Final Internship Report: GIS Research and Analysis at the Center for Homicide Research

Paul Jeffrey Tatting

Minnesota State University, Mankato

Follow this and additional works at: https://cornerstone.lib.mnsu.edu/etds

Recommended Citation
https://cornerstone.lib.mnsu.edu/etds/828

This APP is brought to you for free and open access by the Theses, Dissertations, and Other Capstone Projects at Cornerstone: A Collection of Scholarly and Creative Works for Minnesota State University, Mankato. It has been accepted for inclusion in All Theses, Dissertations, and Other Capstone Projects by an authorized administrator of Cornerstone: A Collection of Scholarly and Creative Works for Minnesota State University, Mankato.
Final Internship Report:
GIS Research and Analysis at the Center for Homicide Research

By
Paul Jeffrey Tatting

An Alternate Plan Paper Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Science
In
Geography

Minnesota State University, Mankato
Mankato, Minnesota
July 2018
July 27, 2018

Final Internship Report: GIS Research and Analysis at the Center for Homicide Research

Paul Jeffrey Tatting

This alternate plan paper has been examined and approved by the following members of the student’s committee.

________________________________
Advisor

________________________________
Committee Member

________________________________
Committee Member

________________________________
Committee Member
# Table of Contents

1. Introduction ................................................................................................................................ 1

2. Scope of the Internship .............................................................................................................. 3

   2.1 Background .......................................................................................................................... 3

   2.2 Duties ................................................................................................................................... 4

   2.3 Benefits of Internship ........................................................................................................... 4

3. Presentations .............................................................................................................................. 6

   3.1 Presentations Conducted by CHR ........................................................................................ 6

      3.11 Paraphilias ...................................................................................................................... 6

      3.12 LAPD Murder Book ...................................................................................................... 7

      3.13 Criminal Justice Data Stream ......................................................................................... 8

   3.2 My Presentations .................................................................................................................. 8

      3.21 Geocoding, Coordinate System, and a Research Tool ................................................... 8

      3.22 GIS for Crime Analysis .................................................................................................. 10

      3.23 Case Study: Homicides in Minneapolis from 2012 through 2016 ............................... 11

4. Literature Review ..................................................................................................................... 13

   4.1 History of Crime Mapping .................................................................................................. 13

   4.2 Crime Mapping and Crime Analysis Tools ........................................................................ 16

5. Case Study: Homicides in Minneapolis from 2012 through 2016 ........................................... 21
List of Figures

Figure 3.1 U.S. Criminal Justice Data Stream ................................................................. 8
Figure 5.1 Minneapolis Homicide Locations, 2012 – 2016 .................................................. 27
Figure 5.2 Spatial Point Pattern Analysis, 2012 ................................................................. 28
Figure 5.3 Spatial Point Pattern Analysis, 2013 ................................................................. 28
Figure 5.4 Spatial Point Pattern Analysis, 2014 ................................................................. 29
Figure 5.5 Spatial Point Pattern Analysis, 2015 ................................................................. 29
Figure 5.6 Spatial Point Pattern Analysis, 2016 ................................................................. 29
Figure 5.7 Mean Center & Standard Distance ................................................................. 29
Figure 5.8 Mean Center & Standard Deviation Ellipse ...................................................... 30
Figure 5.9 Homicides per Neighborhood ........................................................................... 30
Figure 5.10 Hot Spot Analysis and Heat Map ................................................................. 30
Figure 5.11 QGIS Average Nearest Neighbor Analysis ................................................. 31
Figure 5.12 ArcMap Average Nearest Neighbor Analysis .............................................. 31
Figure 5.13 Police Station Buffer Zones ........................................................................... 33
Figure 5.14 School Buffer Zones ....................................................................................... 33
Figure 5.15 Religious Organization Buffer Zones ............................................................. 33
Figure 5.16 Community Center Buffer Zones ................................................................. 33
Figure 5.17 Park Buffer Zones .......................................................................................... 34
Figure 5.18 Off-Sale Liquor Buffer Zones ....................................................................... 34
Figure 5.19 On-Sale Liquor Buffer Zones ....................................................................... 34
Figure 5.20 500-foot Road Buffer Zones ........................................................................ 36
Figure 5.21 Families Below Poverty Level ........................................................................ 37
Figure 5.22 Families Above Poverty Level by 300% ....................................................... 37
List of Tables

Table 5.1  Standard Distance Circle Diameters ........................................................................... 27
Table 5.2  Percent of Homicides per Feature Buffer Zone .......................................................... 32
Table 5.3  Ratio of Homicides per Feature Buffer Zone Area ..................................................... 35
1. Introduction

This final internship report is being submitted as an Alternate Plan Paper as partial fulfillment for the Degree of Master of Science in Geography at Minnesota State University, Mankato. The internship took place at the Center for Homicide Research (CHR) in Minneapolis, Minnesota from January through June of 2018. My title was Geographic Information System (GIS) Intern. The emphasis of the internship was to improve my general research and GIS research skills, to prepare and use data for GIS analysis, and to present the analysis. Besides my own work, I also took part in presentations and discussions lead by the CHR staff and other interns. The internship was significant and beneficial because it developed skills that are marketable, required in the workplace, and increased critical thinking abilities.

This paper is organized into seven chapters. This chapter, Chapter 1, is the introduction to the internship. Chapter 2 examines the scope of the internship. It includes a background of CHR, the duties of a GIS Intern, and discusses the benefits of the internship. Chapter 3 details presentations that were made during the internship. Chapter 4 is a literature review of the history of crime mapping, and tools for crime mapping and crime analysis. Chapter 5 is a GIS based case study. My research on homicides lead to the development of a case study: Homicides in Minneapolis from 2012 through 2016. Much of the research was conducted online, but other records were obtained from physical sources, such as the Minnesota History Center. To present the findings, the open source GIS program QGIS was used, since it is the program CHR utilizes. The paper concludes with an evaluation of the significance of the internship.

The internship was a continual process of learning and evaluation. I learned about the nature of homicides from the research and presentations of the CHR staff and other interns, and how and where to look for homicide data. A new GIS program, new GIS analysis tools, and how
to utilize GIS capabilities were also learned. An evaluation of the data, results, QGIS, and the internship experience was conducted. The internship was a constant progression of learning and evaluation, that was supported by critical thinking.
2. Scope of the Internship

2.1 Background

The Center for Homicide Research (CHR) is a nonprofit organization that addresses the issue of homicide. Their mission is to increase the knowledge and understanding of the unique nature of homicide using sound empirical research, critical analysis, and through meaningful and effective community partnerships. Their goals are to identify all facets of homicides, increase the solvability of cases, and reduce incidents of homicides, especially in minority and disenfranchised communities.

The Center was formed in 1999 as the Minnesota Gay Homicide Study. Their original mission focused on lesbian, gay, bisexual and transgender (LGBT) homicides in Minnesota. As their work advanced, they became a national resource on all types of homicides for communities, police forces, criminal justice professionals, and for academic criminologists. In 2004 the name was changed to CHR, and in 2007 the board of directors widened the scope of research topics to include all varieties of homicides. The Center’s research staff and researchers have assisted in both active and cold-case homicide investigations. Their work has helped to: 1) identify offenders, 2) strengthen cases for prosecutors, and 3) secure convictions.

CHR has a ten-member board of directors, and an academic advisory panel of nine members who have served the center since 2008. The two staff members at CHR are Dallas Drake and Jeff Mathwig. Mr. Drake’s title is Principal Researcher, he is also on the Board of Directors and functions as its Executive Director. He is the cofounder of CHR. Mr. Mathwig’s title is Research Manager/Development Officer, he is also on the Board of Directors for CHR.

The other researchers at the Center are unpaid interns that log hundreds of hours each month. CHR has sponsored both undergraduate and graduate students from many colleges and
universities in Minnesota and elsewhere, and Minnesota’s three law schools. All staff and interns have their backgrounds checked by the Minnesota Bureau of Criminal Apprehension.

2.2 Duties

My title at the Center was GIS Homicide Research Intern, in the program of Homicide Research Internship. The duties and responsibilities of a GIS Intern are:

- Identify appropriate GIS data sources using selection criteria
- Collect homicide case data from online databases, public agencies, and archival sources
- Prepare homicide data for use with GIS
- Analyze homicide and other crime data, searching for trends and patterns
- Participate in group discussions and theory development
- Construct presentations of results using PowerPoint slides and maps where needed
- Write reports detailing progress made and indicate what research actions were taken

2.3 Benefits of Internship

The internship was beneficial in many ways. It developed skills that are very marketable and increased my ability to think critically. Skills that were improved ranged from researching to using analytical GIS tools. Critical thinking was required in discussions with others and in evaluating my own research.

The process of working through a case study on homicide was very beneficial, because it involved several steps to bring the study to fruition. Finding homicide data was vital to the GIS internship, so learning ways to conduct research was crucial. Learning how to analyze the data was the next important step. This involved learning a new GIS program and learning its
capabilities. Evaluation of the GIS analysis was the next step in the process. The case study required the completion of a succession of steps in order to successfully complete a task. The major undertaking of the internship was the case study, but experiencing the presentations by the staff and other interns was also very important.

Critical thinking is an important ability that was required and enhanced by the internship. The internship challenged my critical thinking ability, because it required the continual evaluation of the research, what GIS tools to use, and how to best present the findings. Comprehension and evaluation of presentations by others was also an import aspect of the internship. Discussions followed all presentations, so critical thinking was a required function of all the interns.
3. Presentations

3.1 Presentations Conducted by CHR

CHR uses presentations by its staff and interns to educate the interns, start discussions about homicide, and to give interns practical experience in conducting presentations.

3.11 Paraphilias

One of the first presentations I was involved with was on paraphilias, which was led by Jeff Mathwig on January 23, 2018. Paraphilia is sexual arousal and gratification that is dependent upon engaging in or fantasizing about sexual behavior that is considered not normal, deviant, or extreme. Paraphilias are often exhibited by people who commit homicide, especially serial killers. Knowledge of the many paraphilias can aid in determining the actions and intentions of murderers, and aid in identifying and apprehending a murderer or serial killer. Appendix A is a list of 33 paraphilias; they are categorized as relatively safe, relatively risky, and dangerous.

Examples of relatively safe paraphilias are voyeurism: watching others have sex, and exhibitionism: exposing genitals without permission. Relatively risky paraphilias include masochism: taking pleasure from abuse or domination, and pyromania: setting fire to things. Examples of dangerous paraphilias include bondage: the sexual practice that engages in restraining or tying up a partner, and sadism: deriving pleasure and/or sexual gratification from causing pain or humiliating others.

After the presentation, several interns watched a video on a person who committed a murder and attempted another. It was learned that his intentions were to commit multiple murders, but he was apprehended during his second attempt. As a group we discussed the individual’s actions and what paraphilias he displayed. He exhibited three dangerous
paraphilias, sadism, picquerism, and erotophonophilia. Sadism is inflicting pain on others, picquerism is stabbing someone, and erotophonophilia is the murder of strangers.

3.12 LAPD Murder Book

Dallas Drake organized a webinar viewing of the Los Angeles Police Department’s Murder Book on March 13, 2018. The webinar was led by John Skaggs, formerly of the LAPD. The webinar was on the development, organization, and use of the Murder Book. A Murder Book consists of multiple three-ring binders that contain and organize all the pertinent information about a murder case.

Before the creation of the Murder Book, information on a murder was often poorly organized in boxes and file folders. This made it difficult and time consuming for police officers, staff, and prosecutors to review the information, develop a case, and present it in court. In 1981, the LAPD decided to improve this process with the development of the Murder Book. It drastically improved the organization of the data and how thoroughly the leads were followed. With the Murder Book, information became more complete and could be easily reviewed.

A Murder Book consists of 25 sections that are always listed in the same order. More sections can be added for additional documents, such as computer analysis, as deemed necessary. A Murder Book for a case is started on day one of the investigation. Appendix B lists the sections of each Murder Book.

In summary, the Murder Book has been an invaluable tool for the LAPD. It has helped them keep all the data for a homicide case organized, aids in the thoroughness of the investigation, and ensures that all leads and clues are followed to the end. The people that it benefits the most are the lead detective, the supervisor(s), and the prosecutors.
3.13 Criminal Justice Data Stream

On March 27, 2018, Dallas Drake demonstrated to the GIS interns how data streams through the United States’ criminal justice system. Figure 3.1 is a replication of the flow chart he created. The flow chart shows how a 911 call and a police incident report starts the flow of data. The data continues through a multiple of federal agencies. CHR can then obtain the archived data and utilize it. It is interesting to note that the FBI stores their data in the computer language COBOL, therefore they may request their archived data from CHR instead of trying to retrieve and decipher the COBOL files.

![Data Stream - Criminal Justice, United States](image)

**Figure 3.1 U.S. Criminal Justice Data Stream**

3.2 My Presentations

3.21 Geocoding, Coordinate System, and a Research Tool

Being a nonprofit, the geographic information system (GIS) that CHR uses is QGIS. QGIS is a free and open source GIS. There are many on-line tutorials for QGIS, so I began
learning the software through tutorials. In talking with others at CHR who had used QGIS, I discovered that they had had trouble using the program to geocode addresses.

Through the tutorials and Google searches, I learned that geocoding can be done in QGIS with the plugin MMQGIS. Using MMQGIS, I was able to successfully geocode addresses. Therefore, I decided to create a PowerPoint presentation to record the steps needed to geocode in QGIS. The presentation covered the key steps to geocode. They are: 1) having a spreadsheet of the addresses in .csv format, 2) including columns for address, city, and state, and country if the address is outside the United States, and 3) having an application programming interface (API) key. An API key can be obtained through Google Maps.

Also included in the presentation was the necessary procedure to convert a shapefile to a new coordinate system, and how to use the vector research tool, “Select by Location.” The best way to change the coordinate system of a QGIS shapefile is to execute “Save As…” and create a new file with the appropriate coordinate system. The “Select by Location” research tool was added to demonstrate a tool.

3.211 QGIS versus ArcMap

As indicated CHR uses QGIS, my classwork at Minnesota State University used ESRI’s ArcMap. The two programs have similar abilities, but there are many differences. One difference is the graphic user interface (GUI) for QGIS requires some initial setup by the user for each new project, while the basic GUI in ArcMap GUI is set for any project. Another is that locating and determining how a tool functions is more cumbersome in QGIS. QGIS relies on links to outside websites for details and help about its tools. In ArcMap, tools and their functions are defined within the program itself. Organizing files with ArcMap is also more dynamic. An entire project can be organized as a geodatabase, which can be subdivided into datasets.
Therefore, all the files and data are located within ArcMap. The easiest way to organize and manage data and files for QGIS is to create a folder for the project on a hard-drive.

ArcMap is setup to solve user questions and queries within itself, whereas QGIS requires the user to access online sources. QGIS is not as complex as ArcMap, so it is easier to learn, and its online sources are plentiful. ArcMap is a very powerful program, but it is also expensive; QGIS is a free open source program. So, depending on the complexity of the project or its budget, QGIS could be as capable as ArcMap at bringing a project to fruition. If QGIS is to be used for a GIS project, researching QGIS tools may be as important as researching information for the project.

3.22 GIS for Crime Analysis

My second presentation was a review of a journal article by Ferreira, João, and Martins (2012) entitle "GIS for Crime Analysis: Geography for Predictive Models." Dallas Drake wanted me to create a presentation on the importance of GIS in crime analysis for the other research interns. Most of the research interns at CHR are not involved with GIS, so the presentation was also an introduction to GIS.

The article and presentation began by indicating that crime has geographic or spatial attributes, and that these attributes and the statistics associated with them can be captured, analyzed, and correlated. To better understand the statistics and causes of crime, local and regional authorities have turned to information technologies, such as GIS. GIS is one of the tools being used to determine solutions for criminal activities.

The presentation then covered crime mapping and the development and importance of cartographic representation of crime data. Next, it was indicated how GIS has improved crime mapping by translating physical data, or features, into forms that can be displayed, manipulated
and analyzed. Spatial analysis can then be used to determine relationships and patterns in the data. GIS has been specifically used for crime analysis, changing policy district boundaries, and for crime reduction strategies.

It was concluded that the starting point for crime analysis was turning crime data into a form suitable for GIS. GIS is then able to analyze and determine the causes of crime and can be used to determine actions that will prevent crime. Progress continues to be made in utilizing the analytical capabilities of GIS. Besides spatial data, temporal and cultural data may help identify reasons for crime in specific geographic areas.

3.23 Case Study: Homicides in Minneapolis from 2012 through 2016

On April 13, 2018, CHR held a fund raiser at the Third Way Church in St. Paul. CHR provided pizza and refreshments. Jeff Mathwig started the fund raiser with a presentation on homicides. The next speakers were State Senators John Lesch and Sandra Pappas. I provided the final presentation, my case study: Homicides in Minneapolis from 2012 through 2016. It is detailed in Section 5. The presentation consisted of the steps taken during the case study to conduct GIS research and analysis.

A map of the point data for the five years was shown and explained. The point data was analyzed by measuring their geographic distribution. The mean center, standard distance, and standard deviation ellipse were calculated using the capabilities of QGIS. Maps of the results were shown, which indicated similar characters between the years for location and dispersion.

The point data was then analyzed to determine if it was dispersed or clustered. The tools used were point in polygon, hot spot analysis, heat map, and average nearest neighbor analysis. Maps showing the results of each tool indicated that the point data was clustered.
Being that the homicide locations were clustered, other features were examined to determine if they had an influence on homicides. Locations for police stations, schools, religious organizations, parks, community and recreational centers, on and off-sale liquor licenses were plotted, and buffer zones were created around each point. The resulting maps of the buffer zones and homicide locations showed that these physical locations only had a minimal beneficial effect on reducing homicides.

On physically viewing the homicide locations and city streets in GIS, a pattern arose. Many of the homicides are located with 500 feet of specific street center-line. This distance indicates that the homicide took place within the street right-of-way or immediately adjacent to the street. This was portrayed in another map. The three roads that appeared to be corridors for homicides were Fremont Avenue North, Lake Street, and Penn Avenue North.

The final maps of the presentation used 2010 census data on poverty in Minneapolis. The first map showed the number of families below the poverty level per tract with the homicide locations superimposed on it. Most of homicides were committed in the tracts that had families in poverty. The second map highlighted tracts where families were well above the poverty rate. Very few homicides took place in these tracts.

The presentation summary was that spatial analysis can potentially show trends in homicide locations, GIS can be effectively used to analyze data, and further analysis of demographics could help determine variables that have a relationship with homicides.
4. Literature Review

4.1 History of Crime Mapping

Currently crime mapping is considered a process which involves using a GIS to conduct spatial analysis of crime and other policing issues (Boba 2005). But, the origins of crime mapping begin well before computers were invented.

European researchers in the 1800s began examining crime levels in different regions and how these levels were influenced by sociological factors such as socioeconomic status. These researchers belonged to a school of thought known as the cartographic school of criminology (Groff and La Vigne 2002, Harries 1999). An example of their work are the maps created by the Italian geographer Adriano Balbi and French lawyer Andre-Michel Guerry (Boba 2005, Groff and La Vigne 2002, Wang 2012). Using data from the first French national system of crime reporting and the French census, they created three choropleth maps of crimes. The maps were of crimes against persons, property, and school instruction. These maps revealed geographic patterns for various crimes and showed how the patterns related to each other and to socioeconomic variables such as education level (Wang 2012, Weisburd and McEwen 1998).

During this same period crime maps were also being created by Lambert Adolphe Quetelet, a Belgian social statistician. He examined the correlation between crime and contextual variables such as transportation routes, poverty, climate, education levels, and cultural and ethnic variations (Boba 2005, Wang 2012, Weisburd and McEwen 1998).

Also, in the 1820s, the pin map for charting crime was invented by the London Metropolitan Police Department (Levine 2006). A pin map is simply a map with pins in it at locations were crimes have occurred (Ratcliffe 2004).
In the United States, fundamental spatial analysis of crime was being directed by urban ecologists/sociologists at the University of Chicago in the 1920s and 1930s (Boba 2005, Harries 1974, 1999, Weisburd and McEwen 1998). The research and crime maps of these sociologists linked crime and delinquency to variables such as poverty and social disorganization, and they are acknowledged as developing the social disorganization theory for crime. Sociologists and others who were interested in crime and its causes continued to examine the socioeconomic factors associated with crime through the 1970s. In the early 1960s, researchers began shifting from a focus on aggregate crime analysis to discrete criminal events and their locations (Brantingham and Brantingham 1981, Clarke 1980, Cornish and Clarke 1987). The geographic methods of crime analysis that existed remained uncomplicated until the advent of the computer.

In the early 1980s, GIS was becoming more available and police departments began experimenting with crime mapping on an everyday basis. Information on geography and environment were being incorporated into the crime maps. The National Institute of Justice, part of the Department of Justice, funded a project that partnered practitioners and researchers with five U.S. cities and used innovative analytical technology to study drug markets and track their movement. These projects demonstrated how communities could use GIS tools for crime control (Boba 2005).

The substantial improvements in computer technology and to police information systems in the 1990s made electronic crime mapping a practical tool for researchers and the police. GIS software was now available for desktop computers and data processing could be done quickly. Geographic data such as census information and street grids were becoming available electronically and could be obtained for free or at a minimal cost from government agencies and commercial businesses (Boba 2005, Harries 1999, Ratcliffe 2004).
Wang (2012) referred to the rapid adoption of GIS by enforcement agencies as a perfect storm created by three forces. First was the advancement of the computer and of information technologies that lead to cheaper and more efficient desktop computers and GIS software. Second was that reporting and archiving of crime data became required and standardized within the U.S. criminal justice system. The third force was a shift in focus from criminal offenders to the context of the crime, the “physical organization, and social environments that make crime possible” (Weisburd and McEwen, p.14).

In the 1990s the U.S. federal government supported crime mapping technologies and methods through funding police agencies. The Office of Community Oriented Policing Services (COPS), a part of the U.S. Department of Justice, allocated funds for crime mapping equipment and software through a program named Making Officer Redeployment Effective (MORE). In 1997 the Crime Mapping Research Center (CMRC) was formed within the National Institute of Justice (NIJ). It is now called Mapping and Analysis for Public Safety (MAPS). Its goal was to promote and disseminate GIS technology for criminal justice research and practice (Boba 2005, Harries 1999, Levine 2006, Wilson 2007). In 1998 the Crime Mapping and Analysis Program (CMAP) was created by the NIJ to provide training and assistance to local and state agencies in the areas of crime analysis and GIS (Boba 2005).

Wang (2012) indicated that GIS crime analysis in its early applications was limited to automated pin mapping, data archiving, and cluster or hot spot analysis. But through advancements in spatial statistical testing and the construction of spatial/lag variables in regression, GIS has continued to evolve. GIS applications have turned crime mapping into sophisticated spatial analysis.
4.2 Crime Mapping and Crime Analysis Tools

Police crime reports are a major source of crime data. From these reports, statistics on crime can be derived. Statistics are a valuable tool in crime analysis. Geostatistics center on the spatial and the spatiotemporal aspects of statistics (Ferreira, João, and Martins 2012). Analysis of the geostatistics of crime data often begins with visualizing the records in the form of crime maps (Ferreira, João, and Martins 2012, Wang 2012). Locating crimes with push pins on maps was an early form of using maps to visualize crime data (Ferreira, João, and Martins 2012, Harries 1999). The term crime mapping is a misnomer, because it now entails GIS, spatial analysis, and spatial data analysis (Wilson 2007). Using maps with crime data has been greatly advanced with the development of GIS (Ferreira, João, and Martins 2012, Harries 1999, LeBeau and Leitner 2011, Rossmo 1999, Sandig et al. 2013, Wang 2012). Linking the tabular data of the crime reports with geographic information is a process termed geocoding (Blistanová 2015).

Crime mapping normally involves the creation of a map, but Spicer et al. (2016) used another method to portray crime on major roadways. They used graphs to demonstrate the velocity and variance of crime along linear space and termed their method street profile analysis. One graph can clearly define specific peaks in crime, in both space and time, whereas multiple maps may be needed to convey the same information. This graphic approach of displaying crime data along roadways allows for numerous comparisons which can aid in understanding the dynamics of the location.

To map crime, the site of the crime needs to be located. This can be done through geocoding. Geocoding is a process that links an address to x, y coordinates of a map so the address can be displayed (Ferreira, João, and Martins 2012). The accuracy of address locations have improved as police agencies have implemented global navigational satellite systems (GNSS) as they register addresses (Wang 2012). Crime reports usually include an address, so
geocoding and GNSS can convert the address to coordinates with x, y values. Once the crime data is converted into point locations, spatial point analysis can be conducted.

There are a number of ways to perform point analysis of spatial data. The term centrography covers three types of point analysis: mean center, standard distance, and standard deviation ellipse (SDE). Centrography uses geostatistics, the data points and their temporal elements, to analyze data (LeBeau 1987, LeBeau and Leitner 2011, Rossmo 1999).

Examining the standard distance circles and their mean centers over time, can give an indication if the crime data is migrating, and if the data is becoming more or less dispersed. The same is true for SDE and their mean centers. Analysis of SDE could indicate the growth or dispersion of a crime corridor (LeBeau 1987).

Temporal aspects of crime data can be further analyzed to determine if season, the day of the week, or if the time of day have a relationship to crime. The study by Pereira, Andresen, and Mota (2016) showed that in the tropical climate of Recife, Brazil, season was not a large factor in homicide numbers, because there was little seasonal change. But their literature review indicated that in areas with cold winters, homicide numbers tended to decline during the winter season. So, seasons could be a factor in homicides. Their study also indicated that the day of the week and time of day were factors in homicides in Recife, and often in locations elsewhere.

Ferreira, João, and Martins (2012) indicated that hot spots are the most common method used in crime mapping. Hot spots are not always points, but they can be regions (polygons). The researchers identified three spatial approaches to hot spot analysis. The first is dispersed, where the crime is distributed in a specific area. The second is clustered, where crime is occurring in the proximity of a specific site. The third is hot point, which is a location that is victimized repeatedly.

Blistanová (2015) stated that there a number of techniques to identify and map crime hotspots. The techniques fall into three categories; these categories are global statistical tests, hotspot mapping techniques and local indicators of spatial statistics. Examples of global statistical tests are mean center, standard distance and standard deviation ellipse, and tests for clustering are Nearest Neighbor Index, Moran’s I, and Geary’s C statistic. Hotspots mapping techniques include, point mapping, spatial ellipses using hierarchical or K-means clustering, thematic mapping using enumeration areas, kernel density estimation, and quadrant mapping. Gi and Gi* statistics are examples of local indicators of spatial statistics.

Wang et al. (2013) studied crime hotspots through their related variables. They identified the three main categories of hotspot mapping as point mapping, choropleth mapping, and kernel density estimation. These methods do not incorporate variables that effect crime, such as arrest rate, economic investment, and population density. They improved the identification of hotspots by studying them and their related variables, and developed a model, Hotspot Optimization Tool (HOT), that identified hotspots by their related variables. The hotspots were then grouped using a similar method. The result was the visualization of the clusters based on the related variables. They believed their method helped explain how crime varies over time and provides information in a quantitative and comprehensive manner.
What is the significance of determining whether the data points are clustered or random? The clustering of data indicates that there is a relationship between the data points and other variables. Wang (2012) linked crime to a number of variables, such as climate, transportation corridors, poverty, education level, and cultural and ethnic variations. To determine what variables are affecting crime data, researchers have used additional forms of analysis. One common type of analysis is regression analysis. In regression analysis the type of crime, such as homicide, is considered the dependent variable. The researcher then need to determine the independent or explanatory variables that have a relationship with the dependent variable.

Grubesic, Mack, and Kaylen (2012) used the regression analyses of ordinary least squares (OLS) and geographically weighted regression (GWR) in their research. They pointed out that OLS and GWR have limitations, though. OLS assumes that variables are spatially stationary, even though that may not true. GWR is an exploratory tool and should only be used to identify questions that could be the center of future research. Therefore, the researchers supplemented their analysis with data envelopment analysis (DAE). DAE is a mathematical technique that evaluates how certain units use inputs to create outputs. But DAE is also limited, it does not test if the exploratory variables are appropriate. The researchers indicated that using all three methods complimented each other and made a stronger model for determining appropriate variables. The results of their case study suggested that social disorganization was the leading cause of assault violence for all block groups in the study area.

Wang (2005) used OLS and Poisson regression as he analyzed job access and homicide patterns in Chicago. He determined that job accessibility showed a stronger relationship with homicides than unemployment or jobless rates. Then he analyzed numerous covariates to determine the ones with the strongest relationship to homicides and job access. The covariates ranged from the demographics of poverty and income, to race, residential instability, and to
education attainment. The covariates with the strongest relationship to homicides were public assistance, female-headed households, black, poverty, and unemployment.

My case study mainly focused on the point data associated with homicides in Minneapolis, therefore the literature review did not cover the criminals and their victims. The researchers Rossmo and LeBeau both go into detail about crime theory and geographic profiling, and the behavioral and environmental aspects of crime.
5. Case Study: Homicides in Minneapolis from 2012 through 2016

5.1 Introduction

The object of the case study was to discover and examine homicide data for Minneapolis, Minnesota from 2012 through 2016. The research questions were:

1) Where were homicides located in Minneapolis from 2012 through 2016?
2) Do the points show a directional bias over time?
3) Is the point data random or clustered?
4) What other variables exhibit a relationship with the homicide locations?

5.2 Methodology

Being a nonprofit, the GIS that CHR uses is QGIS. QGIS is a free and open source GIS that is made available by the Open Source Geospatial Foundation (OSGeo). OSGeo is itself a not-for-profit organization. To learn QGIS, I found tutorials on the internet. The two main sites were https://www.qgistutorials.com (copyrighted by Ujaval Gandhi), and http://qgis-tutorials.mangomap.com (copyrighted by MangoMap Limited). Bradley Shellito’s book, Introduction to Geospatial Technologies (Shellito 2016), also has a number of labs that can be run with QGIS.

Once I became proficient with QGIS, I began to search for data sources. Homicide data for Minneapolis was found in the Police Incident shapefiles at http://opendata.minneapolismn.gov. Within the attribute files was a column for offenses. The offense ‘MURDR’ was selected to create a new shapefile for homicides. The Minnesota State Statutes define the term murder for the state (see Appendix C). A shapefile of the homicide locations was made for each year from 2012 through 2016.
The homicide rate for Minneapolis from 2012 to 2016 was then determined. The uniform crime report calculates the crime rate as “crime per 100,000 US population,” (Ansari and He 2015). The U.S. Census estimated population of Minneapolis for these years was: 392,821; 400,137; 406,619; 410,116; and 413,651 respectively. The average population was 404,669.

To determine if the points showed a directional bias from year to year, the geographic profiling method of centrography was utilized. Specifically, the average mean, standard distance, and standard deviation ellipse (SDE) were calculated. In QGIS, the spatial point pattern (SAGA) tools were used to determine the mean center and standard distance. The standard deviation ellipse tool was available as a plugin to the program.

The mean center is the average of the x, y coordinates for the points selected. By mapping the mean centers over a period of time, the change in locations can indicate whether a crime is migrating in a specific direction, or if it is staying sedentary.

Standard distance is a measure of the density of the spatial distribution of points around their mean center. Standard distance is often represented by a circle, whose radius is one standard distance of the points to the mean center. A large circle indicates that the data points are spread out (dispersed), whereas, a small circle is an indication that the points are clustered about the mean center.

The SDE is a summary of the spatial characteristics of the features. The ellipse is determined by calculating the standard distance of the x and y directions from the mean center separately. The axes of the ellipse are defined by these measurements. SDE can show the central tendency and directional trends of the data, and if the data is dispersed. If the resulting ellipse is long and narrow, the data is oriented in that direction, therefore, the ellipse is an indication of a crime corridor. An ellipse that is circular and not elongated is an indication that the data is becoming more dispersed, more random.
Spatial point analysis showed that the point data was clustered. To examine the nature of the clustering, the point in polygon tool was run in QGIS. The points were the homicide locations and the polygons are the neighborhoods of Minneapolis. The neighborhood shape file was available through the Minneapolis open data site.

To further explore the randomness of the points, hot spot analysis was conducted, and a heat map were created. Both of these functions are available as plugins in QGIS. Hot spot analysis calculates the Getis-Ord Gi* statistic for each feature and determines if the point data with high values (or with low values) is clustered spatially. Heat maps are similar to hot spots, but they also show the locations where the geographic point data is at higher densities. The maps are graphical representations of data that use colors to show the level of activity.

Additional cluster analysis was conducted using average nearest neighbor analysis. Nearest neighbor analysis is available in QGIS, but this analysis was also run in ArcMap, because the ArcMap results included the p-value. Three of the main factors that are determined by average nearest neighbor analysis are: the nearest neighbor index, the p-value, and the z-score.

Environmental Systems Research Institute (ESRI) defines the nearest neighbor index as a ratio of the observed mean distance to the expected mean distance, www.pro.arcgis.com. The expected distance is the average between each neighbor in a distribution that is random. A nearest neighbor index that is less than 1.0 indicates a cluster, whereas an index greater than 1.0 indicates random dispersion.

The p-value is the probability that the pattern was created by a random process; if the p-value is very small, there is a small probability that the pattern is due to a random process. The z-score indicates how many standard deviations above or below a component is from the mean.
If the z-score is very high or very low, and coupled with a low p-value, the analysis shows further indication of clustering.

Statistical tests, such as average nearest neighbor analysis, start by identifying a null hypothesis. The null hypothesis is an attempt to demonstrate that the variables are random, that a spatial pattern does not exist. The results of average nearest neighbor analysis indicate if the null hypothesis can be rejected. ESRI indicates that the confidence level associated with z-scores and p-values for rejecting the null hypothesis is as follows (www.pro.arcgis.com):

<table>
<thead>
<tr>
<th>z-score (standard deviation)</th>
<th>p-value (probability)</th>
<th>Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;-1.65 or &gt;1.65</td>
<td>&lt;0.10</td>
<td>90%</td>
</tr>
<tr>
<td>&lt;-1.96 or &gt;1.96</td>
<td>&lt;0.05</td>
<td>95%</td>
</tr>
<tr>
<td>&lt;-2.56 or &gt;2.58</td>
<td>&lt;0.01</td>
<td>99%</td>
</tr>
</tbody>
</table>

Next, other feature locations were examined to determine if they influenced homicides. Discussing homicides with CHR staff, we were curious if other physical sites affected homicides. They indicated that alcohol use is often connected to homicides, so locations of establishments that sell alcohol were researched. They also indicated that churches often spring up in areas where homicides are on the increase, so locations of churches and other religious organizations were investigated to examine their effect on homicides. We discussed other feature locations and came up with a number of sites that potentially could affect homicides.

To begin, shapefiles of the various feature locations were needed. Shapefiles for police stations, liquor license locations, and parks were found at the opendata.minneapolismn.gov site. Schools and their locations were found through www.mpls.k12.us and Google searches. Community centers and recreation centers were located at www.minneapolisparks.org and google searches. The addresses of the schools and center sites were recorded in a spreadsheet and geocoded for use in QGIS. A csv spreadsheet was created with fields for the organization
names, addresses, city, and state. QGIS was able to geocode the csv file through the plugin
MMQGIS and with an API code from Google maps.

Religious organization were compiled using the Polk City Directories at the Minnesota
History Center. The religious organizations that were included were churches, ministries,
missions, religious organizations, mosques and synagogues. The data that was compiled was
then converted to a csv spreadsheet and geocoded.

Other shapefiles were downloaded for mapping purposes. These included street
centerlines from www.hennepin.us/gisopendata and water from opendata.minneapolismn.gov.

Once the features were located, buffer zones were created around the features to show
how the homicide locations fit into the buffers. For the twelve police stations, buffers of 0.5
miles and 1.0 mile were used to show the coverage of the stations per the homicide locations.
The buffer sizes were arbitrary; 0.5 miles was used because the results encompassed almost 50%
of the homicides, and 1.0 mile was used because the results encompassed nearly 90% of the
homicides.

Buffer zones of 500 feet and 0.25 miles were created around the schools, religious
organizations, community and recreation centers, parks, off-sale liquor license locations, and on-
sale liquor license locations. The 500-foot buffer was used to identify the site itself and adjacent
properties. The 0.25-mile buffer was used, because it is within sight and easy walking distance
to the homicide location.

For each buffer zone, the number of homicides within it was determined using the
Vector> Research Tools> Location tool in QGIS. The data was then incorporated into a
spreadsheet and the percentage of homicides for each buffer was then calculated.

When viewing the homicide locations and city streets in GIS, a pattern was noticed.
Many of the homicides were located along specific streets. A 500-foot buffer zone was created
around the street center-lines. This distance was used, because it indicated that the homicide took place within the street right-of-way or immediately adjacent to the street.

The ratio of homicides per buffer zone was also determined using QGIS tools. The Minneapolis boundary shapefile was needed and downloaded from the city’s open data site. The area of the boundary shapefile was calculated using a Geometry Tool in QGIS. The buffer zones were examined and the ones that extended past the city’s boundary were modified so they would not extend outside the city. This was accomplished using the Geoprocessing Tool > Clip tool and the city boundary shapefile. Next, the area of the buffer zones was calculated using the Geometry Tool, and a new column was added to the attribute table that showed the area in square miles. The field calculator from the attribute table was utilized for this step. The data was then entered into spreadsheet and the ratio of homicides per buffer zone area was calculated.

Next, demographics and their relationship with homicides were explored. From the U.S. Census website, www.census.gov, poverty data from the 2010 census was downloaded. Hennepin County tracts were also downloaded from the website. The Minneapolis tracts shapefile was created from the Hennepin County file in QGIS; there are 116 census tracts in Minneapolis. The poverty data was then joined to the Minneapolis tract shapefiles.

Demographic and socioeconomic information were to be compiled and used as independent variables in regression analysis. The dependent variable was homicides. Poverty data was the only independent variable assessed for this study.

5.3 Results

The locations of the homicides for the years 2012 through 2016 were mapped, and each year was color coded. The total number of homicides was 129. The lowest total for one year was 21, and the highest total was 29. The resulting map is Figure 5.1. The data for each year is...
fairly similar and in similar locations. The average homicide rate per year for Minneapolis from 2012 through 2016 was 6.37 per 100,000 people, based on the uniform crime reports formula.

Figures 5.2 through 5.6 show the results of the mean center, standard distance, and standard deviation ellipse for the years 2012 through 2016. Figure 5.7 shows the standard distance circles and the mean centers for all five years. Figure 5.8 shows the standard deviation ellipse and the mean centers for all five years. Table 5.1 shows the diameters of the standard distance circles for the five years.

The results of the mean center, standard distance, and standard deviation ellipse calculations indicated that the mean center migrated to the southwest in 2013, but then migrated back the following years. The distance of the migrations was very small. The standard distance circles were all of similar size. This indicates that the homicide locations were dispersed similarly through the five years. The standard deviation ellipses were all elongated ellipses and not circular. Again, this indicates that the locations

<table>
<thead>
<tr>
<th>Year</th>
<th>Distance - miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>4.66</td>
</tr>
<tr>
<td>2013</td>
<td>4.66</td>
</tr>
<tr>
<td>2014</td>
<td>5.12</td>
</tr>
<tr>
<td>2015</td>
<td>4.30</td>
</tr>
<tr>
<td>2016</td>
<td>4.29</td>
</tr>
</tbody>
</table>
had a similarly dispersed. The long axis ran from northwest to southeast, which is an indication of a crime corridor. The city also runs north-south, so the potential of an ellipse of this nature was high.

Using the QGIS point in polygon tool with the homicide points and the neighborhood polygons, a shapefile was generated that totaled the number of homicide locations in each neighborhood. Using this new shapefile, a graduated map was created showing the number of homicides per neighborhood in five classes determined by natural breaks (Jenks). This map clearly shows that homicide locations were highest in the northwest quadrant and central region of Minneapolis, (see Figure 5.9).
Figure 5.4 Spatial Point Pattern Analysis, 2014

Figure 5.5 Spatial Point Pattern Analysis, 2015

Figure 5.6 Spatial Point Pattern Analysis, 2016

Figure 5.7 Mean Center & Std Distance Analysis
The hot spot analysis and heat map basically outlined the same areas in Minneapolis. The heat map also indicated the areas of highest intensity by the color scheme. The hot spot analysis and heat map were overlaid on the graduated map of homicides per neighborhood. All three indicated that the highest levels of homicides were in the northwest quadrant and central region of Minneapolis, (see Figure 5.10).

Average nearest neighbor analysis was utilized in both QGIS and ArcMap. The results...
were similar; ArcMap was used because it also included the p-value in the report it created. The nearest neighbor index for QGIS was .702, and the z-score was -6.475, (see Figure 5.11). The nearest neighbor index for ArcMap was .755, the p-value was 0.000, and the z-score was -5.321, (see Figure 5.12). Having a nearest neighbor index of less than one is an indicator that the data is not random. The low z-score coupled with a p-value of 0.000 also indicates that the probability of the points being random or dispersed is very low. The confidence level for the rejecting the null hypothesis is 99% as indicated by the numbers and by Figure 5.12. Therefore, the null hypothesis can be rejected, because the points did not exhibit a random spatial pattern.

![Figure 5.11 QGIS Average Nearest Neighbor Analysis](image)

![Figure 5.12 ArcMap Average Nearest Neighbor Analysis](image)
Other physical features were examined to determine if they had an effect on homicides. The twelve police stations in Minneapolis were plotted and buffer zones of 0.5 miles and 1.0 miles were created. The total number of homicides within 0.5 miles of police stations was 52, which is 40.3% of the 129 homicides. Within one mile of police stations 115 homicides occurred, or 89.1%, (see Figure 5.13).

Table 5.1 lists the features and the percentage of homicides that occurred in each buffer zone. The buffer zones were 500-feet and 0.25 miles. Figure 5.14 is a map of the homicides that took place within the school buffer zones. Figure 5.15 is the map for religious organizations. Figure 5.16 is the map for community and recreation centers. Figure 5.17 is the map for parks. Figure 5.18 is the map for off-sale liquor sites, (liquor stores). Figure 5.19 is the map for on-sale liquor sites, (bars and restaurants).

<table>
<thead>
<tr>
<th>Location</th>
<th># homicides</th>
<th>buffer zone</th>
<th>% of homicides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comm/Rec Ctrs - 57 sites</td>
<td>6</td>
<td>500 ft</td>
<td>4.65%</td>
</tr>
<tr>
<td>Off-Sale Liq Lic - 90 sites</td>
<td>11</td>
<td>500 ft</td>
<td>8.53%</td>
</tr>
<tr>
<td>Schools - 241 sites</td>
<td>21</td>
<td>500 ft</td>
<td>16.28%</td>
</tr>
<tr>
<td>On-Sale Liq Lic - 681 sites</td>
<td>25</td>
<td>500 ft</td>
<td>19.38%</td>
</tr>
<tr>
<td>Parks - 168 sites</td>
<td>28</td>
<td>500 ft</td>
<td>21.71%</td>
</tr>
<tr>
<td>Religious Org - 368 sites</td>
<td>39</td>
<td>500 ft</td>
<td>30.23%</td>
</tr>
<tr>
<td>Comm/Rec Ctrs</td>
<td>32</td>
<td>1/4 mile</td>
<td>24.81%</td>
</tr>
<tr>
<td>Off-Sale Liq Lic</td>
<td>34</td>
<td>1/4 mile</td>
<td>26.36%</td>
</tr>
<tr>
<td>On-Sale Liq Lic</td>
<td>57</td>
<td>1/4 mile</td>
<td>44.19%</td>
</tr>
<tr>
<td>Schools</td>
<td>77</td>
<td>1/4 mile</td>
<td>59.69%</td>
</tr>
<tr>
<td>Parks</td>
<td>87</td>
<td>1/4 mile</td>
<td>67.44%</td>
</tr>
<tr>
<td>Religious Org</td>
<td>114</td>
<td>1/4 mile</td>
<td>88.37%</td>
</tr>
</tbody>
</table>
Figure 5.13 Police Station Buffer Zones

Figure 5.14 School Buffer Zones

Figure 5.15 Religious Org. Buffer Zones

Figure 5.16 Community Center Buffer Zones
After the feature buffer zones were compared by the percentages, it was noted that the features with the most sites and, therefore, the largest buffer zones, had the highest number of homicides and the highest percentages occurring in them. One of my fellow graduate students, J.T. Salfer, recommended that the ratio of homicides to buffer area be calculated and examined.

The area of Minneapolis as indicated by its website is 58.4 square miles. Using the
shapefile from the city’s open data site and the QGIS tools, the area was calculated at 57.4 square miles, (a 1.7% difference). Since much of the data I used in this case study came from the same open data site, I decided not to change the shapefiles, because all of the data would be skewed in a similar manner.

The ratio of homicides to the total area of Minneapolis was 2.25 per square mile. The feature with the lowest ratio in either buffer zone was parks, 1.33 homicides per square mile in the 500-foot buffer zone and 2.03 homicides in the quarter mile buffer zone. Religious organizations had the highest over-all ratios with 5.15 per square mile, and 3.66 per square mile for the two buffers.

Table 5.2 lists the features and the ratio of homicides per feature buffer zone. The order of the features from lowest ratio to highest was basically the same for each buffer zone, except for the off-sale liquor license sites, (liquor stores). The liquor stores had a ratio of 5.15:1 which was the highest ratio in the 500-foot zone, the zone that includes the site and its immediate neighbors. In the quarter mile zone, it was just above the city average with a ratio of 2.95:1.

Table 5.3  Ratio of Homicides to Feature Buffer Zone

<table>
<thead>
<tr>
<th>Location</th>
<th># homicides</th>
<th>buffer zone</th>
<th>area in Sq Miles</th>
<th>Ratio: hom/area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parks - 168 sites</td>
<td>28</td>
<td>500 ft</td>
<td>21.0249</td>
<td>1.33</td>
</tr>
<tr>
<td>On-Sale Liq Lic - 681 sites</td>
<td>25</td>
<td>500 ft</td>
<td>7.5632</td>
<td>3.31</td>
</tr>
<tr>
<td>Comm/Rec Ctrs - 57 sites</td>
<td>6</td>
<td>500 ft</td>
<td>1.5568</td>
<td>3.85</td>
</tr>
<tr>
<td>Schools - 241 sites</td>
<td>21</td>
<td>500 ft</td>
<td>4.3126</td>
<td>4.87</td>
</tr>
<tr>
<td>Religious Org - 368 sites</td>
<td>39</td>
<td>500 ft</td>
<td>7.6714</td>
<td>5.08</td>
</tr>
<tr>
<td>Off-Sale Liq Lic - 90 sites</td>
<td>11</td>
<td>500 ft</td>
<td>2.1375</td>
<td>5.15</td>
</tr>
<tr>
<td>Parks</td>
<td>87</td>
<td>1/4 mile</td>
<td>42.8313</td>
<td>2.03</td>
</tr>
<tr>
<td>On-Sale Liq Lic</td>
<td>57</td>
<td>1/4 mile</td>
<td>26.7153</td>
<td>2.13</td>
</tr>
<tr>
<td>Off-Sale Liq Lic</td>
<td>34</td>
<td>1/4 mile</td>
<td>11.5203</td>
<td>2.95</td>
</tr>
<tr>
<td>Comm/Rec Ctrs</td>
<td>32</td>
<td>1/4 mile</td>
<td>10.3089</td>
<td>3.10</td>
</tr>
<tr>
<td>Schools</td>
<td>77</td>
<td>1/4 mile</td>
<td>22.6963</td>
<td>3.39</td>
</tr>
<tr>
<td>Religious Org</td>
<td>114</td>
<td>1/4 mile</td>
<td>31.1325</td>
<td>3.66</td>
</tr>
</tbody>
</table>
When the Minneapolis street grid was shown under the homicide locations, it became apparent that some roads had a relationship with homicides. The roads that appeared to have a connection with homicides were Franklin Avenue, Fremont Avenue North, Hennepin Avenue, Hiawatha Avenue, Lake Street, Penn Avenue North, and West Broadway. A 500-foot buffer zone was then created around the centerlines of these roads. This is a small buffer zone that only contains the street right-of-way and the property adjacent to the street. Fourteen (10.6%) of the 129 homicides were within 500 feet of the centerline of Fremont Avenue North. Thirteen (10.1%) were within the buffer zone of Lake Street, and eleven (8.5%) were in the buffer zone of Penn Avenue North. Figure 5.20 shows the street buffer zones and the proximity of homicides to them.

As indicated by the literature, regression analysis is a tool that has been used to give insights on why homicides are occurring. Using homicides as the dependent variable, independent or explanatory variables were going to be investigated next. Poverty was the only variable that was researched for this report. A shapefile was generated by joining 2010 Census poverty data with the tracts for Minneapolis. A graduated map of the results could then be created. In 2010, the poverty threshold for an individual was $11,139, and a family of four with two children was $22,113, https://www.census.gov/data/tables/time-series/demo/income-poverty/...
poverty/historical-poverty-thresholds.html/. A map was created showing the number of people below the poverty level per tract, and the homicide locations were overlaid on it, (see Figure 5.21). The tracts that registered the most homicides also had many families in poverty.

A reverse map was then created that showed the number of people above 300% of the poverty threshold per tract, (see Figure 5.22). Overlaid on it were the homicide locations. Very few tracts that had a high number of families well above the poverty level had any homicides within the tract.

5.4 Discussion

Spatial point analysis, centrography, showed that the number and location of homicides between 2012 and 2016 stayed fairly consistent. The standard distance circles and SDEs changed in size and location per year, but
the changes were very small. Migration of the mean centers was minimal, and the dispersal of the standard distance circles and SDEs remained consistent. The homicide locations showed a definite pattern. Hot spot analysis, heat mapping and average nearest neighbor all concluded that the locations were clustered. The homicides were clustered in the northwest quadrant and central region of Minneapolis.

Examining feature locations and their possible effect on homicides created some interesting findings. First, the location of the police stations seemed to provide adequate coverage of the city and the homicides sites. Almost 90% of the homicides were within one mile of a police station, so the spatial location of the police stations is appropriate.

The features that had the fewest homicides near them were community and recreation centers, and liquor stores. The features that experienced the highest number of homicides near them were the religious organizations. These statistics were shown in Table 5.1 as percentages. The table orders the features from the lowest to the highest percentage. The order of the features was almost identical to the number of each feature were plotted. Therefore, the features with the least number of points, had the lowest percent of homicides within their buffer zones, and vice versa.

Considering it had a much larger number of points, on-sale liquor sites had a percentage of homicides within its buffer zones that was comparable to that of schools. On-sale liquor sites seemed to have the largest effect on reducing homicides in their vicinity. Both on-sale liquor sites and schools have a high level of activity at the sites, but on-sale liquor sites are open for longer hours and have business throughout the entire year. This activity level may be the cause for their relatively low percentage.

The major anomaly was religious organizations. Its buffer zones were not as large as those for parks or on-sale liquor sites, but they had the highest percentage rates. This may be due
to a variety of reasons. Congregation size could vary greatly among the sites, so the activity level at each site was different. The sites with small congregations and less activity may have less impact on criminal activity since there are fewer people monitoring the site. Breaking down the religious sites into congregation size and recalculating the percentage may show an effect on homicides. As a whole, the sites of religious organizations showed the least ability to effect homicide occurrences.

Since the size of the buffer zones affected the percent of homicides within them, the ratio of homicides to buffer zone area was calculated and examined. Table 5.2 listed the feature locations per this ratio.

The feature with the lowest ratios was parks, its buffer zones were the largest. On-sale liquor sites has the second lowest ratios followed by community and recreation centers. The highest over-all ratios were by schools and religious organizations.

The one feature that showed a large difference in its ranking from the 500-foot buffer to the 0.25-mile buffer was off-sale liquor sites, or liquor stores. Liquor stores had the highest ratio of homicides in the 500-foot buffer, or basically at the site. In the 0.25-mile buffer, it had the third lowest. I discussed this result with Professor Lopez and Dallas Drake. The conclusion was the liquor stores may be acting as gathering points. People who would like to obtain liquor, but are unable to buy it, may be at the site to obtain in another manner. Other transaction may also be occurring at the site as well. When a transaction goes wrong, the result may lead to violence.

A study conducted by Teh (2008) addressed the effect of liquor stores on violent and property crime densities in their adjacent neighborhoods in the City of Los Angeles. His dependent variable was crime density. He summarized his finding by indicating that new liquor outlets appeared to increase both violent and property crime in low socioeconomic status neighborhoods, but only increases property crime in high socioeconomic status neighborhoods.
New liquor stores that are a part of a larger retail store or grocery store have little influence on violent crime in all neighborhoods, though.

The ranking of features by ratio of homicides per buffer area was somewhat reversed of the ranking by percentage, the larger buffer zones tended to have lower ratios. The community and recreation centers had the best ranking when both tables were considered, and religious organizations had the lowest ranking. Calculating both percentage and ratio helped give insight on the effect each feature had on homicides, how the features compared, and why their effects were different.

Certain roads in Minneapolis seem to have a strong connection with homicides. The buffer zone created around the selected roads was very small, and yet the number of homicides located within the buffers was relatively high. Human activities along these corridors and at the road intersections need to be explored in detail to determine why homicides are happening in those locations. Questions such as: 1) are the homicides being caused due to territorial disputes, and 2) are the homicides due to transactions at the locations, need to be addressed. The roads with the highest number of homicides along there right-of ways were Fremont Avenue North, Lake Street, and Penn Avenue North.

Poverty level appears to have a strong relationship to homicides. More research on variables that have relationships to homicide need to be examined for the study area.

5.5 Conclusion

Spatial point analysis can determine patterns from homicide locations. The temporal aspects of centrography can indicate if the location of homicides is migrating over time, and if the locations are becoming more or less dispersed. The clustering of the data points can be further examined through hot spot analysis, heat maps, and average nearest neighbor analysis.
The point data for homicides in Minneapolis from 2012 to 2016 indicated that the homicide locations were clustered, and that they did not disperse or migrate much during the five-year period. The clusters that were revealed were in two main areas, the northwest quadrant and central region of Minneapolis. Analyzing each cluster independently, and for a longer period of time, could provide further details on the centrography of each cluster, and if they are affecting each other. The temporal aspects of season (temperature), time of day, and day of week (weekday versus weekend), should also be evaluated.

Determining why homicides are occurring is essential if they are to be reduced. A number of feature locations were examined to evaluate if they had an effect on homicide occurrences. Community and recreation centers seemed to be a positive influence in reducing homicides near them overall, but their presence did not eliminate homicides. The physical locations of schools, religious organizations, parks, liquor licenses, and police stations, showed varying degrees of effect on homicides, but none were alleviating the occurrences of homicides.

On-sale liquor sites, such as bars and restaurants, appear to lessen the number of homicides near them. This is possibly due to the activity associated with them. Liquor stores had the opposite effect. They are potentially being used as gathering sites, which can increase the potential for crime and homicides at their locations.

Assessing just statistics will not create an answer to why homicides occur. The fluidity of people’s movements through their daily lives also complicates the variables that affect them, and therefore the variables related to homicides. A variety of analyses, and analyses that complement each other are necessary to find an answer for the difficult question of why homicides occur, and to find ways of reducing homicides.
5.6 Future Research

The two homicides clusters in Minneapolis should be examined separately. Homicide data for several decades should be captured and compiled for the areas, and then the statistics of centrography should be calculated. With the larger data sets, migration and dispersion patterns of the point may show different characteristics than the five-year period of 2012 to 2016.

Temporal aspects of homicides should be determined and further investigated. Knowing what time homicides occur could be important in determining if features such as schools, religious sites, and bars and restaurants are affecting the occurrences of homicides. Are homicides near these features only happening when they are closed, or also when they are busy? Also, do seasons play a major role when homicides occur? Policing strategies could be modified if these temporal aspects of homicides show an impact on the occurrences of homicides.

The demographics and socioeconomic status of the people in the study area need to be researched in depth to gain insights on ‘why’ homicides occur. The examination of 2010 poverty level data showed how important these issues may be in regard to homicides and in homicide prevention.
6. Conclusion

The goal of the internship was to improve general research and GIS research skills, to prepare and use data for GIS analysis, and to present the analysis. There were many factors that helped me accomplish these goals.

The staff at CHR, Dallas Drake and Jeff Mathwig, are extremely knowledgeable and passionate about the topic of homicide and finding ways to reduce it and solve homicide cases. They are both very familiar with online and traditional sources for discovering information related to homicides. They are also very positive and helpful and are concerned with developing an intern’s ability to conduct research and present it in both oral and written form.

To help its researchers and interns, CHR has developed basic search and computer search strategies, a data collection process, and has established steps to follow in the research process. CHR also has physical and online libraries to aide its researchers. The environment at CHR is very conducive for conducting research and enhancing the abilities of its researchers.

To learn more about criminal analysis, a literature review was conducted. The review helped me determine methods to analyze point data and determine the significance of the results. Spatial analysis of point data can show trends and patterns in the data over periods of time, but it does not answer the question of why crime or homicides are occurring. Variables that are affecting homicides or have relationships to homicides must be investigated and determined. Further analysis of the variables can then be conducted to determine their influence on homicides.

To learn more about spatial analysis and crime analysis I also spoke with Dr. Jose Lopez. He is a geography professor at Minnesota State University, Mankato. Professor Lopez informed me of ways that GIS can be used to conduct point and cluster analysis. He also directed me to
review the writings of J.L. LeBeau to further understand crime analysis techniques. The time spent with him was extremely valuable to my research.

The internship required that I learn the GIS program QGIS. Besides conducting homicide research, I also needed to research how to use QGIS. Being that the documentation and tutorials for QGIS are online, my online researching skills were continually tested and improved. I performed some of the GIS analysis in both QGIS and ArcMap to see how the two programs compared. The results were similar, so my analysis recognized QGIS as proficient GIS program.

The internship also involved taking part in and conducting presentations. In either case, discussions occurred during and after the presentations. This required critical thinking by the participants and the presenter, and enhanced the experience of the presentation. Preparing for a presentation was very beneficial, because it required the presenter to determine the main points of the research, and pinpointed the significance of the results.

The experience of being a GIS Homicide Research Intern was very beneficial for me. It improved and honed my research skills in many ways. It increased my critical thinking ability, especially in regards to homicide and crime analysis. It enhanced my ability to prepare and conduct presentations. It also improved my ability to organize and write reports. Interning at CHR brought me into contact with a variety of people including interns and staff. Improving one’s listening and conversation skills is always important, because any job and most situations involve working with people. Therefore, the internship was valuable not only for learning “things,” but also learning about people.
References


Appendices

Appendix A. List of Paraphilias

Paraphilias You Should Know
Listed Least to Most Dangerous

Here is a list of paraphilias that you should become familiar with. Look up the definitions and be sure that you understand them. Provide examples of the various manifestations of each one.

Relatively Safe
- Voyeurism
- Frotteurism
- Exhibitionism
- Marauding
- Fetishism
- Kleptomania
- Statuephilia
- Zoophilia
- Infantilism
- Urophilia
- Xenophilia

Relatively Risky
- Vampirism
- Somotophilia
- Masochism
- Pyromania
- Pseudo-necrophilia
- Infibulations
- Raptophilia
- Scatophilia
- Hybristophilia
- Erotomania
- Gerontophilia
- Pedophilia

Dangerous
- Stigmatophilia
- Erotophonophilia
- Picquerism
- Asphyxiophilia
- Sadism
- Cannibalism
- Partialism
- Bondage
- Necrophilia
- Symphorophilia
- Haematophilia

© Copyright 2009 Center for Homicide Research
Appendix B. LAPD Murder Book Sections

Section 1: Chronological Record – date/time summary, lists future actions required
Section 2: Crime Scene Log – who was there, what did they do
Section 3: Crime Report – by handling detective, created in 1st 24 hours
Section 4: Death Report – by officer or doctor
Section 5: Property / Evidence Report
Section 6: Crime Lab Report (and Analysis) – i.e. fingerprints & DNA
Section 7: Vehicle Report
Section 8: Arrest Report
Section 9: Related Crime Reports - i.e. suspects in other crimes
Section 10: Follow-up Reports – status of the case
    Report for court – every reason for prosecution
    90-day Report – things to do, why case not solved?
Section 11: Victim Information
Section 12: Suspect Information
Section 13: Photo Line-ups
Section 14: Witness List / Statements
Section 15: Officer at Scene Report – with notes
Section 16: Crime Scene Notes & Diagrams
Section 17: Crime Scene Photographs
Section 18: Ambulance / Medical Records
Section 19: Medical Examiner Reports – autopsy
Section 20: Communications – includes press articles and social media
Section 21: Search Warrants
Section 22: Miscellaneous Notes
Section 23: Miscellaneous Computer Runs – Lexus/ Nexus reports, Google Searches
Section 24: Video / CCTV – (in disk form)
Section 25: Eliminated Suspects
Section 26 – 28: Additional Documents
Appendix C. Minnesota State Statutes – Murder

Universal Citation: MN Stat § 609.185 (2017)

609.185 MURDER IN THE FIRST DEGREE.

(a) Whoever does any of the following is guilty of murder in the first degree and shall be sentenced to imprisonment for life:

(1) causes the death of a human being with premeditation and with intent to effect the death of the person or of another;

(2) causes the death of a human being while committing or attempting to commit criminal sexual conduct in the first or second degree with force or violence, either upon or affecting the person or another;

(3) causes the death of a human being with intent to effect the death of the person or another, while committing or attempting to commit burglary, aggravated robbery, kidnapping, arson in the first or second degree, a drive-by shooting, tampering with a witness in the first degree, escape from custody, or any felony violation of chapter 152 involving the unlawful sale of a controlled substance;

(4) causes the death of a peace officer, prosecuting attorney, judge, or a guard employed at a Minnesota state or local correctional facility, with intent to effect the death of that person or another, while the person is engaged in the performance of official duties;

(5) causes the death of a minor while committing child abuse, when the perpetrator has engaged in a past pattern of child abuse upon a child and the death occurs under circumstances manifesting an extreme indifference to human life;

(6) causes the death of a human being while committing domestic abuse, when the perpetrator has engaged in a past pattern of domestic abuse upon the victim or upon another family or household member and the death occurs under circumstances manifesting an extreme indifference to human life; or

(7) causes the death of a human being while committing, conspiring to commit, or attempting to commit a felony crime to further terrorism and the death occurs under circumstances manifesting an extreme indifference to human life.

(b) For the purposes of paragraph (a), clause (4), "prosecuting attorney" has the meaning given in section 609.221, subdivision 2, paragraph (c), clause (4).

(c) For the purposes of paragraph (a), clause (4), "judge" has the meaning given in section 609.221, subdivision 2, paragraph (c), clause (5).

(d) For purposes of paragraph (a), clause (5), "child abuse" means an act committed against a minor victim that constitutes a violation of the following laws of this state or any similar laws of
Appendix C. continued

the United States or any other state: section 609.221; 609.222; 609.223; 609.224; 609.2242; 609.342; 609.343; 609.344; 609.345; 609.377; 609.378; or 609.713.

(e) For purposes of paragraph (a), clause (6), "domestic abuse" means an act that:

(1) constitutes a violation of section 609.221, 609.222, 609.223, 609.224, 609.2242, 609.342, 609.343, 609.344, 609.345, 609.713, or any similar laws of the United States or any other state; and

(2) is committed against the victim who is a family or household member as defined in section 518B.01, subdivision 2, paragraph (b).

(f) For purposes of paragraph (a), clause (7), "further terrorism" has the meaning given in section 609.714, subdivision 1.

History: 1963 c 753 art 1 s 609.185; 1975 c 374 s 1; 1981 c 227 s 9; 1986 c 444; 1988 c 662 s 2; 1989 c 290 art 2 s 11; 1990 c 583 s 4; 1992 c 571 art 4 s 5; 1994 c 636 art 2 s 19; 1995 c 244 s 12; 1995 c 259 art 3 s 12; 1998 c 367 art 2 s 7; 2000 c 437 s 5; 2002 c 401 art 1 s 15; 2005 c 136 art 17 s 10; 2014 c 302 s 1

Universal Citation: MN Stat § 609.19 (2017)

609.19 MURDER IN THE SECOND DEGREE.

Subd. 1. Intentional murder; drive-by shootings. Whoever does either of the following is guilty of murder in the second degree and may be sentenced to imprisonment for not more than 40 years:

(1) causes the death of a human being with intent to effect the death of that person or another, but without premeditation; or

(2) causes the death of a human being while committing or attempting to commit a drive-by shooting in violation of section 609.66, subdivision 1e, under circumstances other than those described in section 609.185, paragraph (a), clause (3).

Subd. 2. Unintentional murders. Whoever does either of the following is guilty of unintentional murder in the second degree and may be sentenced to imprisonment for not more than 40 years:

(1) causes the death of a human being, without intent to effect the death of any person, while committing or attempting to commit a felony offense other than criminal sexual conduct in the first or second degree with force or violence or a drive-by shooting; or

(2) causes the death of a human being without intent to effect the death of any person, while intentionally inflicting or attempting to inflict bodily harm upon the victim, when the perpetrator is restrained under an order for protection and the victim is a person designated to receive protection under the order. As used in this clause, "order for protection" includes an order for protection issued under chapter 518B; a harassment restraining order issued under section 609.748; a court order setting conditions of pretrial release or conditions of a criminal sentence or juvenile court disposition; a restraining order issued in a
609.195 MURDER IN THE THIRD DEGREE.

(a) Whoever, without intent to effect the death of any person, causes the death of another by perpetrating an act eminently dangerous to others and evincing a depraved mind, without regard for human life, is guilty of murder in the third degree and may be sentenced to imprisonment for not more than 25 years.

(b) Whoever, without intent to cause death, proximately causes the death of a human being by, directly or indirectly, unlawfully selling, giving away, bartering, delivering, exchanging, distributing, or administering a controlled substance classified in Schedule I or II, is guilty of murder in the third degree and may be sentenced to imprisonment for not more than 25 years or to payment of a fine of not more than $40,000, or both.

History: 1963 c 753 art 1 s 609.195; 1977 c 130 s 3; 1981 c 227 s 11; 1987 c 176 s 1