Crime Threats to Electric Vehicle Charging Station in Vancouver

1.0 Introduction

Technologies such as security cameras, computer vision, and theft alarm have been used by the law enforcements for numerous years to fight against crime. However, there is only a small portion of those technologies that serves to prevent crime before it happens. Geographic Information System or GIS is a computer-based system that allows users to create, manage, analyze, and plot data onto a map (ESRI, n.d.). With the right data and GIS processing tools, it is possible to determine and visualize the areas that has the highest crime rates and thus requires additional crime stopping measures. Being able to understand the spatial patterns of crime incidents allows law enforcements and related stakeholders to identify and explain the reasons behind crime occurrences and thus create niched strategies to prevent those crimes (He et al., 2020).

With the growth of electric vehicle in the automobile market as a luxury vehicle and the increase in electric vehicle users in metropolitan cities such as Vancouver, parked electric vehicles become a visible target to thefts. Thus, it is important to study the frequency of crime incidents that were located near electric vehicle charging stations. The goal of this study is to use summary statistics and a spatial join to identify what crime type occurred most often across Vancouver, BC in 2017, and analyze how many of these crimes occurred within 200m of Electric Vehicle Charging Stations.

2.0 Study Area and Data

According to the Vancouver Police Department or VPD website, Vancouver population swells up to 1.5 million people every day as people visit Vancouver for business and entertainment purposes. With this high number of populations, VPD receives around 700 calls per day consisting of both emergency and non-emergency crime reports (Vancouver Police Department, 2022). This study will focus on the city of Vancouver, represented by the green polygons, and electric vehicle charging stations located in the city of Vancouver, represented by the blue cross on the study area map on Figure 1.

There are two main datasets that are used which are the 2017 crime data and the electric vehicle charging station locations. The 2017 crime data was collected by the Vancouver Police

Department in 2017 and was retrieved from the Vancouver Open Data catalogue. The crime events were mapped to the 100-block address and include other information such as the month, day, hour, minute, neighborhood, street, and the type of crime that occurred. From January to December 2017, there were 33,706 crimes that were recorded including mischief, break and entries, theft, and vehicle collisions. The electric vehicle charging station was collected by the City of Vancouver in 2022 and was retrieved from the Vancouver Open Data catalogue. The charging stations were mapped using longitude and latitude coordinates and include other information such as the street address, and the neighborhood where the stations are located. As per December 5, 2022, there were 31 electric vehicle charging stations located in Vancouver.

3.0 Methods

To identify what crime type occurred most often and analyze how many of those crimes occurred within 200m of Electric Vehicle Charging Station, methods such as summary statistics, spatial joins, and mapping techniques are used. To produce a summary statistic of the crime frequency based on its type, another column called "COUNT" was added to the 2017 crime data so that each datapoint is assigned to the number 1 which serves as a counter. Then, the summary statistics tool is used to produce a summary table of crime events containing attributes such as the type of crime and its frequency of occurrence. Since the crime occurences are classified into nine types, there are nine features in the summary table. By summarizing the frequency of crime based on its type of crime, it is possible to see which type of crime occurred most frequently in the year of 2017, which in this case would be theft from vehicle.

Once the type of crime that occurred most often is identified, the 2017 crime data is filtered using attribute query to only select the type of crime that occurred most often. The query that was used in this case would be SELECT * WHERE "TYPE" = 'Theft from Vehicle'. The selected data was then exported which produces a table with 12,934 data points. With the new exported filtered data, it is possible to only show the locations of the crime that occurred the most in 2017. The electric vehicle charging station data was then plotted to the map based on its coordinates. Buffer was used to establish a 200m perimeter radius around each of the electric vehicle charging station data.

The 200m buffer value was determined based on the Journal of Human Evolution written by Karen L. Steudel-Numbers and Cara M. Wall-Scheffler entitled Optimal Running Speed and

the Evolution of Hominin Hunting Strategies which states that the optimal average running speed is $2.9ms^{-1}$ for females and $3.7ms^{-1}$ for males (Steudel-Numbers & Wall-Scheffler, 2009). Assuming that thieves act within approximately 1 minute of running distance, taking the fastest of both speeds which would be $3.7ms^{-1}$ and multiplying it with 60 seconds would produce a radius of 222m which was then rounded down to 200m.

With the plotted theft from vehicle data and the buffered electric vehicle charging station locations, it is possible to analyze how many of these crimes occurred within 200m of electric vehicle charging stations using spatial join. The electric vehicle charging stations buffer data and the theft from vehicle data was joined using a one-to-one join operation with the count merge rule set to sum. This join method produced a table that summarizes the total amount of theft from vehicle crime that happened within 200 meters of each of the electric vehicle charging station. With this data, it is possible to produce a thematic map to highlight which electric vehicle charging station locations are at most risk to theft from vehicle crime.

4.0 Results

It is identified that the type of crime that occurred the most is the theft from vehicle which constitutes around 38.37% of the total crime types that happened in Vancouver on the year of 2017. This finding is supported by Table 1 and Figure 2 which shows how theft from vehicle has the highest frequency of occurrence compared to other crime type in 2017. Through spatial analysis, it is possible to conclude that electric vehicle charging stations that are in Downton Vancouver are most at risks to the theft from vehicle crime type. This conclusion is supported by Figure 3 which is a map showing the theft from vehicle crime frequency that happens within 200m of each electric vehicle charging stations in Vancouver. The crime frequency is represented using color range with red representing the highest crime frequency and green representing the lowest crime frequency. It is also found that out of the 12,934 thefts from vehicle crimes that occurred in Vancouver in 2017, 1338 of them happened around 200m of the electric vehicle charging stations which translates to approximately 10.34% of the theft from vehicle crime occurrences. This emphasize how electric vehicle charging stations are at risks locations for theft from vehicle crime.

5.0 Discussion

Theft from vehicle crime occurred the most compared to other types of crime that happened in Vancouver in 2017. With the increase in demand of electric vehicle in the automotive market, electric vehicle charging stations becomes a necessity and thus there is an increase on its presence especially in metropolitan cities. As electric vehicles are still considered as a luxury item, it becomes a huge target for crimes especially theft from vehicle since most of electric vehicle owners are considered wealthy. This is supported by a journal written by Elżbieta Macioszek about the problems and issues around electric vehicles which states that electric vehicles were primarily oriented towards wealthy city population (Macioszek, 2019). With this status, electric vehicle charging station becomes one of the places that is most vulnerable to theft from vehicle crime which is supported with the findings of this investigation that around 10% of theft from vehicle crimes happened within a 200m radius of the electric vehicle charging stations.

Summarizing and mapping spatial data allows law enforcements to increase its presence in high-risk areas which in this case would be electric vehicle charging stations. By knowing which charging stations are at most risk, law enforcements could optimize its resources by effectively deploying more personnel at higher risk areas and deploying less personnel at lower risk areas. Other stakeholders including private owners of electric vehicle charging stations could also be aware of the high crime rate that is happening around their charging stations and thus execute necessary measures such as installing more security cameras around the station. Using the available data, it is possible to extend this investigation by investigating which days of the week or even hours of the day have the highest theft from vehicle frequency. This extended investigation will narrow down the timeframe and thus allows law enforcements to optimize their presence further by focusing on high-risk hours or days. All in all, from this investigation, through the use of summary statistics and spatial analytics in Geographic Information Systems, it is identified that theft from vehicle is the type of crime that occurred most often across Vancouver, BC in 2017. Approximately 10.34% of these crimes occurred within 200m of Electric Vehicle Charging Stations with Downtown Vancouver being the neighborhood at highest risk.

6.0 Tables

Table 1. Summary statistics table on the frequency of crime occurrences based on crime types in Vancouver, BC – 2017.

Crime Type	Frequency
Break and Enter Commercial	2194
Break and Enter Residential/Other	2469
Mischief	5388
Other Theft	5509
Theft from Vehicle	12934
Theft of Bicycle	2191
Theft of Vehicle	1495
Vehicle Collision or Pedestrian Struck (with Fatalities)	14
Vehicle Collision or Pedestrian Struck (with Injuries)	1512

7.0 Figures

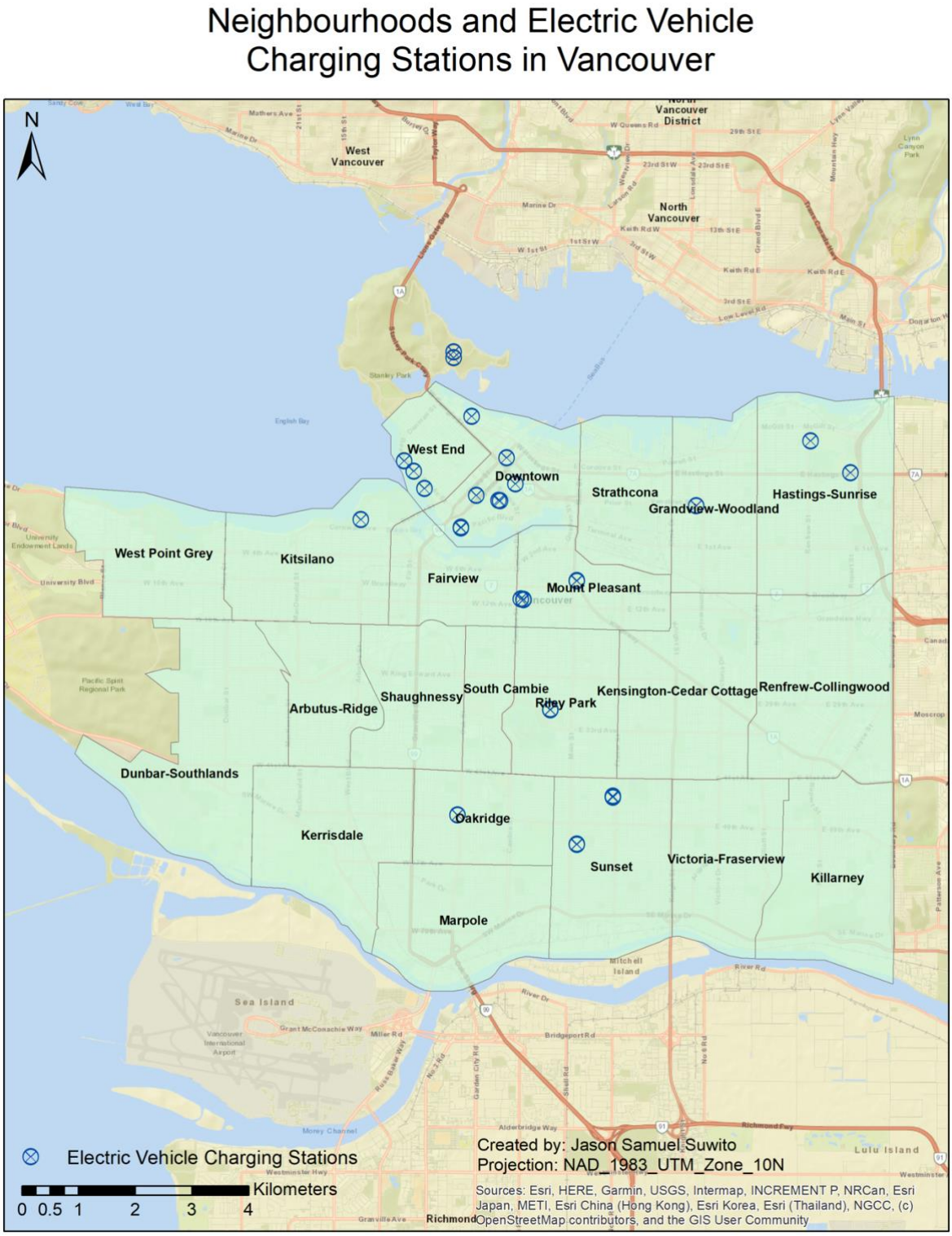

Figure 1. Study area map showing the local area boundary of the City of Vancouver represented with green polygons, labeled neighbourhoods, and Electric Vehicle Charging Stations represented using blue crosses.

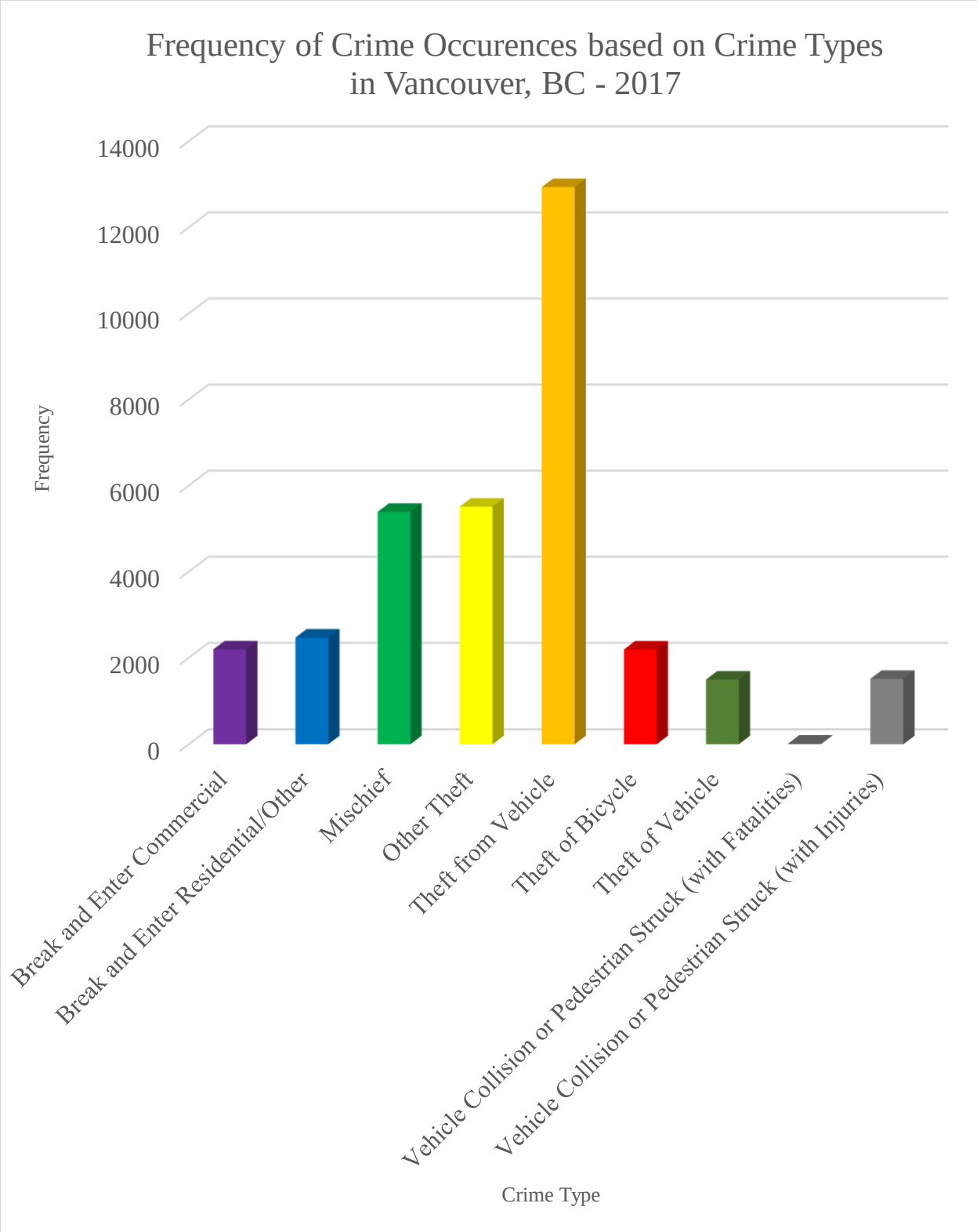

Figure 2. A bar graph of the summary statistics on the frequency of crime occurrences based on crime types in Vancouver, BC – 2017.

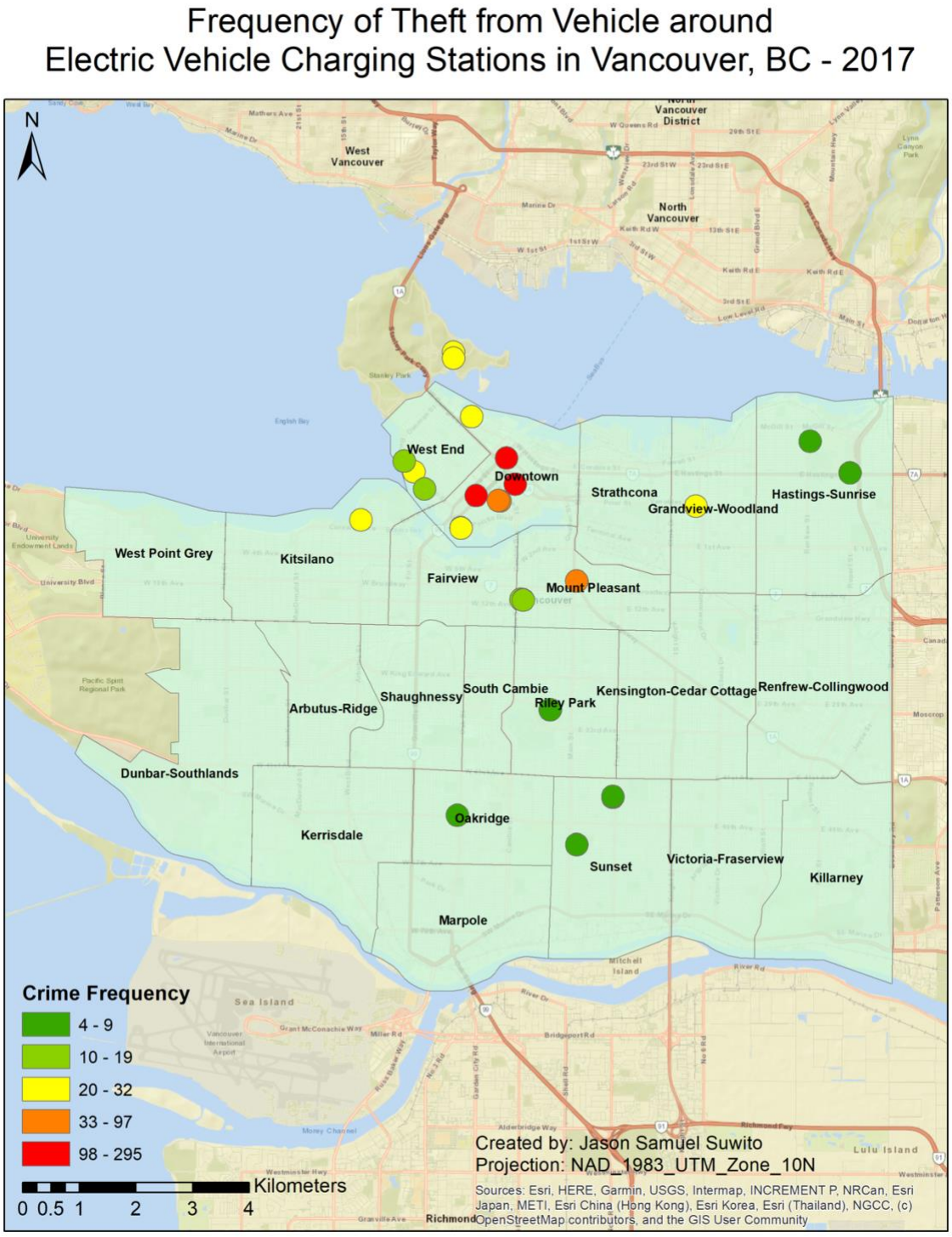

Figure 3. Thematic map showing the frequency of theft from vehicle crime that happened within 200m of electric vehicle charging stations which is represented using graduated colored circles with green representing the lowest crime frequency and red representing the highest crime frequency.

References

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