Montreal Spatial & Statistical Crime Analysis

OBJECTIVE OF THE ANALYSIS

- How well are Montreal police stations placed?
- Which neighborhoods and census tracts have the highest risk of crime?
- Are the levels of income of a neighborhood and the levels of crime in the same area correlated?
- Does the median income in a census tract affect crime counts?

DATA SOURCES

1. The primary data source was issued from Montreal's Open Data website and the GEO7621 course given by K. Khun in Fall 2020 (Applied Problem Solving in GIS) at l'UQAM.
2. The census tract data originally from Statistics Canada, explores demographic data for the island of Montreal, including median income and median age of the population.
3. Crime instance data was sourced from the Montreal Open Data website with all crimes from 2015 to 2020, across the Montreal island.

METHODOLOGY

I. Distance of intervention buffers from police stations by travel time

Creating buffer zones to calculate the distance of intervention according travel time using the *Network Analyst* tool in ArcGIS Pro would allow us to see if the surface of the island is covered by police stations equally. Calculating the travel time instead of a numeric distance is more accurate as we are not sure how much territory an SPVM police station is supposed to cover.
We chose to select the "*Emergency Vehicle*" option for this analysis for obvious reasons. We divided increments into 3, 5, 8 and 10 minutes with facilities being the police stations and choosing the direct "*Away from Facilities*".

With the *Select by Location* tool and the "*Invert Relationship*" option, we can find how many crimes were not covered by the buffers created, meaning it could take 10 minutes or longer for a police car to get there, if it leaves from a police stations.

With this method we can find out how adequately and equally the police stations are spread across the island.

II. Creation of high and low crime risk areas.

We were able to visually map the aggregates of crime instances around the island using the *Optimized Hot Spot Analysis* tool. This creates a trend using confidence intervals of 90, 95 and 99%.
Using this method, we will be able to display **Hot Spots** where crime risk is high and **Cold Spots** where crimes are less likely to happen, considering all crimes in the data.

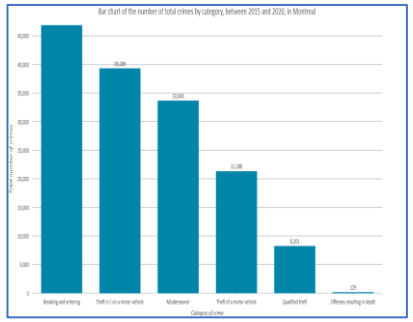
III. Analysis of the number of crimes compared to the annual median income by census tract

A. Mapping the median income by census tract
By joining the annual median income table with the census tract layer we will have an idea of the annual median income by census tract.

B. Mapping the crime count by census tract
By joining the polygon layer of census tracts with the point layer of crimes, we can determine how many crimes have occurred by census tract.

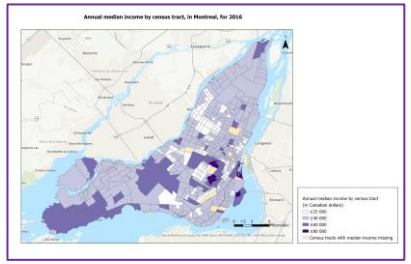
C. Mapping the theft count by census tract
This analysis allows us to know which areas are more subjected to theft. The categories included in our theft analysis will be theft of motor vehicles, thefts of qualified vehicles, and thefts in or on motor vehicles.
Since thefts make up 50% of all crimes recorded between 2015 and 2020 we imagined it would explain the relationship between median income and crime rates in Montreal.

D. Mapping breaking and entering occurrences, by census tract.
This category has the highest crime rate, representing 30% of all total crimes recorded in the data we have which is why we thought we would find a significant relationship between annual median income and crime rates.



Justification for the categories chosen

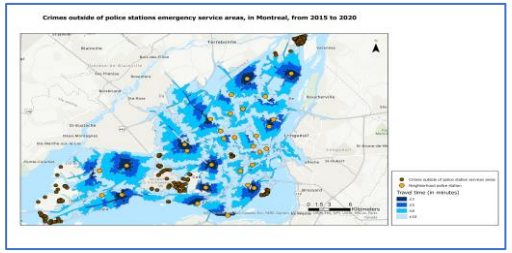
As we can see from the bar chart below, breaking and entering crimes are the crimes that happen the most around the island. They represent 30% of reported crimes on the island. Cumulating all three categories of thefts, we find that these make over 45% of reported crimes in Montreal.

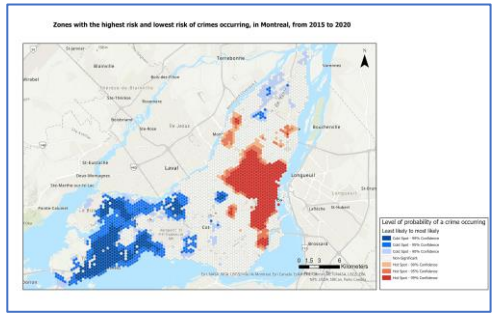


RESULTS

I. Distance of intervention buffer by travel time

Using our method we find that police stations cover the territory adequately although some areas are not reached in under 10 minutes. However some buffers reach even further than the extent of the island of Montreal and cover Laval and Longueuil, although these cities have their own police force.
Some police stations are set up too close to each other.
Crimes outside of intervention buffers make up only 0.7% of all crimes in Montreal between 2015 and 2020, which means that police stations are mostly equally and adequately placed.





II. High and low crime risk areas

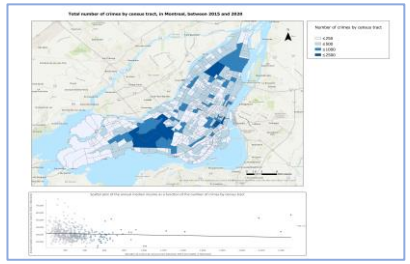
We find that there is a high risk of crime around the island, especially in Montreal North, Tétreaultville, Le Plateau, Westmount and Verdun. However other areas have a lower crime risk such as Mont-Royal, Pierrefonds, Kirkland and others.
We find consistent results that there is a higher risk of crimes in urban areas rather than rural neighborhoods that can be found in the West or the East of the island.

III. Correlation of crime rates and the annual median income

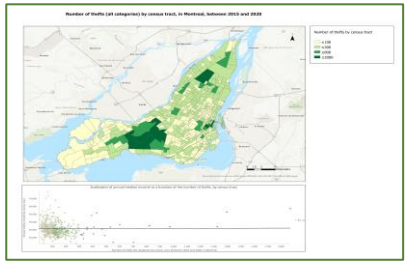
A. Annual median income analysis
Our hypothesis for this third analysis was that financially struggling neighborhoods or census tracts with a low median income have a higher crime rate than other more wealthy neighborhoods.

By creating a map of the annual median income by census tract we found that neighborhoods with the highest median income (over $40 000) are Westmount, Sainte-Anne-de-Bellevue, Outremont, Verdun and Saint-Laurent. However these neighborhoods also have the highest risk of criminality. Other neighborhoods with high median incomes have lower rates of criminality, such as Beaconsfield or Senneville.

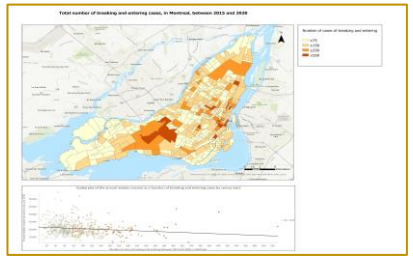
B. Total number of crimes as a function of median income
Comparing the total number of crimes to the annual median income, we find that the census tracts in Ville Saint-Laurent, Saint-Georges, Ville-Marie and Dorval have a high crime count but they don't have low median annual income.
However, other neighborhoods with high median incomes have low crime counts.
The results are questionable and spatial comparisons between both extents are hard to visualize.
The scatter plot produced shows that there is a downward trend between crime rates as a function of the annual median income. We find that the higher the number if crimes in the area, the lower the median income is. However our R^2 score is close to 0 and our slope is not very steep, so the analysis is not conclusive.



C. Thefts as a function of median income
Results when comparing the number of thefts to the median income are similar to the previous analysis. Some census tracts with a lower median income also have a high theft rate. These include Anjou or Dorval while other neighborhoods with a higher median income also have a high theft count.
From the scatter plot, we find that both variables have a null correlation as the slope is completely horizontal. Our hypothesis is not correct.



D. Breaking and entering as a function of median income
This final analysis demonstrated that neighborhoods with lower median incomes had a high amount of intrusion cases such as Mercier, Saint-Henri, Le Plateau. Census tracts with higher median incomes such as Westmount or Old Montreal have a low count of intrusion.
The scatter plot shows somewhat of a relationship between both variables. As median income rises, the intrusion case is lowered. However the slope is not very steep so absolute correlation between both variables is hard to define.



DISCUSSION & RECOMMENDATION

Results for the analysis are mixed. The annual median income is not a good enough variable to explain crime rates. However some errors may have mislead our analysis:

- Some points may be misplaced as crimes are placed at intersections by the Montreal city and not the actual location.
- Some median income were missing from the Statistics Canada data, forcing us to alter the analysis.
- Criminal categories are not detailed enough.

1. We recommend police stations be placed in neighborhoods such as Sainte-Anne-de-Bellevue or Senneville and closer to the Montreal Trudeau Airport.
2. We recommend that areas such as Griffintown oe Verdun have a reinforced police presence. (The effect of police presence decreasing crimes has not been proven)
3. Different variables should be chosen for a future crime analysis.

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