Mapping Crime in Sacramento:

A GIS Approach to analyzing the spatial distribution of crime in Sacramento, California

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Abstract:

Spatial analysis using geographic information systems has been used for many years to analyze various patterns and distributions. More recently, this approach has been introduced as a method to study crime and where it occurs within a designated area. Crime maps can locate areas where crime is more prevalent and give insight and greater understanding into the minds of delinquents. Understanding the patterns and spatial distributions of crime within a city can aid city officials in future actions and decision-making. This study analyzed 2016 crime data from Sacramento, California. The goals were to identify the spatial patterns and locations of various categories of crime and to determine which neighborhoods are the safest and most dangerous. Dispatch data from 2016 was used and sorted by category to extract the crimes being studied. This data was used to create density surface models for each individual crime, as well as crimes as a whole. The analysis showed three major hotspots within the city; Downtown, Old North Sacramento, and Oak Park. Digital Surface Models (DSM) on individual crimes showed car clouting/jacking primarily occurred in downtown, narcotics and assaults primarily occurred in the three hotspots, and the other analyzed crimes had a wider distribution.

Keywords: Crime, density surface model, Sacramento
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**Introduction:**

The study of spatial patterns and distributions has been conducted for many years. Over the last few decades, the use of Geographic Information Systems (GIS) has become more and more prevalent. As this system of geographic analysis has been integrated into research methods, it has brought forth a new approach to observe spatial data.

One of the many areas where spatial analysis can be utilized is when looking at crime. GIS can be used for pattern analysis and for looking at spatial crime distributions. This can reveal key information, showing areas affected by crime which could not as easily be identified and shown through statistical tables alone (Butorac, Marinovic, 2017). It can show “hot spots” where a high density of crime is occurring, giving insight and better understanding of delinquency areas. Awareness of these hot spots are essential for future research and change. Contemporary police organizations regularly use GIS for crime mapping and analysis as a way to recognized trends and patterns of criminal activity occurring in their community (Butorac, Marinovic, 2017). For our research, we will be analyzing 2016 crime data from Sacramento, California. Sacramento is the US state capital of California, and is located in the northern central valley. With nearly half a million people, it is the 6th largest city and fastest growing one in the state (Sacramento, 2017). However, like most growing cities, Sacramento’s crime rates have been rising as well. We will be focusing our research on the spatial density and distribution of a handful of individual crimes, and all criminal activity as a whole.

A deeper look into patterns of crime reveals a complex dynamic centered on the crime and social phenomena. Research revealed that criminal occurrence is heavily dependent on the individual’s knowledge and cognitive map (Brantingham, 1981). Criminal activity tends to have a bias toward areas in or near spaces of awareness or habitual actions; meaning they tend to commit crimes near or in areas they visit regularly/are familiar with. This could be places like
the criminal’s home and work, as well as other frequented places such as grocery stores and shopping centers. Knowing this can aid in interpreting crime density maps and predicting where these criminals are located.

Awareness space however, is not the only factor that is analyzed when looking at criminal activity. Bias crime and crime occurring in proximity of a landmark are two of many factors. Bias crime is a huge, hybrid phenomena. This type of delinquency is a combination of elements from inter-group bias and crime. One study discussed the proliferation of social deviance, breaking it down into three indicators: poverty, ethnic heterogeneity, and residential turnover (Grattet, 2009). Poverty stricken areas are less likely to contain a stable social structure. It is also said that ethnic and racial heterogeneity can make community self-regulation harder to create and sustain. Finally, neighborhoods with people constantly moving in and out are less likely to develop self-regulation. Areas that fit these indicators likely experience larger amounts of criminal activity than the average neighborhood (Grattet, 2009). Proximity to specific landmarks is also a factor considered in criminal spatial distributions. An investigation was performed in 2009 on the relationship of crime rates in Sacramento to medical marijuana dispensaries (Kepple, Freisthler, 2012). This study was performed under the perception that dispensaries are a breeding ground for criminal activity. The researchers concluded that either the density of dispensaries had no association with crime rates, or that the relationship was more complex than they had measured (Kepple, Freisthler, 2012). While these two factors could be very significant, they are also difficult to determine when assessing crime. It requires much more analysis, as well as the knowledge or assumption that the crime was committed with these factors in mind as a motivating influence.
Geospatial analysis has become extremely important in crime analysis for police organization because its patterns are so dynamic. While many crime maps of Sacramento have been made, they quickly become outdated as new crimes are committed. Maps consisting of new data must constantly be made to keep up with crime’s dynamic pattern. These maps can be used for early identification of changing criminal behavior. Observing this can inform us on risk as well as opportunities for development and positive change. It can also visualize if there is a benefit from crime prevention, or if the criminal activity is just being diffused or displaced elsewhere (Ratcliffe, 2005).

The first goal of our research is to identify the spatial patterns of various categories of crime and where they occur. This research will focus on more serious or severe crimes. The 10 crime categories that will be analyzed are arson, shootings and shots fired, burglary, car clouting and jacking, felony assault or battery, misdemeanor assault, narcotics, robbery, stolen vehicle, and vandalism. Smaller, nonviolent crimes, such as traffic violations, public peace, and forgery were not be analyzed for this project. Locations for crimes such as domestic violence and sex crimes are not released to the public and therefore were also not analyzed in this study. The result will be analyzed to look for any patterns in relation to neighborhoods and population density. The second goal will be to identify which neighborhoods are the safest and most dangerous. This will be done by analyzing the 10 selected crime types as a whole and using the results to determine the areas with the highest and lowest amount of delinquency.

**Methods:**

This study was conducted on selected crimes from 2016 in Sacramento, California. Sacramento has an increasing population that is estimated at 495,000 (Bureau, 2017). It is located approximately 90 miles north east of San Francisco, at the confluence of the Sacramento
and American Rivers in the Sacramento Valley. All data and analysis was conducted on crime locations within the Sacramento city boundaries.

Shapefiles for the city boundary, neighborhoods, and census 2010 population by block were downloaded from the City of Sacramento Open Data Portal. A California county shapefile for a locator map was also downloaded from the US Census Bureau Geography Division. All files were projected in ArcMap into NAD 1983 UTM Zone 10N.

Dispatch data from 2016 was also downloaded from the City of Sacramento’s Open Data Portal. The data was then filtered and the following crimes were selected for analysis: arson, burglary, car clouting and jacking, felony assault or battery, misdemeanor assault, narcotics, robbery, shootings and shots fired, stolen vehicle, and vandalism. All crime data was added into ArcMap as XY data in the geographic coordinate system WGS 1984 and projected to NAD 1983 UTM Zone 10N. The files were all then clipped to the Sacramento city boundary shapefile.

Prior to raster processing, the global environment settings were changed to be constrained to the city boundary extent. To create density surface models (DSM), the spatial analyst tool Kernel Density was used. A DSM was created for each individual crime and one for all 10 crimes together. The DSMs were all symbolized using a Natural Breaks (Jenks) classification with 10 classes and a hot to cold color ramp. These models were then analyzed in relation to population density and neighborhoods to determine spatial patterns.
Results:

![Kernel density surface model for the 10-selected crime from Sacramento's 2016 dispatch data. The data is shown in 10 classes, classified using natural breaks (Jenks). The model is displayed with a cold to hot color ramp with 40% transparency.](image)

By analyzing the density surface models for the crimes individually and as a whole, spatial patterns and crime hot spots are clearly represented. The DSM on all the analyzed crime shows that the majority of crime is congregated in three hotspots within the city (Figure 1). The first hotspot is in central Sacramento and includes Downtown, Midtown, Mansion Flats, Boulevard Park, Marshall School, Alkali Flat, Old Sacramento, Richmond Grove, and Newton Booth. The Downtown/Midtown area of Sacramento is the central business district and historic
district. Both are popular neighborhoods and attract large crowds with its many shopping, dining, and entertainment options. Downtown is also the location of the state capital building. The second hotspot centers around the Old North Sacramento neighborhood and includes Noralto, South Hagginwood, Richardson Village, Woodlake, and Erikson Park. The final and smallest hotspot centers around Central Oak Park and extends to North Oak Park, Fairgrounds, West Tahoe Park, and South Oak Park. These two hotspot areas, contrary to downtown, are both lower-income, working-class neighborhoods.

Further analysis on data from the 2010 census showed that the three hotspots had relatively high population densities by square mile, with the downtown area having the highest in the entire city. This is a large factor when analyzing these crime patterns, since delinquency often occurs in densely populated areas.

Analyzing the DSM’s of individual crimes showed varying patterns based on each crime. Narcotics, misdemeanor assault, and felony assault or battery all had similar patterns mostly occurring in the major three hotspots (Appendix 4,5,6). Car clouting and jacking had a much narrower range, primarily occurring in the downtown hotspot (Appendix 3). This could potentially be because the area is more affluent with high traffic, often attracting tourists. Arson, Burglary, robbery, shootings/shots fired, stolen vehicles, and vandalism while still primarily occurring in the three hotspots, had a more spread distribution (Appendix 1,2,7,8,9,10). The models for these crimes show occurrences in other neighborhoods such as South Natomas, College Town, Meadowview, Valley Hi/North Laguna, Swanston Estates, and Del Paso Heights. This could potentially be because these crimes are occurring within the criminal’s space of awareness, and therefore are committed near the individual’s home rather than at hotspots.
Through this analysis, it can be seen that the areas with the highest density of crime are Old North Sacramento, Downtown, and Oak Park. Based solely on crime density, we could predict that areas with very low crime could be considered safer neighborhoods. This would include neighborhoods such as Pocket, Greenhaven, Willowcreek, Del Paso Park, Raley Industrial Park, Natomas, Creekside, Sundance Lake, and Greenbriar.

**Conclusion:**

The high density spatial patterns between crime were consistent, only varying in lower density areas. The neighborhoods in which the majority of the crime occurred fulfilled many conditions which are precursors for high crime, including densely populated, low-income and high traffic. Further research could analyze additional factors such as race, distance from landmarks, and household income. Studies could also analyze gentrification and how crime patterns change and evolve as the city undergoes changes. More extensive GIS analysis could also be done when determining neighborhood safety by assigning each crime a different weight based on severity.

**Acknowledgements:**

We would like to thank Professor Nick Malloy for his advice and assistance during this study. This research was conducted with data retrieved from the City of Sacramento Geographic Information Systems Data webpage, the Sacramento County Geographic Information Services webpage, the Sacramento County Open Data Portal, and US Census Bureau Geography Division.
References:


Appendices:

Appendix 1: Kernel density surface model for arson from Sacramento’s 2016 dispatch data. The data is shown in 10 classes, classified using natural breaks (Jenks). The model is displayed with a cold to hot color ramp with 40% transparency.
Appendix 2: Kernel density surface model for burglary from Sacramento’s 2016 dispatch data. The data is shown in 10 classes, classified using natural breaks (Jenks). The model is displayed with a cold to hot color ramp with 40% transparency.
Appendix 3: Kernel density surface model for car clouting or jacking from Sacramento’s 2016 dispatch data. The data is shown in 10 classes, classified using natural breaks (Jenks). The model is displayed with a cold to hot color ramp with 40% transparency.
Appendix 4: Kernel density surface model for felony assault or battery from Sacramento’s 2016 dispatch data. The data is shown in 10 classes, classified using natural breaks (Jenks). The model is displayed with a cold to hot color ramp with 40% transparency.
Appendix 5: Kernel density surface model for misdemeanor assault from Sacramento's 2016 dispatch data. The data is shown in 10 classes, classified using natural breaks (Jenks). The model is displayed with a cold to hot color ramp with 40% transparency.
Appendix 6: Kernel density surface model for narcotics related crime from Sacramento's 2016 dispatch data. The data is shown in 10 classes, classified using natural breaks (Jenks). The model is displayed with a cold to hot color ramp with 40% transparency.
Appendix 7: Kernel density surface model for car robbery from Sacramento’s 2016 dispatch data. The data is shown in 10 classes, classified using natural breaks (Jenks). The model is displayed with a cold to hot color ramp with 40% transparency.
Appendix 8: Kernel density surface model for shootings or shots fired from Sacramento's 2016 dispatch data. The data is shown in 10 classes, classified using natural breaks (Jenks). The model is displayed with a cold to hot color ramp with 40% transparency.
Appendix 9: Kernel density surface model for stolen vehicles from Sacramento’s 2016 dispatch data. The data is shown in 10 classes, classified using natural breaks (Jenks). The model is displayed with a cold to hot color ramp with 40% transparency.
Appendix 10: Kernel density surface model for vandalism from Sacramento’s 2016 dispatch data. The data is shown in 10 classes, classified using natural breaks (Jenks). The model is displayed with a cold to hot color ramp with 40% transparency.