GEOG 463 - Advanced Geographic Information Systems
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Term Project Final Report:
GIS Analysis of Montreal's Proposed Pink Line

Introduction and Objectives

Our task as developing geographic information systems users is to apply the theory and skills we've learned in our advanced GIS course to real world situations. To demonstrate our new-found proficiency in this field we are undertaking a small personal project inspired by our own interests. As residents of Montreal and patrons of the city's public transit services we felt inclined to apply our GIS expertise to this topic, specifically to the folkloric 'Pink Line' a mayoral campaign promise and focus of local discourse and media in recent years.

Consistently boasting some of North-America's strongest public transit ridership statistics since its early two line origins, Montreal's metro system has had numerous additions and modifications throughout its history. The 'Pink Line' would be the largest addition to date and would cost in the tens of billions to excavate and create. Such an investment should not be taken lightly and merits extensive forethought, planning and cost-benefit analysis. Geographic information systems play an integral part in the urban transit planning process. Extensive research, stemming predominantly from the United States and East Asia, where densely built and populated metropolitan areas aim to satisfy immense local transit demand, have proven critically important to analyzing metro systems and planning for their long-term sustainability and success.

Predicting urban transit projects is no small feat as urban systems are extremely unique and complex and require equally detailed mathematical models to analyze. Thankfully, there is an extensive body of literature devoted to the study of public transit. Multiple studies have drawn links between built environment, socioeconomic factors and ridership . External variables like land use, population density and income have universally proven to be the most influential factors in influencing and predicting ridership(Chan, Miranda-Moreno 2013). As such, multivariate regression models are a common tool used by researchers to model public transit ridership, especially for rail commuting in the United-States and throughout Asia, unfortunately such studies are more limited in a Canadian context. Similarly, multicriteria analysis is a key technique for spatializing trends in

geographic information system software.

Our objective is to paint a picture of the Pink Line, the areas it services and create rudimentary maps to show anticipated ridership trends using such GIS tools. We hope our project will be part of the research and analysis surrounding Montreal's potential metro expansion and foster informed and successful decision making.

Drawing from the literature and taking into account the availability of data at our disposal we elected to use population density and household income in a 1000 meter radius around the Pink Line metro stations for our analysis. Population and income data represent two of the most influential factors in analyzing metro ridership (Chan, Miranda-Moreno 2013) and are readily publically available through the Canadian Census and can be retrieved in a neatly pre-processed file through the university of Toronto's CHASS data center. The 1000 meter radius buffer is mathematically significant because it represents the larger end of the walkable distance to metro stations, representing accessibility. This buffer encompasses the activity taking place around the stations and is therefore significant in analyzing their ridership and trip generation.

Methodology

For the project, we used three different data files, a file of the complete STM bus stops, the Montreal road network file and the census boundaries with corresponding demographic data.

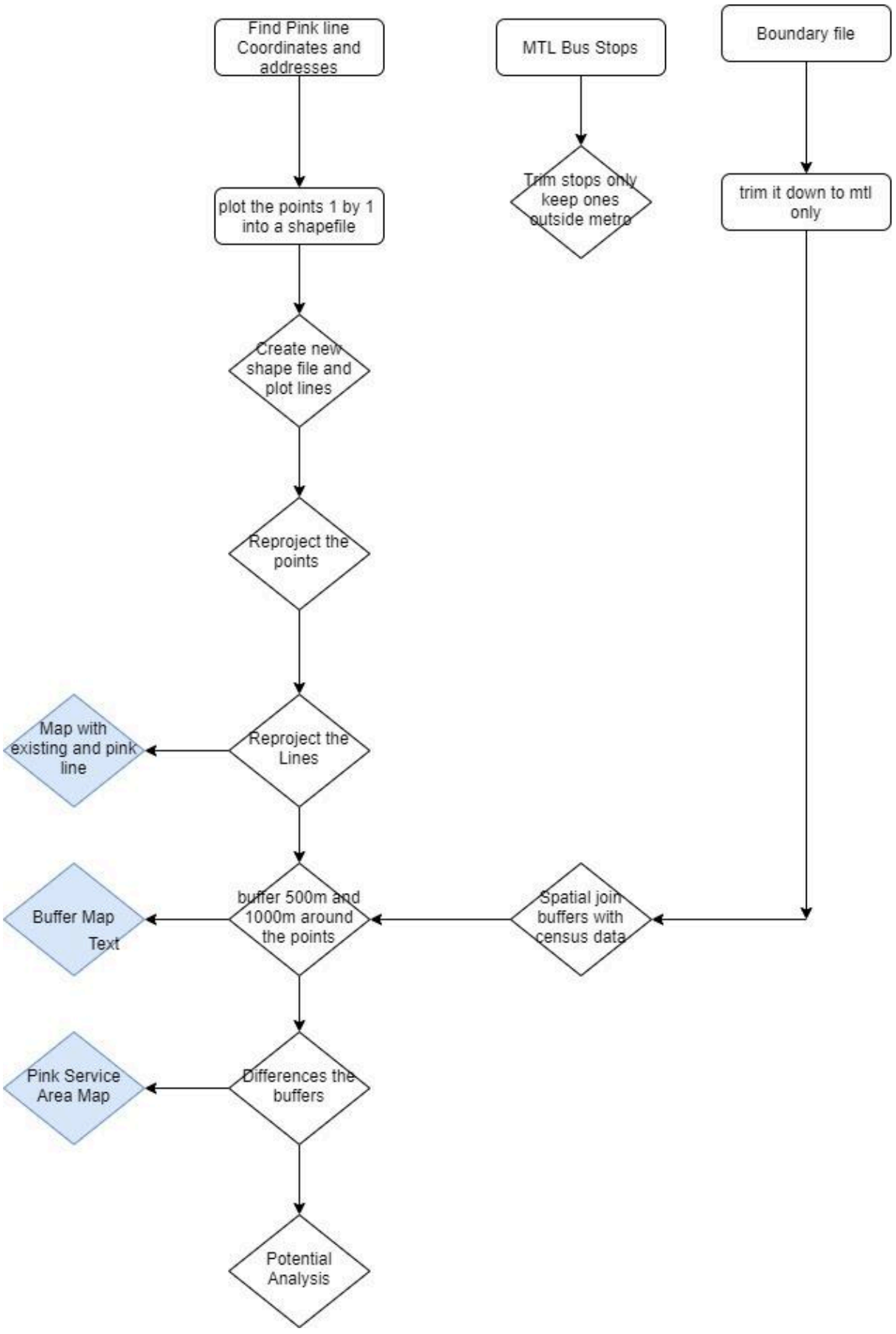
Because the STM does not have a metro line data file, we had to plot our own metro line with the STM bus stop file. It is common knowledge that buses stop outside metros to facilitate transport. Thus out of 9180 total bus stops, we picked out those that are at metro entrances. Each of these stops has a different code number, there was no choice but to select them one by one. We then export the points into a new shape layer, to create our metro stations shapefile.

There are many different versions of the pink line but we chose to take the pink line stations from the Wikipedia article. Most sources only include an illustration of the proposed metro line which is not geographically accurate enough to use for mapping. The Wikipedia article on the other hand contains the streets of the pink line stations and their coordinates. (https://en.wikipedia.org/wiki/Pink_Line_(Montreal_Metro)).

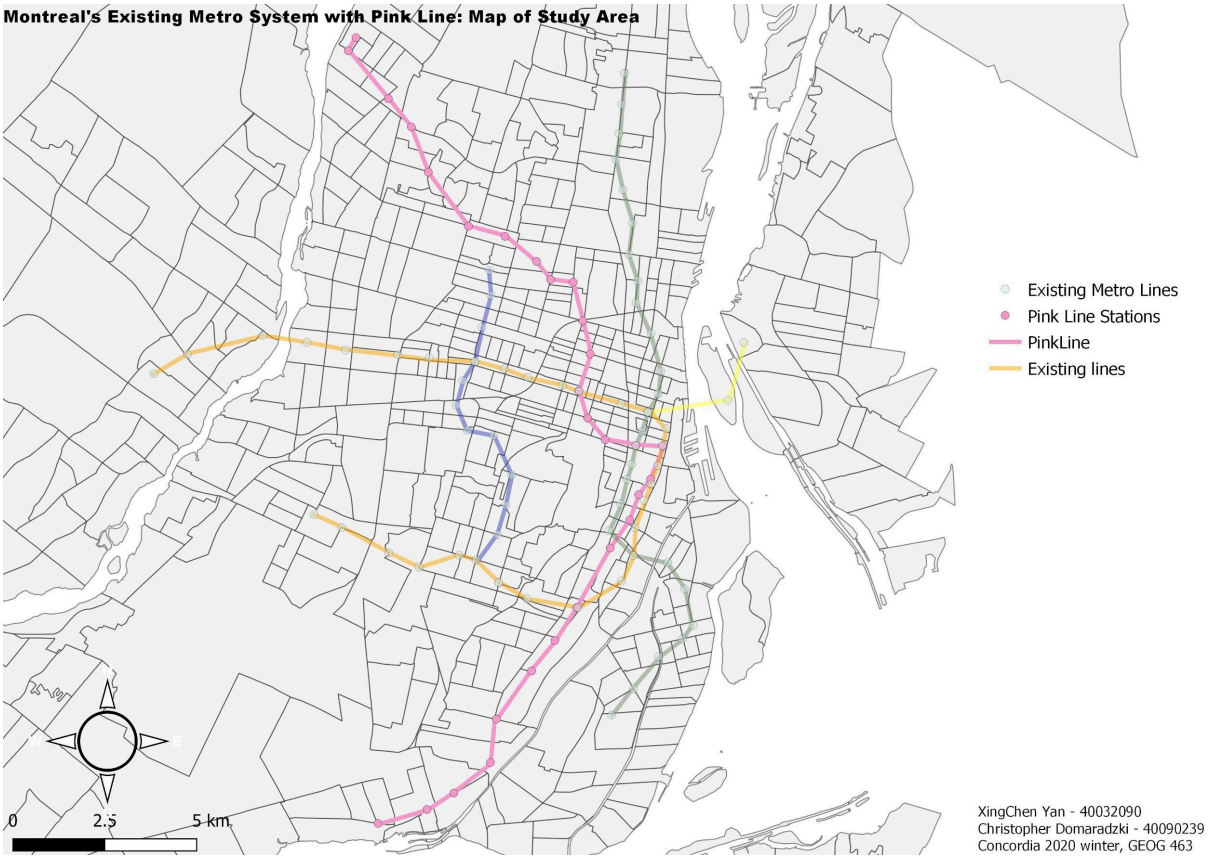
To map our points we create layer > new shape file > geometric (multiple points) and add the points. For the location of the points, we plotted using a Montreal road map with the

help of wiki addresses. We searched by expression (“street” =) and found the intersecting street to roughly plot the location of the pink stations. Some of the stations only show a place name, for example Saint-Léonard-Montréal-Nord station, Montreal Central Station, Canadian Centre for Architecture and many more. For those, we used the coordinate associated with the places and searched them on google maps and plotted using that as reference.

After we got all the points it was necessary to reproject all the points into the same coordinate system otherwise they were just points and we couldn’t do anything with them. (vector > data management tools > reproject layer.) Then we joined the points and lines with the census division data. Now, it was possible to create buffer zones and lines. For the buffer we used vector > geoprocessing tools > buffer and we used the same process, create layer > new shape file> geometric (lines) to plot the metro lines. Once we’ve got the buffer zones, we used vector > geoprocessing tools > differences and made a map of the service area of the new pink line.

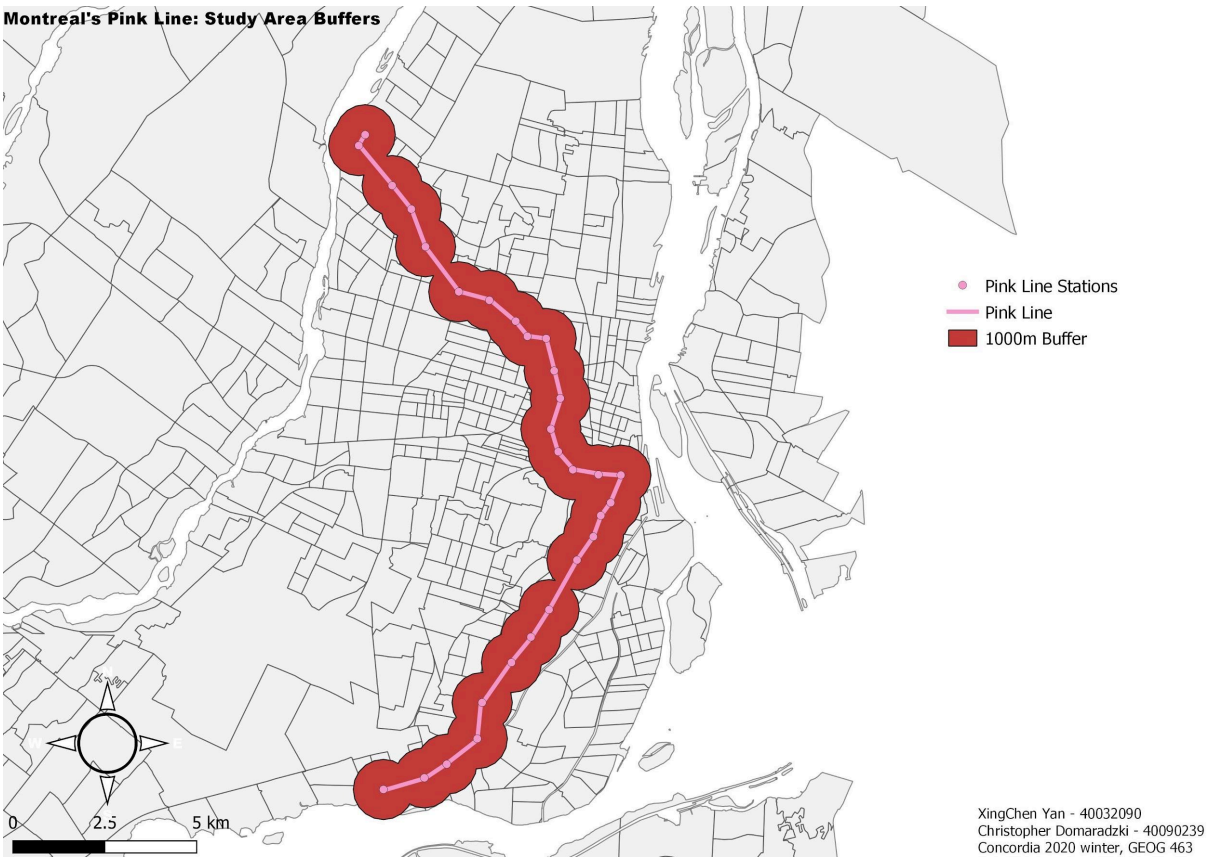

Find Pink line Coordinates and addresses
MTL Bus Stops
Boundary file
plot the points 1 by 1 into a shapefile
Trim stops only keep ones outside metro
trim it down to mtl only
Create new shape file and plot lines
Reproject the points
Map with existing and pink line
Reproject the Lines
Buffer Map
Text
buffer 500m and 1000m around the points
Spatial join buffers with census data
Pink Service Area Map
Differences the buffers
Potential Analysis

Results

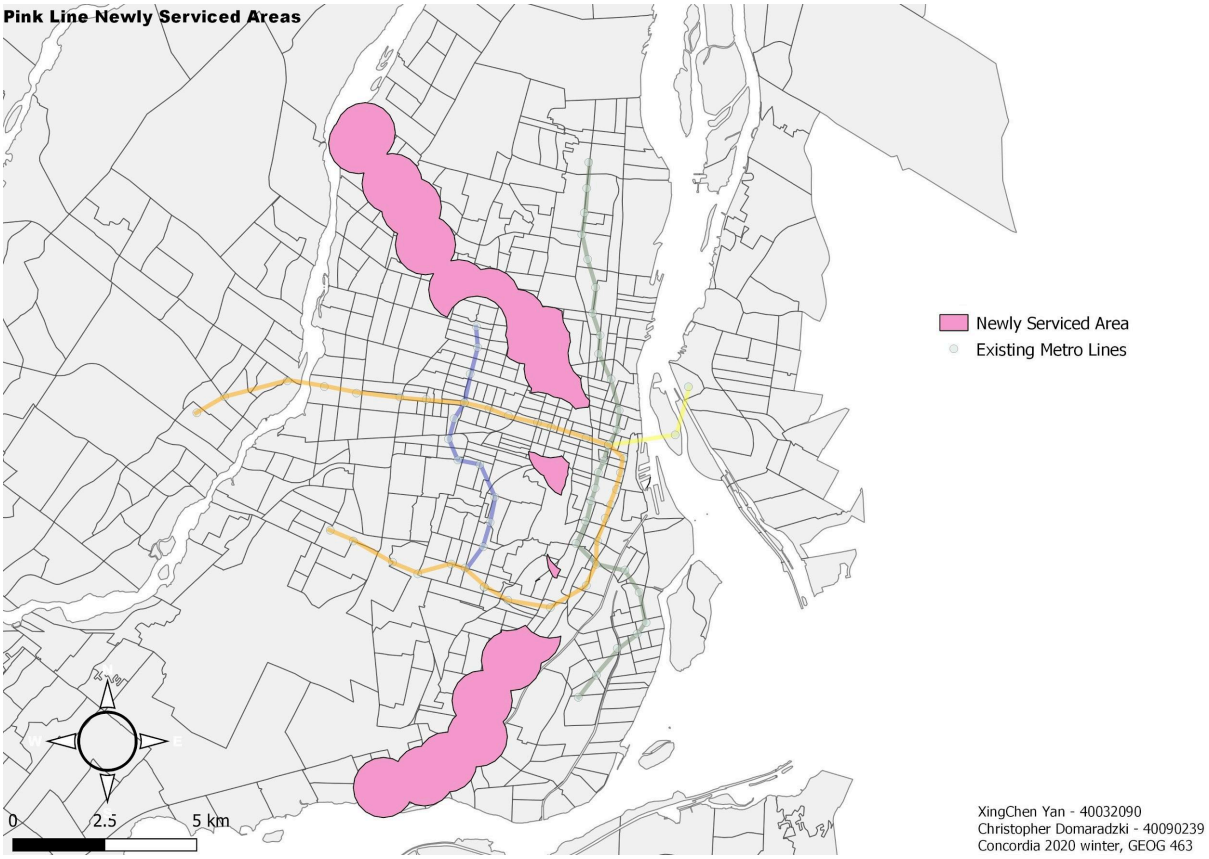


The first map we've created is a simple portrait of the proposed Pink Line incorporated into the existing metro network. The purpose of this map is to provide the audience with essential geographical context surrounding our project. It also provides us with the base for our further GIS analysis.

Our initial project goals included a network analysis of the existing metro network combined with the new Pink Line addition. This model would demonstrate functionality throughout the system and help to pinpoint potential strengths and weaknesses. Unfortunately, due to unprecedented viral outbreak circumstances related to COVID-19 our access to university space and software was cut short and our ambitions had to be tailored. In order to conduct our network analysis we would have used our created metroline shapefile and incorporated processed time data, which is regularly published by the STM, to create our network environment and objects. Running the network analysis would reveal impedance points which could be mapped to demonstrate issued areas of the metro system that would merit extra attention from Pink Line project developers.



This secondary map shows the 1000m walkable radius area surrounding the proposed Pink Line. The area represented contains the population and income data that is essential to ridership prediction but could be further supplemented with additional data types, particularly land use and zoning data. This walkable service area and the data contained within the buffers would function as the basis for multi criteria analysis. Using fuzzy logic, data relationships, like positive for greater population density and negative for increasing household income, could be assigned and weighted to create heat maps illustrating areas of higher ridership. This ridership portrait is vital for project developers as it helps inform station design and anticipate network usage. Furthermore, similar models for alternate or future scenarios, like differently positioned stations or with the construction of transit-oriented development (TOD) could be compared in order to maximize service coverage for sustainable long-term success of the Pink Line.



Using our earlier 1000 meter walkable service area buffers, we illustrated the parts of the city newly covered by the Pink Line metro expansion. Mostly for the general public, this map does little in terms of critical project analysis, but does provide valuable geographic context for the potentially impacted regions and neighbourhoods of the city. This map demonstrates the exciting potential of having better public transit supply in the West and North-Easterly regions of Montreal, neighbourhoods that historically struggle with public transit options. It should be noted that this is not the full potential extent of the Pink Line's coverage as other transportation options like bus and bike make for a much larger connectivity radius, greater than 1000m, this map simply illustrates walkable accessibility.

References

Chan, S., & Miranda-Moreno, L. (2013). A station-level ridership model for the metro network in Montreal, Quebec. *Canadian Journal of Civil Engineering*, *40*(3), 254–262. https://0-doi-org.mercury.concordia.ca/10.1139/cjce-2011-0432

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Data taken from

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Angela Kross, Concordia University, Montreal Road shapefile

Angela Kross, Concordia University, Census Boundary shapefile