways and green spaces incentivize people to ride their bicycles and use those spaces. Ideally, people will use bikeways to access those green spaces. However, typically, wealthier neighbourhoods have more access green spaces than less wealthy ones. This project will identify if there are any relationships between distribution of green spaces and bikeways with the distribution of wealth in Census Tracts of the City of Vancouver. We will analyse this with three choropleth maps. The first map shows the percent of green space per census tract, the second map shows the percent of bikeways normalised to road distance per census tract, and the third map shows the distribution of income for populations aged 15 and over per census tract.

The three maps all display different data so they may be analysed side-by-side, in order to highlight the relationship between the distribution of the variables. The first map has green space data from City of Vancouver from the year 2009, and this data was classified into census tracts using the natural breaks (jenks) classification. The second map acquired bikeway and road data from the City of Vancouver from the year 2019, and joined the data from these to the VanCT layer. A new field was then created which normalised bikeway lengths to road lengths to produce proportion of bikeways per census tract. This data was then classified using the natural breaks (jenks) classification. The third map took income data from CHASS from the year 2015, namely income statistics for the population aged 15 years and over in private households. This data was also classified using the natural breaks (jenks) classification.

Methodology

Map one: Percent of green space per census tract

- Parks and city boundary data were **acquired** from the City of Vancouver Open Data Portal, Census Tract data was acquired from Abacus Dataverse Network (and used data that originated from Statistics Canada)
- Data was first **parsed** by conducting a query of Canada Census Tract layer (CanadaCT) to create a new layer with only Vancouver Census Tracts (VanCT). Then, the City of Vancouver boundary polyline was converted into a polygon, and the VanCT layer was clipped to the cityboundary_polygon to create a new layer with census tracts within the boundary of the City of Vancouver.
- Then, the tabulate intersection tool was used to **intersect** VanCT and parks data (VanCT_parks). This new table was then **joined** to have parks information be apart of the VanCT attribute table (represented as VanCT_boundary_parks in the flowchart). Null values for were **removed** and a new layer was then created from this (VanCT_percentgreenspace).
- The map was **represented** as a choropleth map and the data was classified by natural breaks with 6 different levels, which indicated the varying percentage of green space per CT through a green gradient color scheme.

Map two: Percent of bikeways per census tract

- Bikeways, roads, and city boundary data were **acquired** from City of Vancouver Open Data Portal, Census Tract data was acquired from Abacus Dataverse Network (using data originally from Statistics Canada).
- Data was first **parsed** by conducting a query of Canada Census Tract layer (CanadaCT) to create a new layer with only Vancouver Census Tracts (VanCT). Then, the City of Vancouver boundary polyline was **converted** into a polygon (cityboundary_polygon). The VanCT layer was **clipped** to the cityboundary_polygon to create a new layer with census tracts within the boundary of the City of Vancouver (VanCT_cityboundary)
- For the **analysis** to take place, the tabulate intersection tool was used to **intersect** VanCT and bikeways data (creating new table VanCT_bikeways), and VanCT and roads data (creating new table VanCT_roads). These new tables were then **joined** to VanCT in order to have the lengths of the bikeways and roads in the VanCT attribute table (represented as VanCT_boundary_bikeways_roads in the flowchart). A **new field** was created to obtain bikeway lengths normalised to road lengths per census tract using the **field calculator**. Null values were removed from the table using **select by attribute**, and a new layer (VanCT_normalised_bikeways) created from this.
- The map was **represented** as a choropleth map. The data was classified according to natural breaks (jenks), into 5 levels, displaying the colour with a purple gradient colour scheme.

Map three: Wealth distribution per census tract

- Census Tract data was **acquired** from Abacus Dataverse Network (using data originally from Statistics Canada), Income statistics in 2015 for population aged 15 years and over in private households in Vancouver Census Tracts was **acquired** from University of Toronto CHASS site.
- Data was first **parsed** by conducting a query of Canada Census Tract layer (CanadaCT) to create a new layer with only Vancouver Census Tracts (VanCT). THen, the City of Vancouver boundary polyline was **converted** into a polygon (cityboundary_polygon). The VanCT layer was clipped to the cityboundary_polygon to create a new layer with census tracts within the boundary of the City of Vancouver (VanCT_cityboundary)
- Use **selected by attribute** to **classify** the income data, create a new table with only income statistics in Vancouver (VanCTincome).
- **Joined** the VanCTincome to the VanCT, by merging the CTUID in both tables.
- The map was **represented** as a choropleth map. The data was classified according to natural breaks (jenks), into 5 levels, which was displayed with a yellow gradient color, to indicate the varying income level of every Census Tract.

Table of dataset

Layer / datafile name (original and renamed)	**Uses**	**Entity / data model**	**Attributes**	**Source (agency, date compiled, data extracted)**	**Modifications**
CTboundaries (Original name:lct_000 b16a_e)	To perform analysis (percentage / distribution of variable per census tract)	Vector	CT boundaries for CMA's in Canada	Abacus Dataverse Network, UBC Dataverses https://data.library.ubc.ca/ (Data originally from Statistics Canada), compiled February 9th 2017, extracted November 20th 2019	Clip Projected coordinate system change: Canada Lambert Conformal Conic to UTM Zone 10N
City boundary (Original name:City	Delineate map area	Vector	Boundary of the City of Vancouver	City of Vancouver Open Data Portal https://data.vancouv	Clip

Boundary data)				er.ca/datacatalogue/cityBoundary.htm, compiled August 6th 2019, extracted November 20th 2019	
Parks (Original name: Parks data)	Variable to be mapped	Vector	Data about the parks/green space locations in the City of Vancouver for 2009	City of Vancouver Open Data Portal https://data.vancouver.ca/datacatalogue/parks.htm, compiled September 9th 2019, extracted November 20th 2019	Tabulate intersection, join, projected coordinate system changed: WGS 84 to UTM Zone 10N
Bikeways (Original name: Bikeways)	Variable to be mapped	Vector	Data on bikeways in the City of Vancouver for 2019	City of Vancouver Open Data Portal https://data.vancouver.ca/datacatalogue/bikeways.htm, compiled July 8th 2019, extracted November 20th 2019	Tabulate intersection, join
Roads (Original name: City project package - Street)	To normalise bikeways to roads in order to obtain a percentage of bikeways	Vector	Data on roads in the City of Vancouver for 2019	City of Vancouver Open Data Portal https://data.vancouver.ca/datacatalogue/cityStreets.htm?fbclid=IwAR0eFywV1feCCJEiSx0xysaE0gwZefjKOPFIIueIBjuMsFqdPsKAMoXHRo	Tabulate intersection, join

	per census tract			Y, compiled November 26th 2019, extracted November 20th 2019	
VanCTincome (Original name: Income statistics in 2015 for population aged 15 years and over in private households in Vancouver Census Tracts)	Variable to be mapped	Tabular	Income statistics in 2015 for population aged 15 years and over in private households in Vancouver Census Tracts	University of Toronto, CHASS http://datacentre.chass.utoronto.ca/census/, extracted November 20th 2019	Join

Discussion and Results

Several trends are visible throughout both the individual and collective levels of this analysis. Concentrations around waterfronts and downtown areas are especially prevalent. As Vancouver is recognized for its high quality of living, this discussion with further consider the infrastructure behind this ranking and how quality of life may vary throughout the city, with respect to bikeways, green space and wealth. Respective map findings and results will also be analyzed in the paragraphs to come.

Map one shows us that green space is most concentrated in Stanley Park (close to downtown), with up to 94% of that space being green space. This makes sense as Stanley Park is the largest urban park in Vancouver. The areas with the second highest amount of most green space include Point Grey, False Creek, Champlain Heights in East Vancouver, and parts of downtown West End area, which comprise of 15-30% of green space. Other well known parks, such as Queen Elizabeth, clearly stand out on the map. Most census tracts contain around 0.02-5% of green space, and many census tracts have higher amounts at around 5-15% of green space. As only 11 out of 117 Census Tracts contain no green space, which equates to only 9.4%. These CTs with no green space are almost evenly spread out throughout Vancouver.

Furthermore, there does not appear to be any large dead zones with minimal green spaces in the city.

Map two shows us that bikeways are most concentrated in Stanley Park and Yaletown area, with 66-101% of bikeways normalised to road lengths. Similar to the green space trend, this aligns with the facts as Stanley Park holds the majority of the Seaside Greenway, which is recognized for its immense length of 28km according to the introduction made by City of Vancouver[1]. Next, in the general downtown, Granville, Cambie, and Kitsilano areas, 31-65% of bikeways normalised to road lengths. These are generally the locations that also have higher incomes. The East Vancouver area has higher income earnings, but this map shows us that bikeways are less concentrated here. The relationship between income earnings and proportion of bikeways per census tract is not apparent in some areas, whereas in other areas there seems to be a positive relationship between the two. This suggests that higher income and proportion of bikeways are not necessarily contingent on each other, and may actually vary according to other factors instead. Such factors include width of roads, proximity to locations with views, and proximity to parks and the ocean.

Map three shows us that highest income earnings are concentrated in Yaletown, False Creek and parts of Kitsilano, and the Fraser area of East Vancouver, with monthly incomes ranging from $6,970 to $12,435. The lower three tiers of wealth ($4,940 to $6,970, $3,735 to $4,940, and $2,285 to $3,735) are generally evenly scattered around Vancouver, although East Vancouver has generally higher average income than other parts of Vancouver. Although high income is definitely concentrated around some trends, there does not seem to be any major dead areas, or large bunches of CTs, in the lowest income category.

Overall, a few key trends are apparent. The census tracts with higher incomes are generally located close to the ocean, and have generally more beautiful views. This could be a reason why those areas have higher percentages of bikeways. This presents the idea that there is a higher emphasis on bikeways being put in place for recreational reasons instead of day-to-day mode of transport reasons. It is possible that the infrastructure, as well as the proximity to the ocean, drives up the cost of living in these areas.

For people with lower incomes, biking provides a cheaper mode of transport compared to a private vehicle or public transit. Although Vancouver is recognized for its bikeways, it is possible that they were not designed with the key thought of boosting accessibility for those with lower incomes. Since it has been shown that access to green space is important for human well-being, and that bicycles provide an affordable form of transport for those who may not be able to afford other forms of transport, the City of Vancouver should consider increasing the amount of bikeways (in particular protected bikeways) in census tracts with lower incomes. It should also consider expanding the network of these bikeways as well to allow for accessibility and connection between different parts of the city and different census tracts. By expanding the

[1] *Note.* From City of Vancouver. (n.d.). The Seawall in Vancouver. Retrieved December 3, 2019, from https://vancouver.ca/parks-recreation-culture/seawall.aspx.

network of bikeways and making them more accessible and easy to use, the City would be able to send a message to its residents that it does care about their well-being. This would also put Vancouver in a position where it is further promoting pro-environmental activities.

In all three maps, the high concentrations of bikeways, green space and wealth seem to be concentrated around the span of the Point Grey, Kitsilano, False Creek and Downtown areas bordering the oceanfront. This adds to the previous assertion that the locations of green space and bikeways could be more attributed to the prime location rather accessibility as the focus. On top of this, it makes sense that wealth is also strongly concentrated along this large path. This aligns with the high quality of life experienced by those residing in Vancouver. It also presents the idea that perhaps this high quality of living is most prominent among high income populations.

All of the three map also shows an unbalanced trend that the west part of Vancouver has more facilities and resources in comparison to the east part of the city. Divided by Ontario Street, the East Vancouver district has much smaller percentage of green spaces and bike lanes, compared with west Vancouver. This distribution is not surprising, as according to the traditional sense, the wealth is more concentrated in the west. However, when examining Map three, East Vancouver's average income is higher than that in Vancouver West. This phenomenon reflects that today the balance of wealth distribution in Vancouver has gradually shifted from west to east, which leads to the increasing demand of public facilities and higher living qualities in East Vancouver. It reminds public administrations to pay attention to the new changes and make appropriate plans to support the new development and shifts throughout the city.

Error and Uncertainty

There are several possible sources of error throughout this GIS project. The first is the potential errors in the original data and dataset utilized in this analysis. For example, in map two, the "Bikeways" dataset was divided into "status", "active" and "planned". However, some bikeways which exist under "active" status also appear in "planned", since the "type" of bikeway might have shifted (for example, from "shared lanes" to "protected bike lanes"). Therefore, some bikeways are counted for repeatedly, which leads to error in the percentage of bikeway in some census tracts.

The second possible source of error is that some of the data are not recent or up-to-date. This includes income data from City of Vancouver' Census Tracts updated from 2016 and the parks data from 2009. These datasets may or may not reflect the current situation in 2019, so the result of the analysis may not be an accurate reflection of the actual distribution present today. Furthermore, because CT data was from 2016 while parks data was from 2009, it is possible that this could lead to more discrepancies.

Thirdly, when converting the projection and coordinate systems, error will inevitably affect the analysis. In this analysis, the projected coordinate system of the downloaded Census Tracts shapefile was Canada Lambert Conformal Conic, however, during analysis, we used

UTM Zone 10N as the projected coordinate system. This conversion may cause a loss of unmatched data which might have hindered the final results.

The last possible source of error is the visualisation of the classification of the data per Census Tract. Different classification methods will provide different results and thus will have an impact on the analysis. It is important to choose a classification method which most accurately reflects the data while also communicating the information appropriately. We used the Natural Breaks (jenks) classification, which typically reduces within-class variance and maximize between-class differences. For the map showing distribution of income levels, the range of income in the last two levels of the classification ($4940.01-$6970.00 and $6970.01-$12435.00), are wider than the others. The distribution of income in some areas is also not necessarily representative, since the gap between higher and lower income is large.

As for uncertainty in this analysis, in all three maps there are blank CTs (white) that show no data. This is missing data from the original dataset or data that was lost when converting or joining layers. In addition, we were unable to include data on bike racks in this map. Bike racks are a critical part of the city's bike facilities, and have an impact on bikeway usage as it is reasonable to assume that people are less likely to use their bikes and bikeways if they have nowhere to safely park their bikes. In this analysis, we downloaded a CSV file of bike racks, but we could not find an appropriate column which could be merged with other features and attributes. Because of this we were not able to present the distribution of bike racks, which leaves the analysis incomplete.

All in all, it is imperative to recognize and reflect on the potential sources of error and uncertainty when drawing conclusions from the analysis and results. However, there will always be a certain amount of error and there are still many significant findings throughout this report.

Further Research & Recommendations

This analysis was focused around a broad look at the relationships between the distributions of green space, bicycle infrastructure and wealth. As such, there is space for many modifications and advancements. As the world continues to urbanize, there is growing value in the field of research.

In order to further the analysis of wealth, a look at more demographics could help better explain what shapes or makes up the census tracts of the City of Vancouver. For example, incorporation of data about race and minority populations could be informative. Percentage of immigrants and language profiles could also add unique angles to the analysis, as could the level of education of the dwellers. Furthermore, rent prices for each census tract could be incorporated to complement this wealth analysis. Vancouver is known for being an international city so this could yield interesting results.

In terms of green space and bicycle infrastructure, there are many ways to further the analysis. Park infrastructure and offerings, such as tennis courts or playgrounds, could be added in. Buildings such as community centers would also elevate the understanding of distributions

throughout Vancouver. Missing bike infrastructure like bike locks, cages and protected bikeways would be a good way to complement the bikeways analysis. Frequencies of bikeways usage might be hard to acquire but could help us better understand patterns and the impacts of existing infrastructure. Inclusion of data around drop bikes and other bike rental programs could also help us further understand how Vancouver can improve its bike accessibility while also providing insight around where to best position such resources.

The addition of other variables would also lead to more informative results. Bus routes could be a good complement to bikeways data, and perhaps help us better understand the incentives behind commuters. Different graphs of all three scenarios over time, for example 2005, 2010 and 2015 could help us better understand how things have evolved and predict what is to come. All in all, the topics explored in this analysis are becoming increasingly more relevant as urbanization includes and there is much value in continued research within this field.

Appendices

i. References

City of Vancouver. (n.d.). The Seawall in Vancouver. Retrieved December 3, 2019, from https://vancouver.ca/parks-recreation-culture/seawall.aspx.

Legacy Open Data Catalogue - Bikeways data package. (2019, July 8). Retrieved November 20, 2019, from https://data.vancouver.ca/datacatalogue/bikeways.htm.

Legacy Open Data Catalogue - City Boundary data. (2019, August 6). Retrieved from https://data.vancouver.ca/datacatalogue/cityBoundary.htm.

Legacy Open Data Catalogue - City Streets data. (2019, November 26). Retrieved November 20, 2019, from https://data.vancouver.ca/datacatalogue/cityStreets.htm?fbclid=IwAR0eFywV1feCCJEiSx0xysaE0gwZefjKOPFIIueIBjuMsFqdPsKAMoXHRoY.

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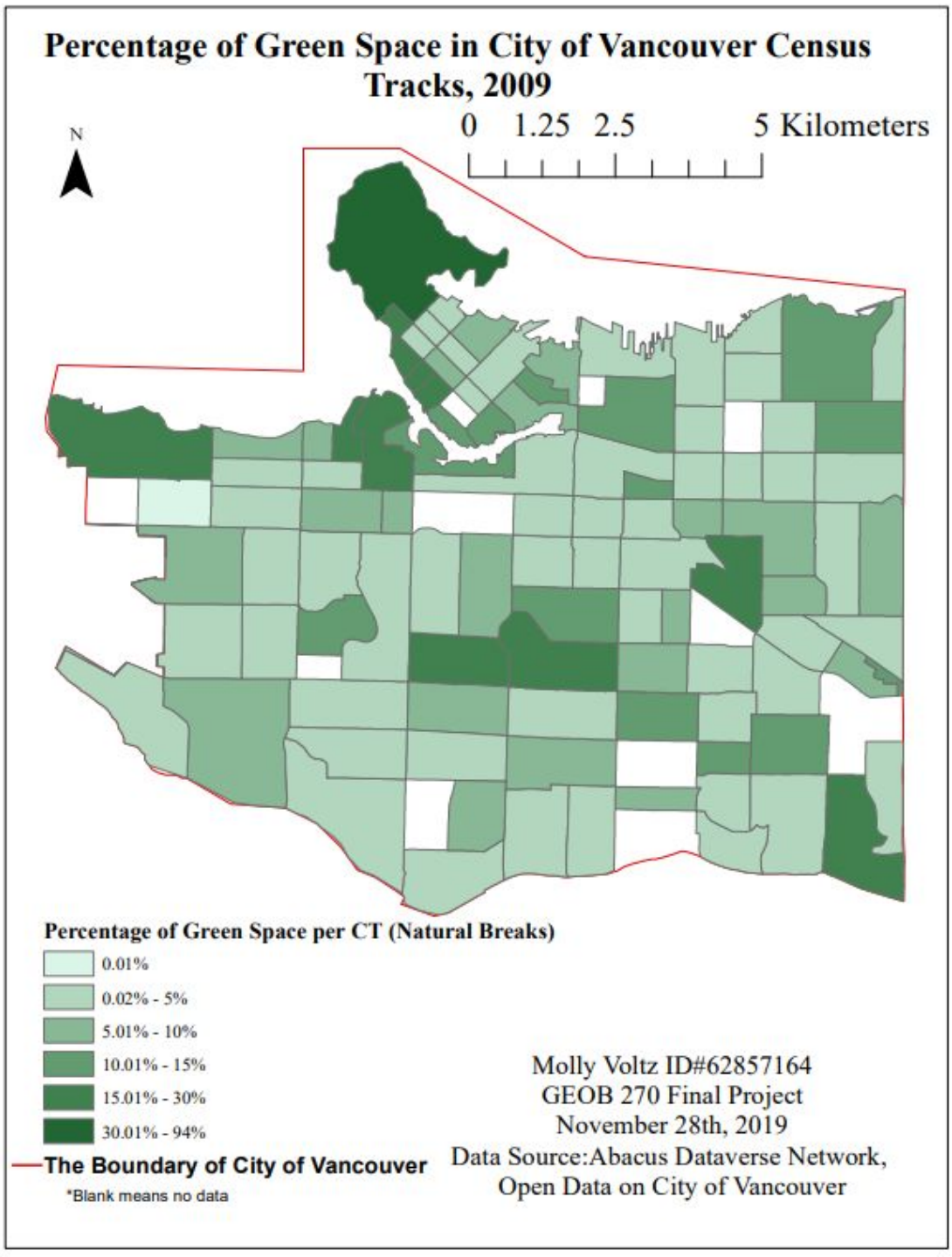
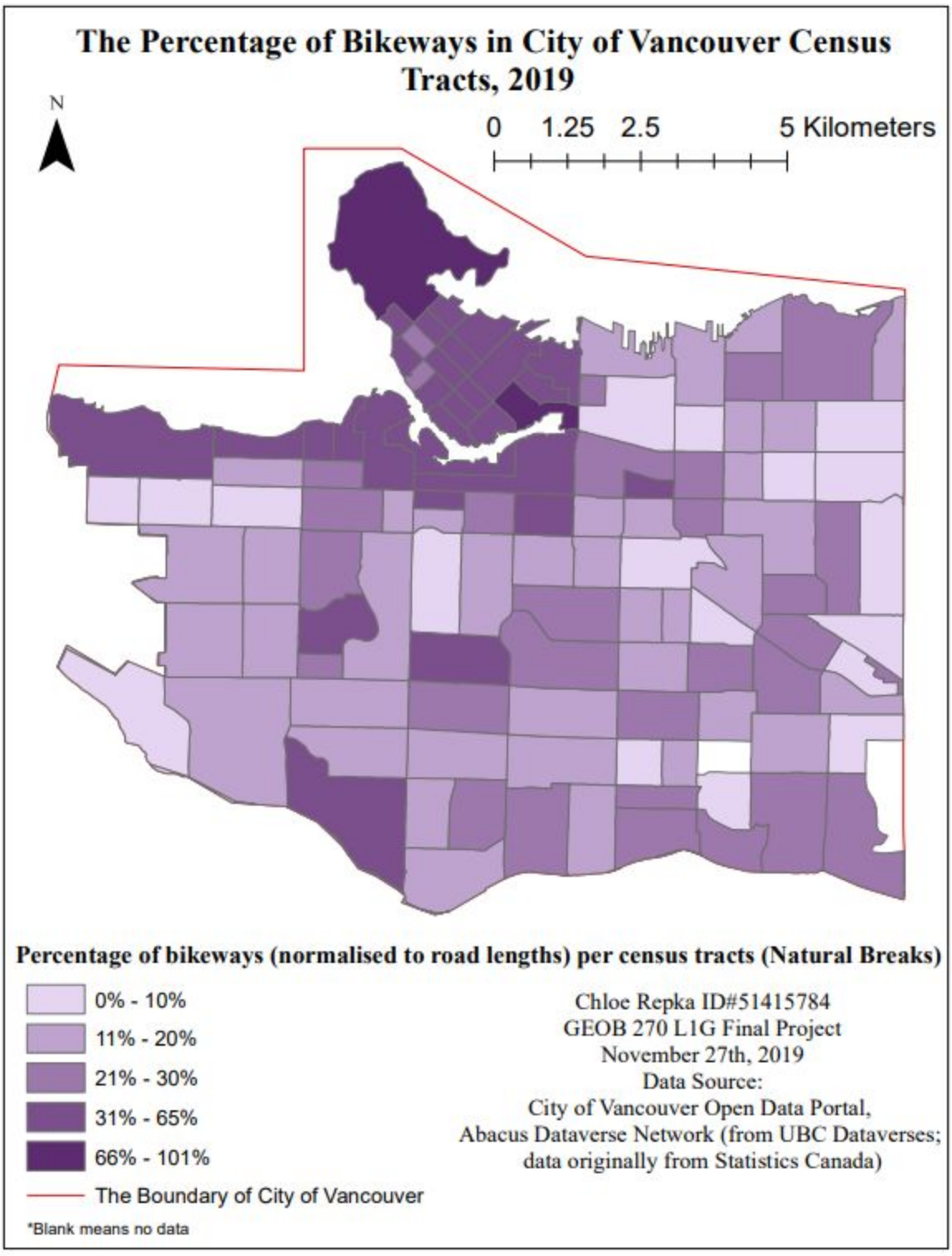
ii. Maps

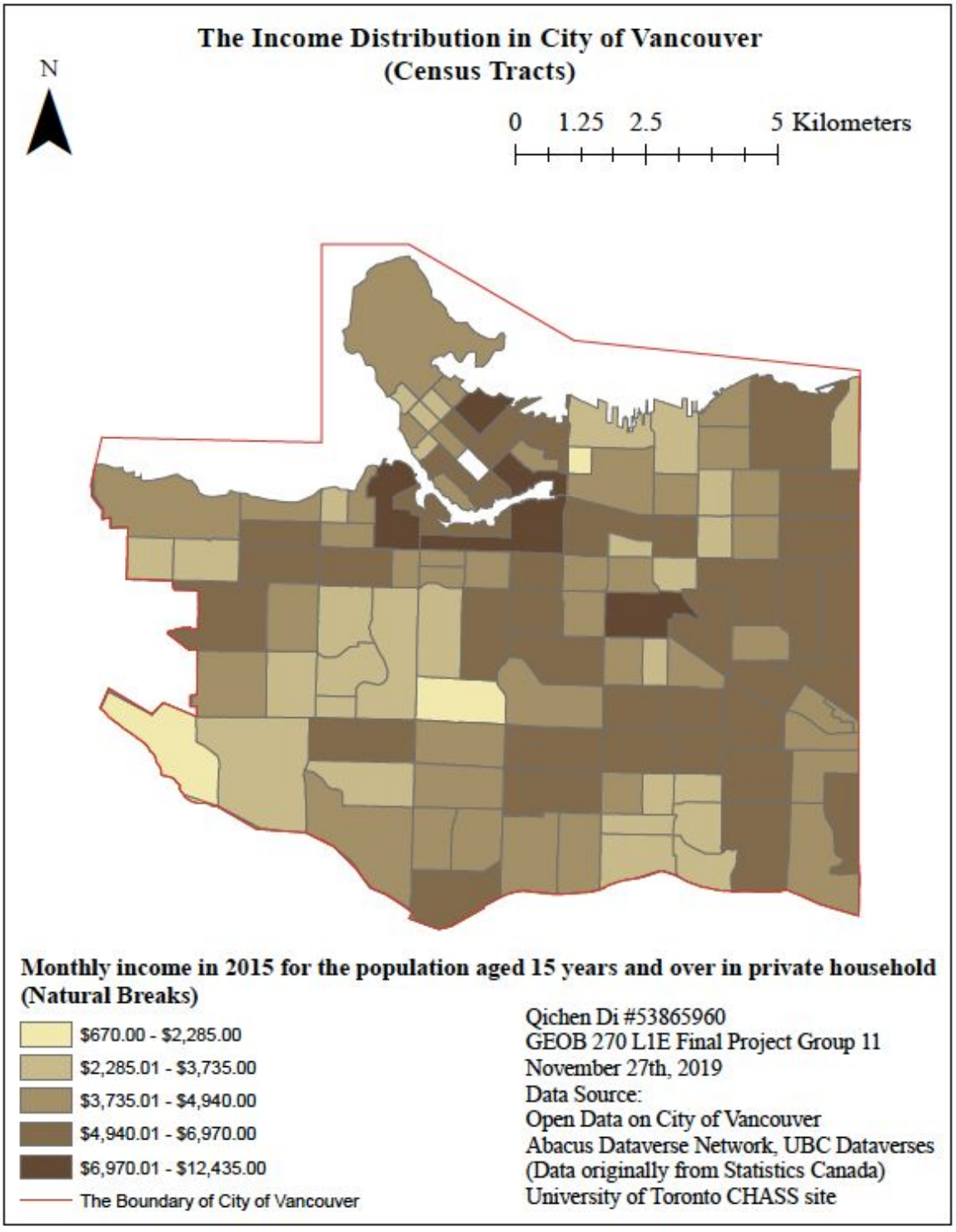
Map I: Percent Green Space per Census Tract



Map II. Percent Bikeways per Census Tract

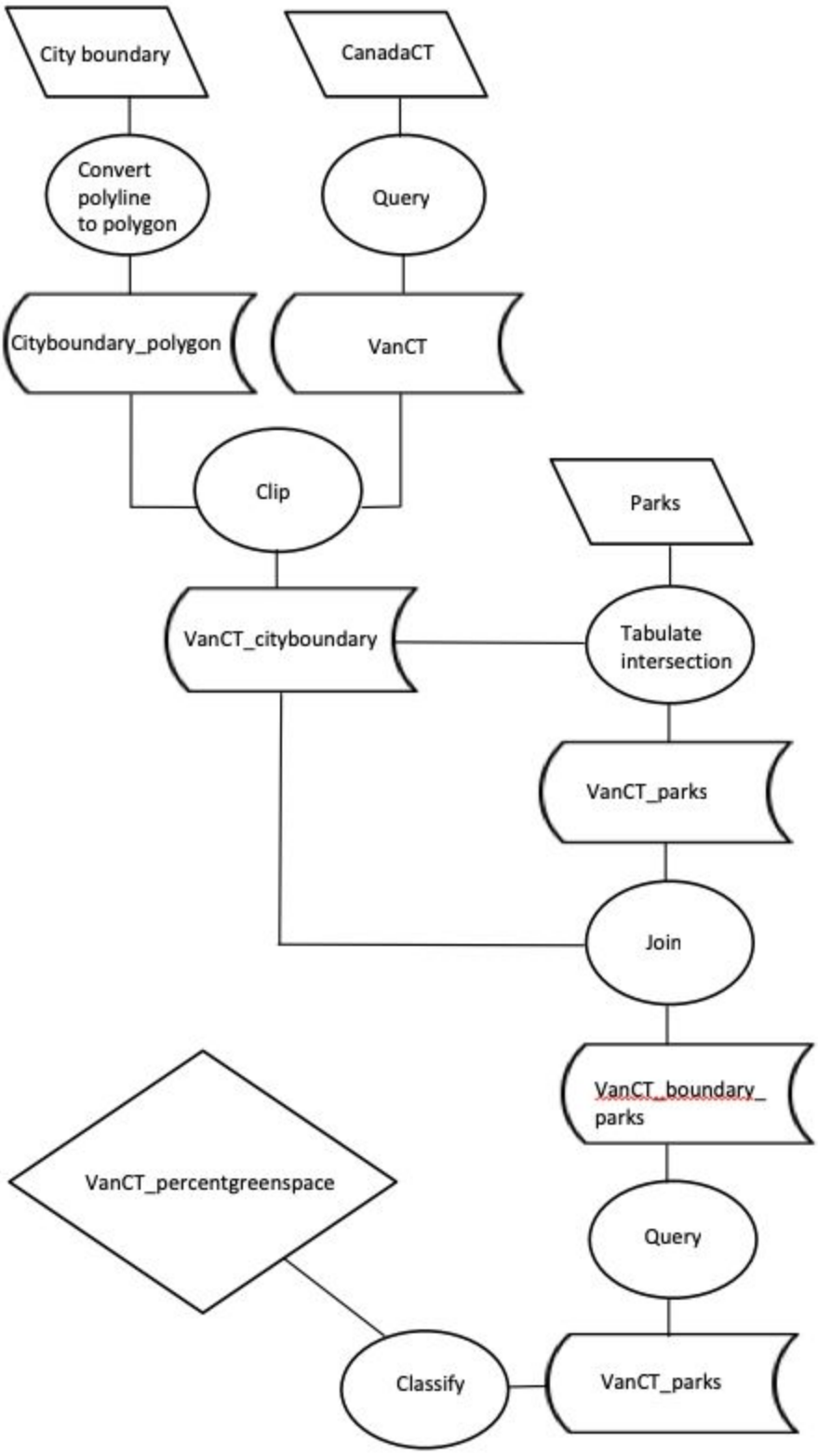


Map III: Income Distribution per Census Tract

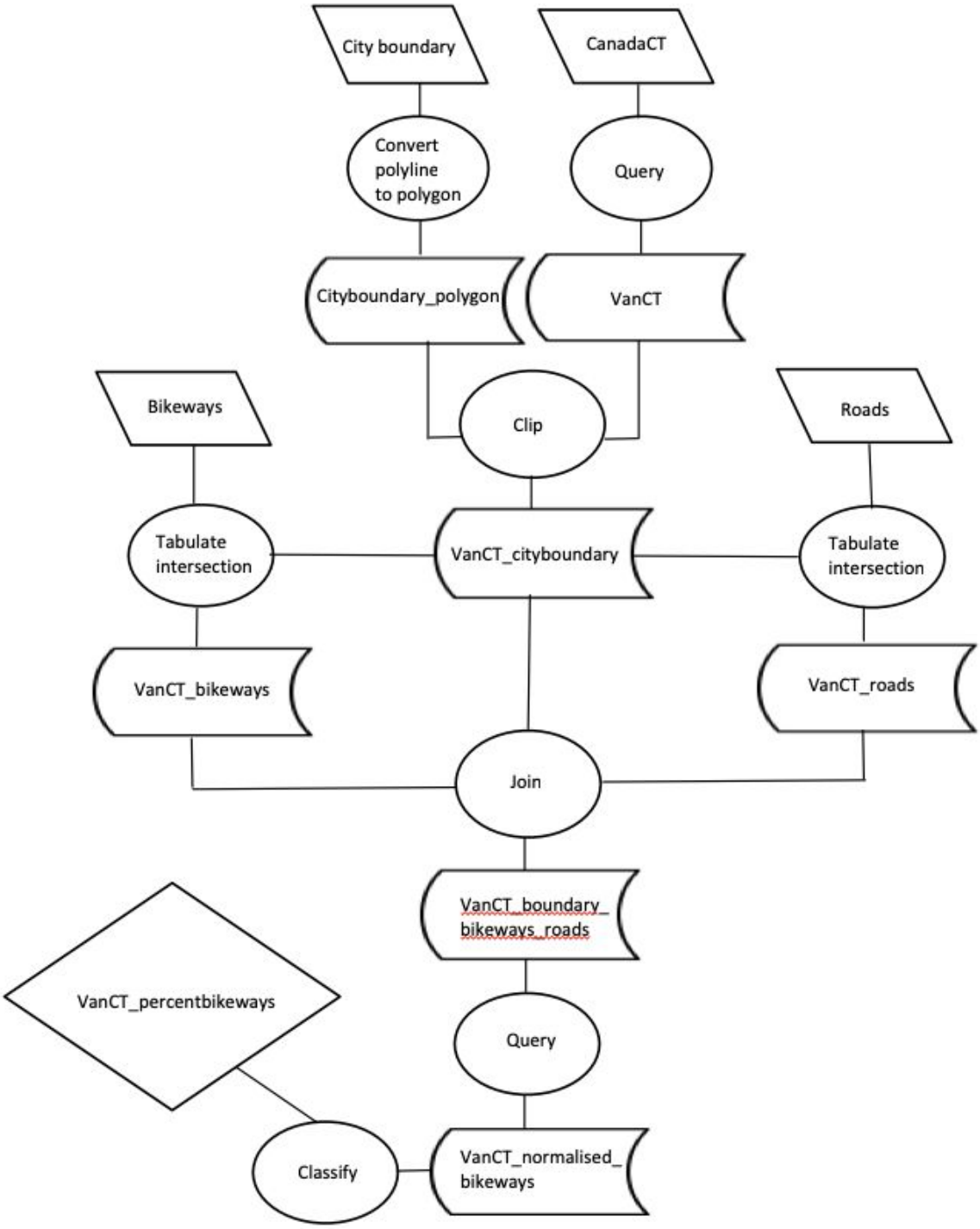


iii. Flowcharts

Flowchart for map I: Percent Green Space per Census Tract



Flowchart for map II: Percent Bikeways per Census Tract



Flowchart for map III: Income Distribution per Census Tract