THE SPATIAL EQUITY OF PARKS

IN THE OKLAHOMA CITY

METROPOLITAN

AREA

By

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CHAPTER I

INTRODUCTION

Purpose of Study

Cities strive to project an image of livability through urban amenities. The urban marketplace, shopping malls, cultural activities, social and athletic events, parks and streetscapes are among the elements that make an urban area attractive and livable. These urban amenities give people a way to identify with their city and instill a sense of belonging. Answering the demand for an improved quality of life means questioning whether the amenities offered by a city are distributed equitably among its citizens.

In an analysis of amenity distribution, one must distinguish between equality and equity. While equality is equal access for all groups of people, equity is the concept that those who require more of a service have proportionally more access to it. Whether it be access to medical facilities, shopping centers, or parks, equality is simply providing an equal number to each given area. The motivation for equity changes depending on the situation of the users of a particular service.

William Lucy's (1981) definitions of equity are based on need, demand, preference, and willingness to pay. Seventeen years later, Emily Talen (1998) used the same definitions with the exclusion of preference, which is closely related to demand. Willingness to pay allows access for those who consider a particular service worth their time and money. In Oklahoma City, this concept would apply to such sites as the Oklahoma City Zoo, the Omniplex, Frontier City, and White Water Bay. Although these places are open to public and do not require any special skills to participate, they do involve an entry fee and an investment of time. Demand-based equity is the provision of services that is often market driven. Golf courses and more recently skate parks are two recreational facilities in Oklahoma City that are demand driven.

The definition of equity that applies to this study of Oklahoma City is that of need. Need-based equity ensures that those who need a service more have greater accessibility to that service. In this study, the “need” under consideration is park access for various groups. Equity measures determine how accessible resources are to potential users, or the distances between certain groups of people and their available recreational facilities. The number of facilities, the number of citizens, the needs of the citizens, and the actual distance between neighborhoods and recreational facilities are all factors that enter into measuring accessibility.

Hypothesis

The hypothesis for this thesis is that parks in Oklahoma City are not distributed equitably throughout the city. Through various accessibility measures, this paper will identify the underserved and oversaturated parts of the city. Ideally, more parks will be available to the poorer socioeconomic groups and the ethnic minority groups within the urban core area. I expect to find that wealthier socioeconomic groups in the northwest section of the city have disproportionately greater access to parks while the northeast section provides adequate park access to the black minority population. The southern part of the city has fewer numbers of parks thereby affecting a large portion of the Hispanic population and some lower socioeconomic groups.

Overview of Study

This study comes at an appropriate time for Oklahoma City. The past several mayors and the City Council have made plans and set goals to create a contemporary and modern city that is attractive and livable. Within the last ten years, there has been an effort to redevelop the downtown area and implement improvements throughout the city. Most of the changes were made possible through the Metropolitan Area Projects (MAPs) initiative. To improve and build new recreational and entertainment facilities, a bill to add a one-cent sales tax was passed by voters in 1994. One of the most significant projects was the complete renovation of the downtown warehouse area called Bricktown. This has revitalized the core of Oklahoma City by providing a place for recreation and entertainment. The Oklahoma City Bombing in 1995 interrupted MAPs progress but generated an outside interest in the downtown area. MAPs concluded in 2004 with the completion of the Ronald J. Norick Library, named after the governor who initiated the projects.

Separately from the MAPs improvements, the city has developed the *OKC Plan 2000-2020* which addresses a myriad of city improvement and development goals. Part of the plan calls for the development of parks and open spaces: "Increasing population and changing demographic characteristics will continue to impose increasing demands on urban open space. A balanced and adequate system of parks and open space is essential. Oklahoma City must commit to improving and maintaining the system for present and future generations" (*OKC Plan 2000-2020,* 57). Parks were built to provide recreation and enhance the aesthetic quality of the city. Many parks are small and located within neighborhoods while others are large open spaces that may or may not provide much in the way of recreation. Various recreational parks have been added or improved, which include skating parks and aquatic centers. In addition, the city has a long-term plan to create a 200-plus mile urban trail network. The trails will wind throughout the entire metropolitan area and will connect with many area parks. These outdoor amenities are meant to improve the overall quality of life for Oklahoma City residents.

Given that Oklahoma City has set goals for itself, a quantitative analysis can measure whether the city is meeting its own objectives. Measuring accessibility can expose deficiencies in the existing distribution of parks and help the city managers address these deficiencies as well as plan for a more equitable future. It is expected that the results from this analysis will reveal that park distribution within Oklahoma City does not equitably serve the various socioeconomic and racial / ethnic groups.

Study Area

The Oklahoma City metropolitan area is the focus of this study. Oklahoma City is the capital of Oklahoma, is located in Oklahoma County, and is centrally located in the state. Oklahoma City has expansive boundaries that result in a comparatively low population density. Table 1 below shows the comparison between Oklahoma City and nearby metropolitan areas.

Table 1. Comparison of Population Statistics
Between Oklahoma City and Surrounding Urban Cities

	Population, 2003 est.	Population Density, 2000 persons / sq. mile
Oklahoma City	523,303	833.8
Tulsa, Oklahoma	387,807	2,152.0
Amarillo, Texas	178,612	1,932.1
Austin, Texas	672,011	2,610.4
Little Rock, Arkansas	184,053	1,576.0
Wichita, Kansas	354,617	2,536.1

Source: U.S. Census Bureau

Also included in the study are the following townships that surround or are embedded within the Oklahoma City limits: Bethany, Del City, Edmond, Midwest City, Moore, Nichols Hills, The Village, and Warr Acres. A single city street serves as the boundary between Oklahoma City and each suburb. The significance of a single city street is that no discernible boundary between the city and the suburb is apparent. Therefore, despite being considered suburbs of Oklahoma City, the townships of Norman and Yukon are not included. Due to the rural expanse outside the urban boundary of Oklahoma City, the town of Mustang is also not included (Figure 1).

The geographic units of study are 620 block groups that comprise the Oklahoma City metro area. A block group located in the center of downtown was eliminated from the study because of its lack of census data. Block groups within the Oklahoma City city limits were excluded if they were considered rural or outside of the urban delineation. The sources for determining the study area were a land use map from the *OKC Plan 2000-2020* and shapefiles of Oklahoma City boundaries and urban area outlines. The Oklahoma City boundaries shapefile was provided by the Oklahoma City Parks and Recreation department and the urban area shapefile was downloaded through the U.S. Census website. Together, these comprise an acceptable and reasonable study area to measure the park accessibility of each block group.

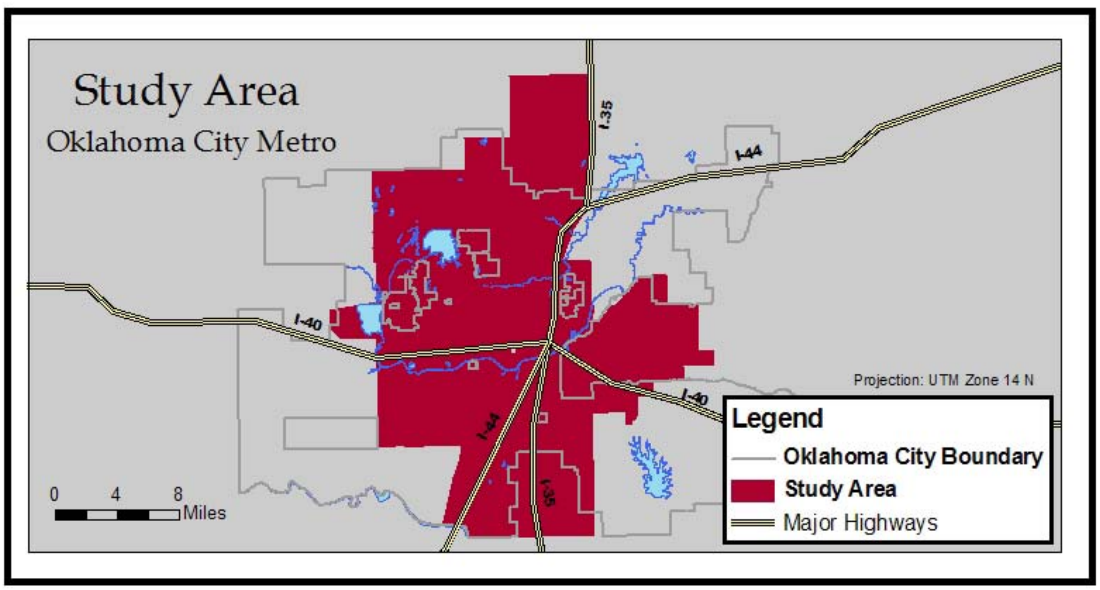


Figure 1. Study Area: Oklahoma City Metropolitan Area

Parks comprise the other component of the study (Appendix A). Parks are separated into two categories based on their size and generalized functions. Neighborhood parks are smaller parks that range from one acre to twenty acres.

Neighborhood parks should be accessible to pedestrians, and they provide basic services, such as open space and park benches, to residents within a local area. Community parks are larger, include all the parks that are twenty acres and greater, and service the entire metropolitan area. These park and function distinctions were taken from the park classifications in *Park, Recreation, Open Space and Greenway Guidelines* (Mertes and Hall 1999).

Presumptions of Study

This study focuses solely on park location and size. The analysis is purely quantitative: it does not take into account the quality of parks nor does it look into individual park usage. However, the study does provide a foundation for further and more expansive studies. After the initial study is completed, it could be revised to rate parks according to aesthetics, facilities, and functionality. Recreational behavior of Oklahoma City residents could be explored to determine activities that serve as substitutes for parks. Of immediate interest is the impact of the urban trail network on park usage and changes in recreational behavior that it will produce.

The heuristic nature of the accessibility indices, to be introduced later, could also be considered restrictive. The accessibility measures use distances in various summation formulas to generate values. They do not have an absolute standard like the z-scores of the spatial autocorrelation statistics. Rather, the accessibility indices are compared and evaluated in relation to one another. Interpretation of results is left to the discretion of the researcher.

Oklahoma City Metropolitan Area

The Oklahoma City of today is divided into four quadrants by Interstate 35 and Interstate 40 (Figure 1). Interstate 35 separates the city into east and west sections while Interstate 40 separates the city into north and south sections. The city is set up on a square-mile grid with numbered streets increasing north and south of Interstate 40. The north-south streets run the length of the city extending into the surrounding suburbs. The downtown area is small and concentrated in the northwest corner of the intersection of these two major interstates. Although recent developments have increased the number of living spaces, Oklahoma City's downtown is not a residential area.

Oklahoma City residents exceed the state average for median household income, per capita income, and the percent below the poverty level. As the largest urban area in the state, the city maintains certain affluence while sustaining its low income groups. This is a key variable in testing the equity of the distribution of parks and other public facilities. Another key variable is the accessibility for the various ethnic groups. While the ethnic composition consists of a white majority of 68.4%, the black, Hispanic, and Asian populations are increasing rapidly. In 2000, blacks comprised 15.4% of the population, Hispanics comprised 10.1% of the population, and Asians comprised 3.5% of the population (U.S. Census Bureau). See Appendix B for maps of the distributions of the variables included in this study.

Oklahoma City became a township after the Land Run of 1889. Once it had established itself economically, attention was paid to Oklahoma City's entertainment and recreation. During the first decade of the twentieth century, a streetcar system was put into operation that gave access to Wheeler Park, south of the city along the river, and Delmar Gardens, a 140 acre amusement park near the intersection of Western Avenue and Reno. At the head of the Classen trolley line was Belle Isle Park, which is now a conglomeration of shopping centers. In the year of its statehood, 1907, 160 acres at NE 10th Street and Eastern Avenue became the grounds for the State Fair of Oklahoma. This site is still in use today. Two years later, in keeping with the advancement of the automobile, Grand Boulevard was built around the city and connected by four large parks at each of the four corners. The Northeast Park was the largest and would eventually become into the Lincoln Park Zoo (Faulk et al. 1998).

As the number of automobiles increased, road improvements and residential districts allowed Oklahoma City to expand over the course of the next two decades. In parallel to federal zoning laws and urban park development, Oklahoma City built its own park system as it expanded as an urban metropolitan area. This expansion called for the development of parks and recreational areas in the nearby suburbs. Over the course of time, Oklahoma City has absorbed many of these townships although it is not responsible for their city management or parks maintenance. However, Oklahoma City, together with the eight included suburbs, represent a unique urban area where citizens use the facilities without regard to the managing or maintaining township. Therefore, the park system of each town becomes a component of the super-park system of the metro area. This paper explores the accessibility of all citizens within the given area to all available metro parks.

Oklahoma City is working to meet the rising demand for a city that offers a unique quality of life standard. This encompasses all the amenities a city can offer.

Among these amenities is that of recreational opportunities, specifically in the form of parks. The question remains that as Oklahoma City improves the quality of life for its residents, is it providing recreational services equitably? Measures of accessibility and spatial statistics allow for a quantitative analysis of equity within the given study area. Spatial statistics includes testing for spatial autocorrelation, the strength of similarity among neighboring block groups.

This analysis is followed by an examination of the demographics and other characteristics of the block groups that lead to an overall evaluation of the equity of park distribution within the Oklahoma City metropolitan area. The next chapter looks at the history and philosophy of park development in the United States, the methods used in assessing equity and accessibility, the methods that produce spatial autocorrelation statistics, and the specific methods that will be utilized in this particular study.

CHAPTER II

REVIEW OF LITERATURE

Introduction

Parks are a staple of nearly every community. From the hanging gardens of Babylon to the creation of New York City's Central Park, open space has always been a part of the human existence. Whether focusing on the aesthetic or functional qualities, the demand and design of parks has become an imperative component of modern cities. Over the last hundred and fifty years, parks have developed until they are essential to life in American cities. The resulting questions ensue: Why do humans need parks? How were they introduced into American society? And, how are they implemented into urban design?

Methods for assessing the equity of the distribution of a particular service have been emerging over the last thirty-five years. In this study, park locations in the Oklahoma City metropolitan area will be used to measure the provision of recreational opportunities for residents. The quantitative measures and spatial analysis techniques used in this study were developed and improved during the late 1980s and 1990s. Running parallel to these improvements was the advancement of geographic information systems. Together, quantitative methods and mapping capabilities enable researchers to measure accessibility, study patterns of distribution, and make forecasts for the equitable implementation of services. The literature reviewed for this study focuses on the history of recreation as studied by professionals, the use of measures of accessibility and spatial statistics, and current applications and trends.

The Need for Parks

In *Parks For People* (Whitaker and Browne 1973) the need for parks is explained as part of the human condition. The authors suggest that while they provide no economic value, parks are of seemingly utmost importance in urban design. People do not like to be alone yet they engage in conflict if crowded too close to one another. Parks provide the medium for peaceful living, especially in crowded urban areas. Therefore, parks should be designed for the people who surround and use them.

Parks maintain the individual human identity by helping to remind people who they are (Rolston 2003). Through nature, they foster life in the seemingly oppressed individual. By providing an opportunity for recreation, "parks. . . preserve human life by re-creating it" (103). Thus, a demand exists for informal recreation. For small parks, like the neighborhood parks of this study, accessibility is more important than size. Small parks provide a brief and convenient escape during the week day (Patmore 1970). Larger parks take on a separate recreational role for an urban community. "The need. . . is to view open space as part of the whole functioning of the town as a place in which to both work and live" (111).

The History of Parks

Andrew Jackson Downing and Frederick Law Olmsted first recognized the need to plan for parks. Born in 1815, Downing first campaigned for public parks in 1848. His focus was on creating a great park in New York City (Chadwick 1966). Downing died before he could execute his idea; nevertheless, his partner Calvert Vaux (1824-1895) teamed with Frederick Law Olmsted (1822-1903) to ultimate bring Downing's dream to fruition. Olmsted is now known as the father of American parks.

Olmsted's love of the open space and appreciation for the aesthetic design of nature gave him the vision to produce beauty in the urban jungle. Olmsted's ideas developed through two travels abroad. The southern part of the United States showed him that people need to enjoy the outdoors. A walking tour of England showed him the interaction between parks and people. In New York, Olmsted concerned himself with how to bring the outdoors to the city. His purpose was to provide public open spaces where city dwellers could escape the noise and activity of their urban environment (Beveridge and Rocheleau 1998).

Olmsted's design of Central Park included using natural landscape features, planting flower gardens, and building playgrounds. He was very particular about the role of the park in the city. It was not to be flooded with activities or business that detracted from the sense of rural escape. Furthermore, he was intent on providing a place where all classes of society could meet and mix. The park provided a feeling of ownership to the poor. In England, he saw where young men turned to crime because they had no hope of escape from their urban squalor. For the wives of working men, the park provided relief from domestic duties and allowed children to play outdoors. For the rich, the park provided relaxation and leisure and kept them from fleeing to the suburbs (Beveridge and Rocheleau 1998).

After the success of Central Park, Olmsted and Vaux created a park system in Boston. This was the beginning of park planning in American society that developed over the next fifty years. Following the aftermath of the Civil War, park systems were designed for cities such as Chicago, Detroit, Buffalo, and Washington, D. C. Commissions were established to oversee the building and maintenance of the park systems. In the 1920s, Olmsted's son returned attention to New York and teamed with Robert Moses who organized the New York Metropolitan Conference on Parks. During his tenure as mayor of New York City, LaGuardia coordinated regional park provision (Chadwick 1966). Since this time, public parks have become an issue of federal and local governments.

Modern Park Standards

Space standards for parks were stated by George Butler of the National Recreation Association in the early 1900s (Mertes and Hall 1996). The "ten acres for every 1,000 people" was long standing, but even Butler was reluctant to make it absolute because of the factors that could modify a situation. Even a hundred years ago, equity was a nameless but existing concept. Equity was named and realized in the most recent edition of *Park, Recreation, Open Space and Greenway Guidelines* (Mertes and Hall

1996). Within this publication of the National Recreation and Parks Association (NRPA) is a demand for equity and uniform quality.

The NRPA outlines service guidelines that are "needs based, facilities driven, and land measured" (7). The agency further addresses to whom services should be directed. The following is a list of the demographic profiles to be considered: age, race, ethnicity, income, education, sex, marital status, household size and makeup, and population densities (21). The most critical of these are age, race, ethnicity, and income, all of which are variables included in this study.

Understanding that each community is unique, the NRPA states that, "The open space system cannot and should not be equated with a numerical standard of any kind" (49). The measures of accessibility used in this study are ideal because they adapt to an individual system. While the heuristic nature of the results was discussed as a limitation, here it can be perceived as a strength given the reproducible application for various urban park systems. The particulars of the accessibility measures will be discussed later in the literature review.

Park Planning

Parks and open space planning is a part of any good comprehensive plan. At the time *Recreational Geography* was published (1974), there was no geographic approach to recreation. The contributors of this book were from several professions. However, since that time, methods for studying parks and recreation have been gradually discovered and applied. The role of geography increases as maps are used as planning tools and the role of GIS becomes more widely accepted. Even for a relatively small urban area like Oklahoma City, the parks and recreation department relies heavily on GIS software for its park mapping and trail network plans.

The textbook *Community Planning* (Kelly and Becker 2000) specifies certain elements that should be incorporated into a city's comprehensive plan, especially in the area of parks and open space. "An inventory of park and recreation facilities must be mapped. . ." (87) directs an examination of the existing conditions. This thesis will perform this function while taking into consideration the unique qualities of the Oklahoma City metro area. While dealing with the park systems of nine separate townships, evaluations and suggestions can be made regarding how to make the individual systems work together as one comprehensive whole. Application of measures designed to evaluate a system's accessibility within a service area will guide and ultimately determine how well the Oklahoma City metro area provides parks to its citizens who need them most.

Background of Accessibility

Matters of accessibility appeared in sociological work in the early 1970s. Within a compilation entitled *Social Behavior, Natural Resources, and the Environment* (1972) were two pieces that examined mental constraints and perceptions of accessibility. Lee looked at who goes, and does not go, to outdoor recreation places in "The Social Definition of Outdoor Recreation Places." In the same book, Cheek also looked at parks and who goes to them in "Variations in Patterns of Leisure Behavior: An Analysis of

Sociological Aggregates." This piece introduced primitive quantitative analysis that Cheek et al. further developed in *Leisure and Recreation Places* (1976). They differentiated the nature of place with the nature of the participant. They also investigated the effects of background, age, and ethnicity on recreational behavior. Several of the chapters involved sampling and evaluating data. Each component studied had carefully outlined procedures and methodologies followed by discussion of the results. The analysis was basic and not spatially related, but it introduced a quantitative approach to studies that were previously qualitative.

Quantitative analysis of the equity of recreation evolved within the work of management scientists. In 1978, Savas defined three E's: efficiency, effectiveness, and equity. He asserted that the first two were addressed by management scientists, but that equity deserved more, and ultimately the most, attention. He discussed different types of equality and how equity should be used to evaluate efficiency and effectiveness.

Lucy (1981) brought equity into local planning. He presented five concepts of equity: equality, need, demand, preference, and willingness to pay. He discussed how equity goes beyond simply providing an equal amount of services to all the people. Equity becomes providing services in proportion to the need or demand of a particular group. Lucy showed the quantitative ability of his time in his statement, "Perhaps it is worth emphasizing that neither equity nor inequity can be analyzed objectively" (452). While Lucy could not foresee the future of spatial models and statistics, his equity definitions have proven to be sustainable within modern applications.

The thoughts of Lucy were debated in two articles that appeared in the *Annals of the Association of American Geographers.* McLafferty discussed spatial constraint and how it “varies among study areas depending on the relative locations and densities of income groups” (McLafferty 1982, 347). Kirby responded in the following issue and attacked McLafferty for failing to bring into account different levels of attraction and for confusing equity with distributional equality. “In consequence we must recognize that a spatial pattern may be efficient or equal; additional information is required to determine whether it is equitable” (Kirby 1983, 292).

Varying perceptions of urban recreation service allocation was studied in “An Analysis of the Relationship Between Equity Choice Preferences, Service Type and Decision Making Groups in a U.S. City.” Published in a 1987 issue of the *Journal of Leisure Research*, Wicks and Compton used Austin as a case study. To address the planning issue of who gets what, they surveyed citizens, park and recreation employees, and city council members. The survey was based on ranked answers, and they conducted an analysis of variance to compare the means of the responses. They found that the different groups had different perceptions of the equity of Austin’s park system. Their ensuing goal was to use their model to encourage discourse between the public and the public decision makers.

Regression was used by Scott and Munson (1994) to determine the best predictors of perceived constraints to park visitation in the city of Cleveland. They began with an extensive literature review followed by their study area and procedures. Through surveys, they identified a number variables contributing to perceived constraints. Step-wise regression concluded that income was the single best predictor.

Measures of Accessibility and Spatial Statistics

Public parks are the most obvious and most open of public recreational facilities. They are open spaces that are free to everyone regardless of age, income, or ethnicity. They are easily mapped and measured for distance. In "Assessing Spatial Equity: An Evaluation of Measures of Accessibility to Public Playgrounds," Talen and Anselin (1998) conducted an analysis of spatial equity for playgrounds in Tulsa, Oklahoma. This is a pivotal article because it influences much of the work that follows in this review. Talen and Anselin provided a modern definition of accessibility and attempted to measure to what degree the distribution of urban public areas is equitable.

Four measures of accessibility were introduced, discussed, and applied. They were the container approach, the gravity model, travel cost, and minimum distance. The container approach simply reveals how many facilities are located within a specified area, and the authors address the misleading results it can produce because of its generality. The gravity potential model takes into account the distance of each facility from the various locations of origin. The higher the score with the gravity model means a greater supply of facilities. Travel cost deals solely with distance; thus, the lower the score, the better the access. Lastly, minimum distance merely identifies the shortest distance between an origin and its nearest facility.

Box maps, Moran's I statistics, and LISA statistics (discussed below) were portrayed for all or some of the measures. The main objective of the paper, as stated by the authors, was that each measure of accessibility should be chosen carefully and with the purpose to the distribution being studied. Within the Oklahoma City study, the container approach and minimum distance model will be used for evaluation of the accessibility of neighborhood parks. Buffers around block groups will be created and then the number of parks within the buffer will be counted and the distances measured. The travel cost method cannot be used for neighborhood parks because it requires the same number of destinations for every origin. Thus, this measure, along with the gravity potential and minimum distance models, will be used for evaluation of the accessibility of the community parks. Since neighborhood parks and community parks play different roles in the kind of recreation provided, it is important to measure the accessibility of both groups independently. Then, valid conclusions can be drawn based on the results of a block group's access to neighborhood facilities and the park facilities of the community.

Anselin (1995) developed his own technique for exploratory spatial data analysis that brought together the Γ index, Geary's c, Moran's I, , and the G_i and G_i^*, the existing spatial autocorrelation statistics. Anselin called his statistic a Local Indicator of Spatial Association (LISA) and defined it in two ways. First, "the LISA for each observation gives an indication of the extent of significant spatial clustering of similar values around that observation" (94). This identified "hot spots," or local spatial clusters. The second definition was, "the sum of LISAs for all observations is proportional to a global indicator of spatial association" (94). This is a more complicated process that exceeds the scope of this research. However, the article sheds further light on the use and application of spatial autocorrelation statistics, namely Moran's I and the $G_i(d)$ and $G_i^*(d)$. These two are applied extensively in the papers to follow and will be used to study spatial patterns of parks and public facilities in Oklahoma City.

Getis and Ord (1992) introduced the $G_i(d)$ and $G_i^*(d)$ statistics in *Geographical Analysis*. Used in conjunction with Moran's I statistic, the G statistics help to explore spatial association at a local level and "detect local 'pockets' of dependence that may not show up when using global statistics" (190). The unique results that the G statistics give are whether high values or low values are dominant within a certain distance (d). In the article, various situations are proposed (High-High, Low-Low, Medium-Medium, High-Low, High-Medium, Medium-Low) along with the expected z-values that correspond with each. The $G_i(d)$ statistic reveals patterns of spread and diffusion while the $G_i^*(d)$ statistic reveals patterns of clustering. Their case studies were the patterns of sudden infant death syndrome (G_i) in North Carolina and dwelling unit prices in San Diego County (G_i^*).

Ord and Getis (1995) extended their work on their G-statistics and published a follow-up article. This article reviewed the properties of G-statistics and provided more examples of how to calculate and interpret possible clustering. Two new features added depth to the statistics. The first feature was a discussion of correlation that included a table of expected and observed correlations for the $G_i^*(d)$ statistic and four probability distributions at varying distances. The other feature was the treatment of extreme G-statistics by applying approximate tests and the Bonferroni inequality. The case study was the occurrence of AIDS cases in the San Francisco area. Essentially, the methods applied in the case study were the same as in the first article, but this analysis covered data over four years and had to deal with extreme statistics. For the purpose of studying spatial autocorrelation and identifying clustering in Oklahoma City, the $G_i^*(d)$ statistic will be used.

GIS and Spatial Data Analysis

In March of 1991, a workshop was held by individuals interested in linking GIS and spatial data analysis (SDA). Goodchild et al. (1992) prepared the summary report for the *International Journal of Geographical Information Systems* that detailed the objectives set and met during the workshop. The two objectives were to identify spatial analysis tools that would be useful to GIS users and to assemble a data analysis package that could interface with GIS. At the time, GIS and SDA were not strongly linked because GIS was market driven and SDA was an obscure field of research. Obviously, GIS has grown beyond its commercial and government uses and is now an important research tool. Modern geographical information systems incorporate spatial statistics into the software, requiring minimal programming and effort by the user.

Beginning analytical features within software packages such as ArcInfo showed the improved integration of GIS and spatial data models. The modeling process became an important part of the exploratory spatial data analysis of GIS. Batty and Xie (1994) outlined a modeling process that included the following steps: data selection/analysis, model selection/specification, calibration, and prediction. Implementing the spatial data tools into the GIS software allowed for modeling of spatial data within an urban setting and enabled the user to explore spatial data by creating scatterplots, thematic maps, or examining patterns of population density.

Application of the new modeling capabilities of GIS was quickly adopted by the Dutch for city planning. The potential model was incorporated into GIS for the purpose of designing a public transportation system that increased accessibility for Randstadt

Holland, a large urban area. The authors, Geertman and Van Eck (1995), hypothesized that "potential models, used in combination with GIS network modules, can produce a general picture of accessibility" (67). They felt that GIS was more capable of measuring the centroids of groups of people and their destinations, permitting the authors to evaluate the accessibility of their situation. Although the mathematical abilities of GIS now surpass those employed in this article, the authors' procedures are easily repeatable and could be applied today. In addition, the analytical work is complemented by a discussion of the political policies of Dutch public transportation that give this study context and purpose.

In the same year that she published her article with Anselin, Emily Talen (1998) channeled her work on measuring accessibility into something proactive. Rather than measuring accessibility of an existing system, she designed a prototype method to help planners visualize an "equity map" through the use of GIS. Various maps of resource distribution could be produced and evaluated as to what best serves the needs of the community. The overall process entailed defining the type of facility and choosing the accessibility measure or measures to be employed. Once these are established, the locational and attribute data could be entered into GIS for mapping and analysis (Talen 1998, 31).

From the most basic function to complex equations, GIS is invaluable in the study of spatial equity. In New Zealand, GIS was used to develop a community resource accessibility index (CRAI). Witten et al. (2003) implemented the CRAI to evaluate access to six domains of community services, facilities, and amenities. Clearly defining their steps for geocoding and design in GIS, the authors determined an overall accessibility score based on quality, distance, choice and ranking of the domains. The CRAI was seen as having potential planning and policy applications.

Integration of GIS and Measures of Accessibility

Integrating GIS and measures of accessibility completes this literature review. Applying the container approach as defined by Talen and Anselin (1998), Lindsey et al. (2001) used GIS data to define census tracts and create a half-mile buffer to measure accessibility. Counting the number of trails within each buffer, they then characterized the population of each tract by eight demographic and socioeconomic variables. Maps revealed the ratio of the population around the trails to the overall population of the county. Poor socioeconomic and black population groups had disproportionately larger access to the trails. According to their cited research, these groups used recreational trails significantly less than white middle to upper class groups. For the Oklahoma City research, the methods and results used in this paper will serve as a guide for implementing the container approach.

Another study that implemented the container method focused on measuring accessibility for people with disabilities. Church and Marston (2003) reviewed the standard measures of accessibility and then explored modifications and enhancements needed for their particular study. The article included sections covering gross-accessibility (sum of all possible opportunities), access measures for multiple activities, and relative access (limited for those with disabilities). While not directly applicable to the Oklahoma City study, these findings are worth noting for their overview and solid examples.

A study of playgrounds in Edmonton, Canada, not only employed the container approach but also various other measures of accessibility. Smoyer-Tomic et al. (2004) introduced their paper with the importance of studying the locations of playgrounds. Measuring accessibility, assessing spatial equity of playgrounds according to need, and evaluating the Edmonton Neighborhood Park Development were their purposes. Accessibility was measured by buffers surrounding a neighborhood centroid and minimum distance. Neighborhoods were assigned a "need indicator" based on local government statistics. First, the authors measured all playgrounds, then measured only the "good" playgrounds, and mapped their findings. A Spearman's ranking correlated the "need indicator" to the calculated accessibility measures. Moran's I statistics were computed separately for need and accessibility.

In a 2005 article that examined the location of HIV service providers in Toronto, Fulcher and Kaukinen dismissed the container approach and adopted the distance measure. Related services were divided into five categories according to the service provided (testing, health care, etc.). After mapping the locations of HIV related services, the authors used GIS to find the centroid of neighborhoods and to measure the distance from the centroid to the nearest provider. Maps of the HIV service providers showed spatial autocorrelation as measured by Moran's I statistics. Dividing the Moran's I statistics into four intervals, cholorplethic maps were created for each service. Each of these maps was accompanied by a discussion of the results and possible implications. The conclusion addressed community characteristics (young, single, gay) that would more often utilize HIV related services and where these communities fell into the mapped distribution areas.

More complex mathematical operations and more complex definitions were applied in a study that examined physician accessibility in Washington, D.C. Spatial accessibility was defined as provider to population ratios, distance to nearest provider, average distance to a set of providers, and a gravitational model of provider influence. Published in *Heath and Place*, Guagliardo et al. (2002) geocoded actual physician locations over a map layer showing the density of physicians. Utilizing quadratic approximation in ArcView Spatial Analyst, they created cone maps where the radius of the cone showed the extent of a provider's practical service area. Ending with a discussion of the demographics of Washington, D.C., Spearman's correlation coefficient compared the accessibility measure to the percent of black children within each area.

The next chapter takes the measures of accessibility as discussed above and describes how they will be specifically applied in the study of Oklahoma City. Calculations of all of the measures will be conducted as well as the G_i*(d) statistic which reveals spatial autocorrelation. The intended data sources and manipulations will also be described.

CHAPTER III

METHODOLOGY

For this study, distance is the key factor in determining the equity of park distribution in the Oklahoma City metropolitan area. Using the distances between the geographic units, block groups, and the service facilities, parks, accessibility models provide repeatable processes that assign a value to each block group. In turn, these values can be used to explore the degree of correlation among the block groups through spatial statistics. The results of the accessibility measures and spatial statistics may show that parks in Oklahoma City are not distributed equitably and give some indication as to how extensively park locations deviate from an equitable distribution.

GIS software and extensions will serve as the tool by which parks will be drawn and distances calculated. The Oklahoma City Department of Parks and Recreation provided the shapefiles for the city's parks. The addresses for the parks of the eight suburbs have been provided by the respective parks departments or city halls. After building a geodatabase, the parks will be digitized using aerial photos brought into ArcMap 9.1. Block groups and block group data are available through the U.S. Census. Once these key elements are incorporated in the study area map, centroids can be found and buffers can be created. The centroids are necessary for building the buffers and for establishing points on a road network. The road network that will be used is available through ESRI data files. Sum distances can be calculated for each individual block group through Network Analyst. The accessibility formulas can be incorporated through the calculation capabilities of ArcMap to produce values for the respective accessibility measures.

The four measures of accessibility that will be calculated and included in this study are the gravity potential model, the travel cost model, the container approach, and the minimum distance model. Each of these serves a different purpose regarding the types of parks that they will measure. Accessibility to community parks is best measured with the gravity potential model, the travel cost model, and the minimum distance model. The container approach and the minimum distance model best measure the accessibility of neighborhood parks.

Applying the Measures of Accessibility

Gravity potential is a summation of the number of parks divided by the distance from each block group to each park. The formula is $\Sigma\ S_j / d_{ij}^{\alpha}$ where S_j is the number of parks and the alpha is two because it is an accepted parameter that moderates the distance decay variable. If the number of parks is 5, and the distances from the centroid to the parks are 3, 4, 6, 8, and 10 miles, then the gravity potential would be: (5/9) + (5/16) + (5/36) + (5/64) + (5/100), producing a score of 1.135. A higher score indicates a greater supply of parks for a given block group. With the gravity potential model, distance acts a deterrent for residents. Every park is available for use, but certain block groups must travel further distances. The shorter the distance means a higher value and thus more opportunities for recreation.

Travel cost is a summation of the distance between each block group and each park. The formula is $\Sigma\, d_{ij}$. In this case a lower score indicates closer proximity, or greater accessibility. This measure is relegated to community parks only because it requires the same number of destinations for each origin. Since it is a direct summation, an equal number of destinations standardizes the results. Having the same number of parks for everyone is equality; finding the cumulative distance from each block group to every park is one way to expose inequity.

For both methods, distances will be derived through the capabilities of Network Analyst. Using the ESRI road network, a cost matrix will determine the distance from every block group (origin) to every community park (destination). Once these distances are found, sum-output tables and uniform calculations can produce the index values for the total cost and gravity potential models. A closest facility analysis will be run to find the minimum distances. The values will then be joined to the original block group data to create maps. Comparison of the measures maps to the distribution maps allows for visual assessment. The values produced can also be correlated with the demographics of each block group.

Minimum distance is a proximity measure that assumes residents will visit the facility closest to them (Talen and Anselin 1998). Running a closest facility analysis through Network Analyst renders the distance between each origin and its nearest destinations. Again, the output table will be joined to the original block group data to create a map of the results. Minimum distance will be used for both community and neighborhood parks.

The container approach counts all the parks that intersect with the half-mile buffer. A buffer is created around the centroid of each block through the capabilities of the extension Spatial Analyst. Performing a spatial join will identify and count which buffers intersect with neighborhood parks. A new layer will be created with a count field that for the number of intersections. Joining the attribute table of the new layer to the original study area allows the container counts to be mapped.

Methods of Evaluation

Accessibility to parks in relation to various demographics determines the equity of the spatial distribution. Index values calculated for each block group will be compared to the demographics of the respective block groups. The most critical variables are those of age, race / ethnicity, and income. Race and ethnicity are strongly related to income and are important issues in the provision of services. Correlation tests will be used to discover the relationships between the demographics and the accessibility measures. The correlation results, in conjunction with the maps, will be the evidence for or against an equitable distribution of community and neighborhood parks.

After the measures of accessibility have been calculated and correlated with the demographics, the last analysis is to test for the degree of spatial autocorrelation among the study variables and the results of the accessibility measures. Each block group must be weighted in compliance with the requirements for the $G_i^*(d)$ statistic. ArcToolBox will run the $G_i*(d)$ statistic and render a map revealing the local "hot spots." Overlapping clusters between the variables and the measures will be compared and contrasted for a further evaluation of spatial equity.

Patterns that emerge from the spatial autocorrelation analysis will be compared to the results from the accessibility measures. Should the distribution of park locations be revealed as inequitable, recommendations for park additions or improvements can be made based on where certain groups are lacking. Or, if Oklahoma City's park locations are shown to be distributed equitably, the statistics will defend and justify the pattern of park provision in the metropolitan area and suggestions will be made for further study.

CHAPTER IV

RESULTS AND ANALYSIS

For the analysis of the spatial equity of parks in Oklahoma City, neighborhood parks and community parks will be treated separately. The two types of parks provide different service functions at different scales. Community parks are large in area and designed to provide recreation to an extensive population. Neighborhood parks are available to the public but their small size focuses their service on a local population within a specific geographic area. Therefore, different measures of accessibility will be applied to the two types of parks.

Based on a visual examination, access for the various socioeconomic groups is difficult to determine (Appendix A). Community parks appear to be randomly dispersed. The notable absence of parks in the center of the city could mean that the lower economic block groups have less access. Many gaps exist in the distribution of neighborhood parks (Appendix A). The effect of these gaps on the accessibility for the various socioeconomic groups will be revealed.

None of the variables have normal distributions and all are somewhat or highly skewed (Appendix C). Because of non-normal distributions, Spearman’s rho correlation coefficient is used to study the relationships between variables and the accessibility measures. Following the results of the accessibility measures are the spatial autocorrelation statistics that should reveal pockets within the study area of high access and low access.

Community Parks

To evaluate the accessibility of community parks, the gravity potential, travel cost, and minimum distance methods are used. Distance and its related costs impede those groups lacking resources for travel. The gravity potential model takes into account "the effect of distance as a deterrent" (Talen and Anselin 1998). In the gravity potential summation formula, the distance between the origin and destination is in the denominator. Thus, a higher index value indicates greater accessibility. If parks are distributed equitably, higher values will result for the minority and lower income block groups.

Because of the extreme range of gravity potential values (7.097 – 20,099.097), the natural log of the values is used for mapping and evaluation purposes. Two regions of high accessibility are prevalent within the center of the study area (Figure 2). One area lies to the northwest and the other lies in the south. This southern pocket is significant because it the predominantly Hispanic area of Oklahoma City. The outer boundary of the study area has block groups with larger white populations. The outer boundary of the gravity potential map shows lower accessibility for the same groups. In comparison to the economic distribution maps (Appendix A), the gravity potential map appears inverted. This means that the higher income block groups have less access to community parks.

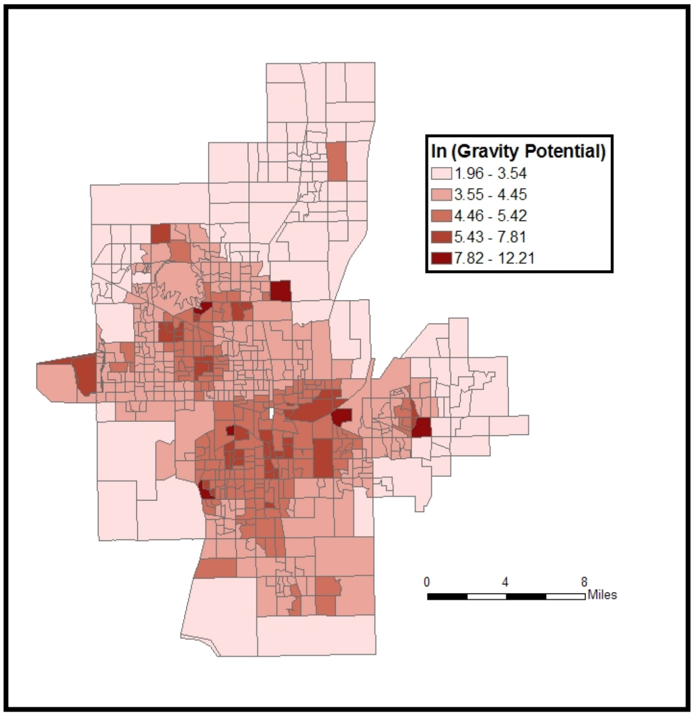


Figure 2. Gravity Potential Measure Results – Community Parks

The correlation values support the visual assessment (Table 2). For an equitable distribution, negative correlations are desirable for the income variables and the white population. Both income variables have negative correlations with the gravity potential measure. Likewise, the white population negatively correlates with the measure although to a lesser degree. The white population composes nearly 70% of the population of the study area, and a number of block groups with the highest white populations share the borders of block groups with the lowest white populations. Having such a high percentage, the income variables play a greater role in assessing equity in park distribution.

The three negative correlations discussed above, in conjunction with the positive Hispanic correlation, indicate the spatial distribution of community parks is equitable for lower economic groups and for the Hispanic population. As for the other ethnic groups included in this study, the black population has no significant correlation with the gravity measure. In the block groups with the largest concentration of the black population, the gravity potential results vary from the high to middle to low values. Some block groups have adequate access while others have insufficient access.

Table 2. Correlations for Community Parks

	Pct. White	Pct. Black	Pct. Asian	Pct. Hisp.	Med. HH Inc.	Per Cap. Inc.
ln (Gravity Potential)	-.247(**)	-0.011	-.211(**)	.421(**)	-.450(**)	-.384(**)
Travel Cost	.497(**)	-.218(**)	.148(**)	-.506(**)	.606(**)	.503(**)
Minimum Distance	.098(*)	.134(**)	.260(**)	-.312(**)	.329(**)	.305(**)

** Correlation is significant at the 0.01 level (2-tailed).

The Asian population has a negative correlation with the gravity potential measure. The Asian population is very small, but the block groups with the largest percentages are located along the edge of study area, with the exception of a small, concentrated area near the center of the city. This center concentration makes for a smaller correlation, but the negative correlation mirrors the results of the white population along the outer boundary.

This does not mean that the distribution of community parks is not equitable for the Asian population. The correlations between the ethnic populations and income variables show that a positive relationship exists between the income variables and the white and Asian population, and a significant negative relationship exists for the Hispanic population (Table 3). Comparing the correlation values of the economic and racial / ethnic variables, according to the gravity potential measure, the spatial distribution of community parks in Oklahoma City can be argued equitable for two of the minority populations.

Table 3. Correlations Between Income and Racial / Ethnic Variables

	Pct. White	Pct. Black	Pct. Asian	Pct. Hisp.
Med. HH Inc.	.710(**)	-.448(**)	.247(**)	-.525(**)
Per Cap Inc.	.659(**)	-.384(**)	.317(**)	-.521(**)

** Correlation is significant at the 0.01 level (2-tailed).

To further the analysis and support the findings of the gravity potential model, the travel cost method calculates the cumulative distance from each block group to every community park. Where high values were desired with the gravity potential model, low values are desired with the travel cost model. Greater distances mean greater cost, so a lower value is desired for the various ethnic minority and lower economic groups. The correlation between the gravity potential measures and the travel cost measures is -.746. This strong negative correlation supports the results of the gravity potential analysis. However, the map is vastly different (Figure 3). The block groups in the center of the study area have the shortest overall distance to travel with the distance values increasing toward the edges of the study area.

This particular variable has a concentric ring pattern. It makes sense that the central block groups have lower total cost values because they have a shorter distance to travel to parks within the core of the study area and are equidistant to the parks situated toward the edge of the study area. The majority of the community parks lie within the southern and western portions of the study area. Therefore, the block groups with the lower accessibility values tend to be located toward the northwest and south.

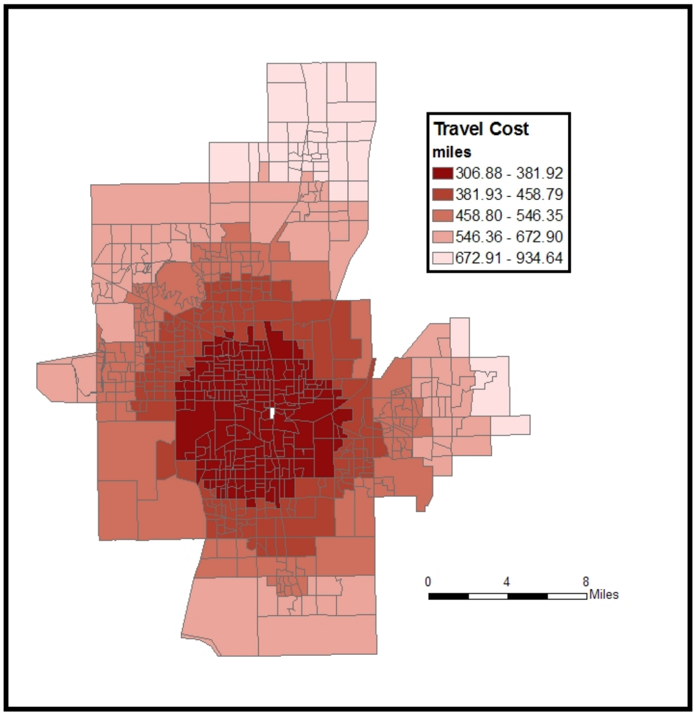


Figure 3. Travel Cost Measure Results – Community Parks

The northern section of the study area has the highest cumulative travel distances. This area is predominantly white with higher incomes. In keeping with the definition of equity, those who must travel greater distances to enjoy community parks have the means to do so. In the travel cost map, the Hispanic population appears to be served well. The black population seems to have greater access with the travel cost method, more so than with the gravity potential method. The correlations corroborate the conclusions of the visual examination, and the variables have stronger relationships than with the gravity model (Table 2).

A positive relationship between the travel cost measure and the variables indicates less access. The higher income block groups have greater distances to travel. The white population has a strong positive correlation while the Asian population has a weak positive correlation. As shown previously, both these ethnic groups correlate positively with the income variables. This supports the findings of the gravity potential model and suggests that community parks are distributed equitably across the city.

Further support for the equitable distribution of community parks comes from the negative correlations. Negative values indicate more access for the variables or that more parks are closer to those who lack the means to travel greater distances. The correlation coefficient between the travel cost measure and the Hispanic population is -.506. The strength of this correlation is evident by the locations of the community parks. Over half of the forty-five of the parks are located in the southern portion of the study area. Many of these parks lie in or near the areas with the largest Hispanic populations.

The black population has a weaker correlation than the Hispanic variable but it is still significant. The black population is concentrated to the northeast of downtown but extends to the northwest and to the south. This dispersal accounts for the stronger correlation with the travel cost model. However, this result is misleading because few parks lie within areas having higher black populations. The concentration happens to be near the core of the study area. Block groups that contain the black population concentration do not have the advantage of being near community parks. Rather, these block groups are equally distant from the majority of parks in the southern and western portions of the city.

Assuming that people will frequent the park that is nearest to them, minimum distance is an appropriate measure to study community parks (Figure 4). A number of parks seem to be located within the central portion of the study area. Diagonal clusters reveal two areas where residents have very short distances to travel. The southern cluster covers the Hispanic population and other lower economic block groups. The northern cluster extends across lower and higher economic block groups. Without looking at the correlations, it appears that parks are more available for the more ethnically diverse and poorer block groups.

Unfortunately, the correlations are not as strong as would be expected (Table 2). A negative correlation exists between the minimum distance and the Hispanic population, but so many community parks lie in or around the Hispanic corridor, it is surprising that the correlation is only -.312. The income variables have positive correlations, but these are not as strong as the previous measures. Although the variable correlations are weaker, the overall results of the minimum distance measure correlates strongly with the gravity potential measure (-.900).

Similar to the other measures, the black population has only a slight relationship with the results of the minimum distance measure. Throughout the three measures, nothing has been revealed about the location of parks in relation to block groups with higher black population percentage. Unlike the Hispanic population, which is tightly grouped, the black population seems to spread from the northeast both to the east and back toward the center of city. Being so seemingly dispersed, a portion of the population would have more access and another portion would have less, resulting in a lack of an overall relationship with the accessibility measures.

The correlation between this measure and the white population is nearly zero (Table 2), though still significant due to the large number of block groups. Comparing maps, the block groups with large white populations vary from high access to low access. The income variables also have less of a positive correlation with this measure. The white and higher income populations have more access to one park than overall access to all the parks.

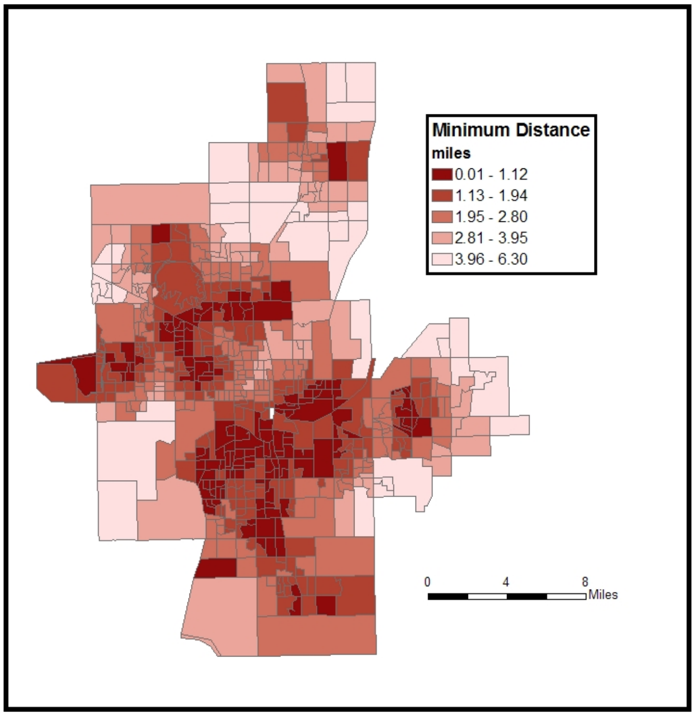


Figure 4. Minimum Distance Measure Results – Community Parks

The minimum distance measure exposes deficiencies that the other two measures cannot because the results are dependent upon the location of one park. A shorter distance means that recreational opportunities are more readily available. Proximity to one park is perhaps more desirable than proximity to a number of parks. Based on this assumption, the Hispanic and lower income groups still retain the greatest access.

Given the results of the three measures, the overall assessment of community parks is that they are distributed equitably regarding income groups. Higher income block groups proved to have less access with all three measures. The white population correlates highly with the higher income groups and also has less access to community parks. Similar correlations resulted from all three measures that indicated that Asians within the city have less access to community parks. However, the Asian population also correlated positively with the income groups, so this ethnic group may not be considered to “need” and benefit from proximity to the parks as much as the other minority groups included in this study.

The Hispanic population has significant access to community parks. Lower income block groups also have significant access to the community parks. The Hispanic population negatively correlates with the income variables, as does the black population. Although, for the black population, no significant correlation resulted from the gravity model, a slight negative correlation resulted from the travel cost model, and a slight positive correlation resulted from the minimum distance measure. Given these discrepancies, accessibility to community parks is indeterminate. The spatial autocorrelation statistics presented later may aid in explaining the lack of relationship between the accessibility measures and the black population.

Neighborhood Parks

Neighborhood parks provide service at a smaller scale than community parks and have a completely different purpose for residents. Neighborhood parks are designed for weekday pedestrian use, a place for recreation that is close to home. Ideally, at least one neighborhood park should be available within the half-mile buffer for the block groups with the most need. Realistically, some block groups will have access to many neighborhood parks and others will have access to none. Thus, counting the number of parks within a half-mile buffer of each block group and finding the minimum distance from each block group to its nearest park are the most appropriate methods of measuring accessibility to neighborhood parks.

Neighborhood parks are important for the lower socioeconomic groups because they provide open space and a local place for people to recreate. Residents of the wealthier block groups can afford to recreate elsewhere, at a local gym, for instance. Wealthier residents can also afford landscaping to create a park-like area in their own yards and playground equipment for their children. Higher income block groups and block groups with higher white populations need less accessibility than the poorer, more ethnically diverse block groups.

Included among the variables for the neighborhood park analysis is the percent of residents below the age of eighteen years. The percentage of children is included because young families and school-aged children have a greater need for the recreation that neighborhood parks can provide. Local parks give young children a place to play and older children a place to mingle. In order for young residents and the families of young residents to enjoy, a neighborhood park must be within walking distance.

The container count method tallies the number of parks that intersect the half-mile buffer around the centroid of each block group. Nearly half of all the block group buffers do not intersect with any parks (304 of 620). Most of the block groups with a count of zero lie along the outer edge of study area (Figure 5). The outer block groups have larger areas, and some of the neighborhood parks escape the buffer around the centroid. A larger buffer could be applied and studied, but it would not alter the end result. First, pedestrian accessibility would diminish. Second, a park that lies toward a corner would only serve a portion of the population within that block group, qualifying that block group as having an unequal distribution. In the context of this study, this quirk may help the cause of spatial equity since these block groups have larger white and higher income populations.

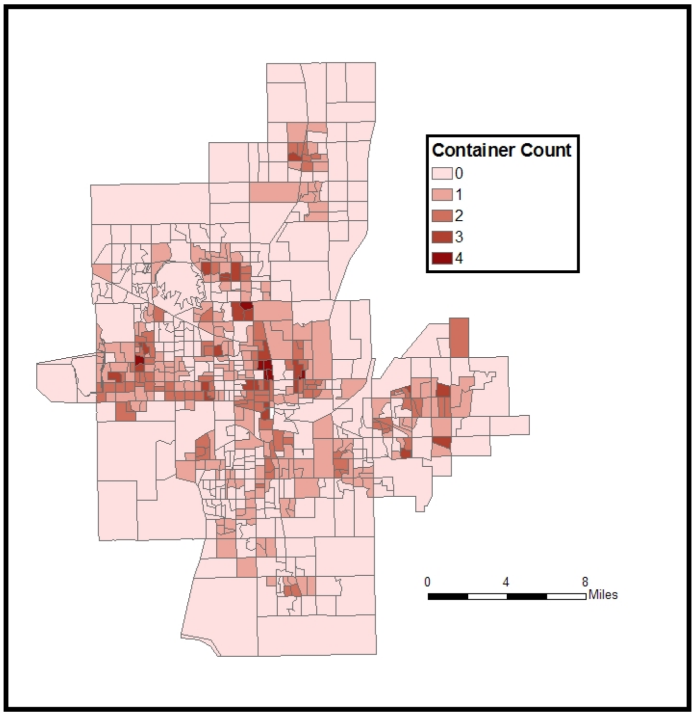


Figure 5. Container Count Results – Neighborhood Parks

The lack of parks is easier to determine by a visual estimation. The black population and Hispanic population appear to be underserved by the number of neighborhood parks available to them. Correlations do not reveal much more than the maps. Most are significant, but the numbers, like the map, do not give a strong indication about which groups are served and which groups are not. In this case, the container count method does not reveal much about the spatial equity of neighborhood parks. Slight positive and negative relationships exist, but the resulting values do not lend themselves to any kind of strong argument (Table 4).

Table 4. Correlations for Neighborhood Parks

	Pct. White	Pct. Black	Pct. Asian	Pct. Hisp.	Med. HH Inc.	Per Cap. Inc.
Container Count	-.093(*)	.079(*)	-.121(**)	0.058	-.200(**)	-.152(**)
Minimum Distance	.199(**)	-.124(**)	.084(*)	-.174(**)	.319(**)	.260(**)

*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

The study variables with less availability to neighborhood parks are the white population, the Asian population, median household income, per capita income. These negative relationships support the defense of spatial equity. The largest negative correlations are with the income variables, indicating that block groups with higher incomes have fewer neighborhood parks available. Yet, these may be distorted correlations. As mentioned previously, the block groups with counts of zero tend to be larger in area. Comparing the results to the neighborhood park maps (Appendix A) some parks exist in these larger block groups. Some of the residents may have access to a park while others do not. In this instance, lack of access for some is regarded as access for none. The black and Hispanic populations have virtually no relationship with the container count. Both correlation values are close to zero, and the value for the Hispanic population is not significant. The lack of a positive relationship could be argued as a lack of available parks.

The correlation between minimum distance and the container count is -.801. The more parks available to a block group, the shorter the distance from the block group centroid to the nearest park. On the surface, this correlation value would seem to corroborate the findings of each measure, as the correlation value did with the gravity potential and travel cost models. Rather, this correlation merely states the obvious. Since nearly half of the block groups do not have a park within a half-mile radius, these groups must travel a greater distance to access a neighborhood park. For the block group buffers that do intersect at least one park, this correlation is meaningless. Only one park can be the closest whether one or four are within the buffer zone.

The minimum distance measure identifies the shortest path to the nearest park for each block group. For some block groups, the closest neighborhood park may lie in another block group. Although a community park may be closer than a neighborhood park, only neighborhood parks are considered in the first part of the evaluation. The block groups with the furthest distances to a park lie along the perimeter of the study area and are largely developing neighborhoods (Figure 6). Parks may be planned for these neighborhoods, but none exist at the time of the study. However, parks may not be needed for these block groups since they are high income with large white populations. The houses being built in these areas are quite large and situated on fairly large plots of land. The residents can afford to landscape a mini-park in their own yards or substitute park recreation with other outdoor activities, such as golf.

The map does not reveal any distinguishable clusters, so it is difficult to ascertain which groups are served the most. Correlations help to clarify the relationships between the variables and the minimum distance measure (Table 4). The income variables are positive and have the strongest relationships. Higher income block groups have a longer distance to travel to a neighborhood park. The Asian and white populations also have positive relationships with the minimum distance measure and although they are significant, they are slight. The black and Hispanic variables have a negative relationship indicating that these block groups have a shorter minimum distance to their nearest parks.

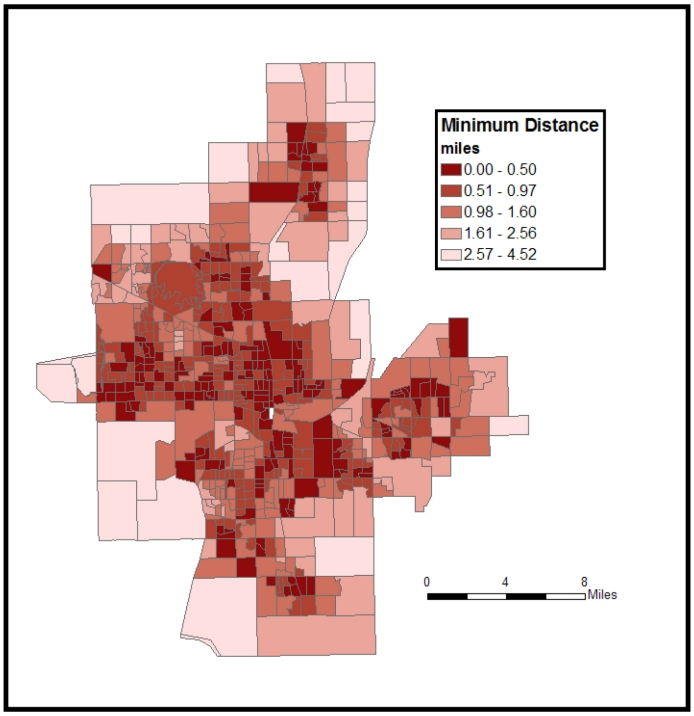


Figure 6. Minimum Distance Results – Neighborhood Parks

These values agree with the results of the container count. According to these two results, the locations of neighborhood parks are spatially equitable. However, the small correlation values do not lend themselves to a strong argument. By looking at the location of neighborhood parks set among the various socioeconomic distributions, it appears that certain block groups are completely underserved.

The above measures included only neighborhood parks, not community parks. However, community parks can function as neighborhood parks. Conducting the same measures of accessibility, container count and minimum distance, including community parks favorably alters the outcome. The improvement is not immediately noticeable with the container count map (Figure 7) and minimum distance map (Figure 8), but the correlations (Table 5) show marginal improvements with one exception. Remembering the definition of equity, improvement means that access to parks is increased for the groups who need more, and that access is decreased for the groups who need less.

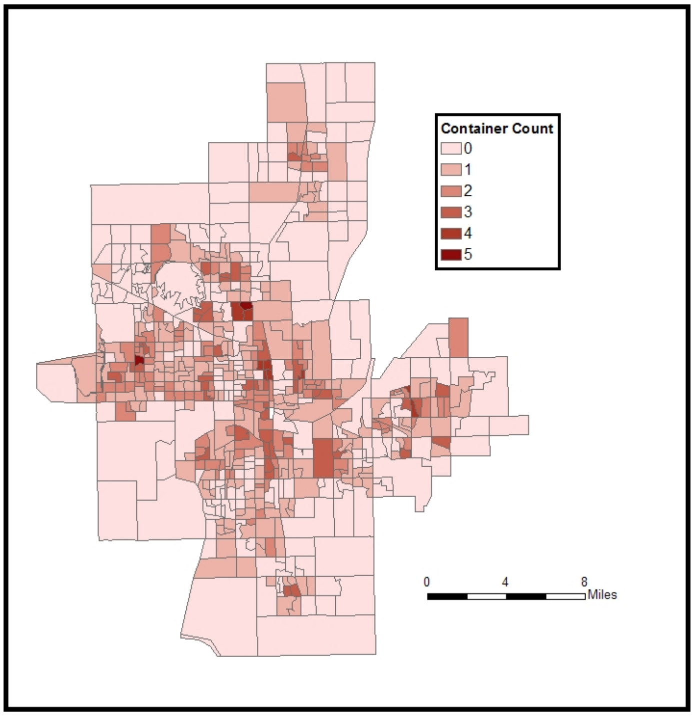


Figure 7. Container Count Results – All Parks

The correlations are more negative between the container count and the white population and the higher income variables. Adding more parks to the evaluation actually decreases the overall accessibility for these groups. In contrast, accessibility for the Hispanic populations slightly increases. This is no surprise given the Hispanic population's high access to community parks. The correlation value for the Asian population is less negative with all parks included; thus, the accessibility is improved for some of the population. For the black population, the addition of community parks is meaningless because the correlation coefficient moves closer to zero and loses significance.

Table 5. Correlations for All Parks

	Pct. White	Pct. Black	Pct. Asian	Pct. Hisp.	Med. HH Inc.	Per Cap. Inc.
Container Count	-.126(**)	0.058	-.177(**)	.120(**)	-.274(**)	-.195(**)
Minimum Distance	.209(**)	-.106(**)	.125(**)	-.194(**)	.349(**)	.297(**)

**Correlation is significant at the 0.01 level (2-tailed).

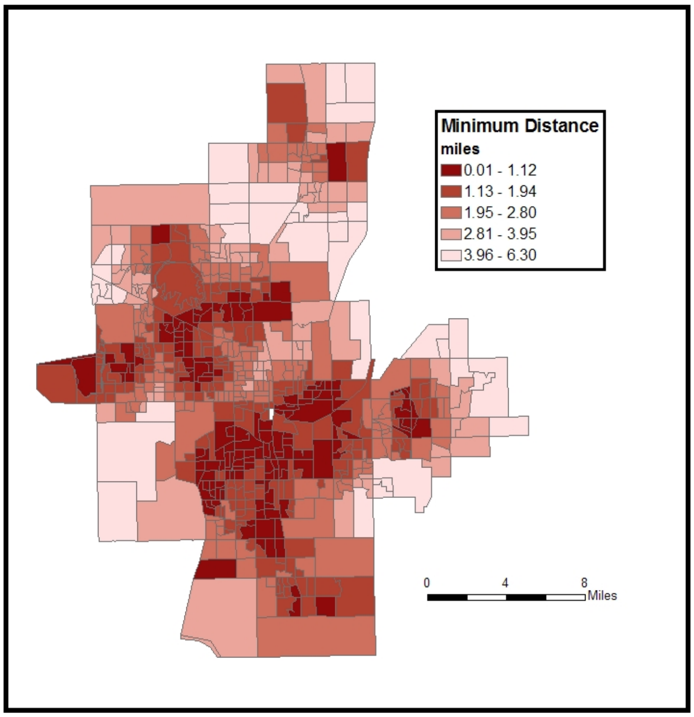


Figure 8. Minimum Distance Results – All Parks

The minimum distance measure for all parks shows more equitable access for all the variables except the Hispanic population. In comparison with the neighborhood parks minimum distance measure, the correlations for the white population, the Asian population, and the higher income groups are more positive. The black population correlation is less negative, but again this moves the correlation closer to zero. As expected, the Hispanic population's access increases with the addition of community parks.

Below are the results of the spatial autocorrelation statistics that better reveal the accessibility to neighborhood parks. Improved accessibility is evident when community parks are included with the neighborhood parks. The results also support the accessibility findings for community parks.

Spatial Autocorrelation Results

Study Variables

Spatial autocorrelation statistics were run for the results of every accessibility measure and for all of the variables. First, Moran's I tests for global spatial autocorrelation and the I values vary between -1 and 1, where a high positive value indicates positive spatial autocorrelation. Moran's I also helps determine the most appropriate threshold distance to use in the local spatial autocorrelation tests. The distance threshold applied was two miles. Two miles is a reasonable distance for block groups to maintain similar characteristics. Outside of two miles, neighborhoods change and demographic similarities begin to deviate.

All of the variables and measures exhibit some form of positive correlation and are significant, $z > 1.98$ (Tables 6 and 7). Without surprise, the Hispanic population has an I-value of 0.77. Interestingly, the black population has an I-value of 0.67. The weakness of the correlations between the accessibility measures and the black population must be attributed to the location of parks and not the dispersal of the population. The Asian population is fairly clustered, and it will be shown with the $G_i^*(d)$ statistic that a number of pockets are found throughout the city.

Table 6. Moran's I Values for the Study Variables,
2-mile Distance Threshold

	I	z
Pct. White	0.59	52.08
Pct. Black	0.67	59.36
Pct. Asian	0.42	38.15
Pct. Hispanic	0.77	67.92
MHI	0.31	27.74
PCI	0.32	28.31

The economic variables are slightly clustered, but not as much as would be expected given the higher I-value of the white population. Between the white population and the economic variables, the correlations were strongly positive. The lower I-values of median household income and per capita income indicate that clustering is evident, but not as much as the racial / ethnic variables. To identify the location of the clusters, a local spatial autocorrelation statistic must be used.

The $G_i^*(d)$ statistic identifies "hot spots" which are areas of high spatial autocorrelation. Hot spots are clusters of high spatial autocorrelation that are significant, have a z-value of 2 or above, and they are distinguished by red. Areas of "cool spots" are distinguished by blue. Z-values between -1 and 1 indicate spatial randomness. The following maps reveal the various demographic block group clusters within the city. The maps are discussed and arranged in descending spatial autocorrelation order according to their Moran's I values.

The Hispanic population is grouped as one large cluster (Figure 9). The bulk of the population lives south of Interstate 35. The black population (Figure 10) is spread over a greater area than the Hispanic population. Covering the urban core and northeast parts of the city, the black population cluster extends north and west into the central portion of the study area and into the eastern suburbs. Represented by four distinct clusters, the white population (Figure 11) is most prevalent in the suburban townships and noticeably absent from the Hispanic and black population clusters.

The Asian population (Figure 12) consists of six clusters: five small clusters which surround one large central cluster. The outer clusters account for the positive correlation with the income variables. The two income clusters (Figures 13 and 14) are nearly identical. Higher income populations lie to the north while the lowest income populations are in the center of the study area. The locations of these variable clusters are compared to the cluster results of the accessibility measures to complete the analysis.

Community Parks

The same spatial autocorrelation statistics are applied to the results of the accessibility measures. The gravity potential values are so skewed (skewness = 17.6) that the natural logs of the values are used to run the statistical analysis. All of the measures show some type of significant positive autocorrelation (Table 7). Travel cost is the most highly autocorrelated, as would be expected based on the travel cost accessibility map.

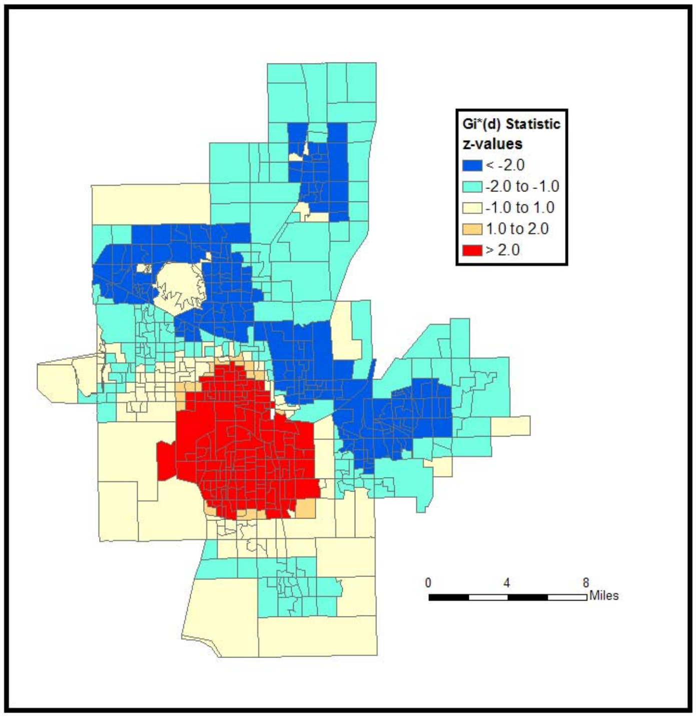


Figure 9. G_i*(d) Statistical Map of Hispanic Population

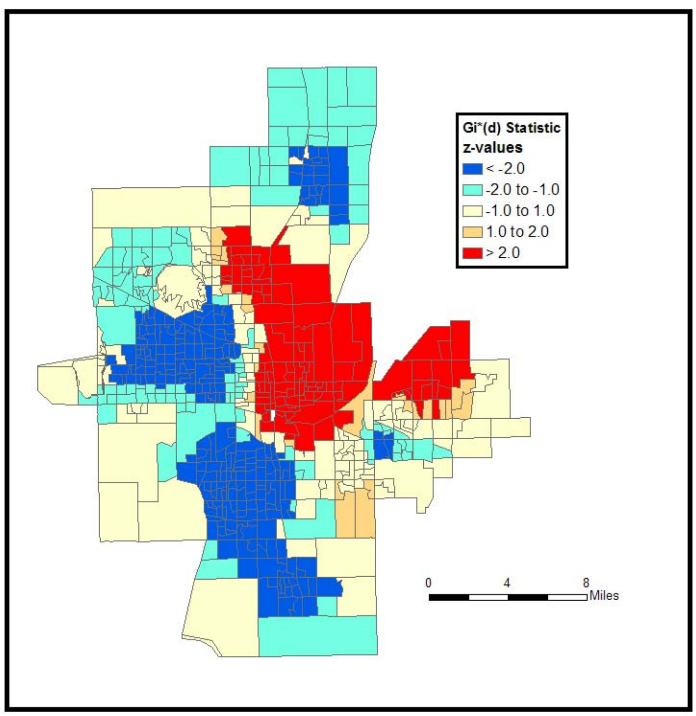


Figure 10. G_i*(d) Statistical Map of Black Population

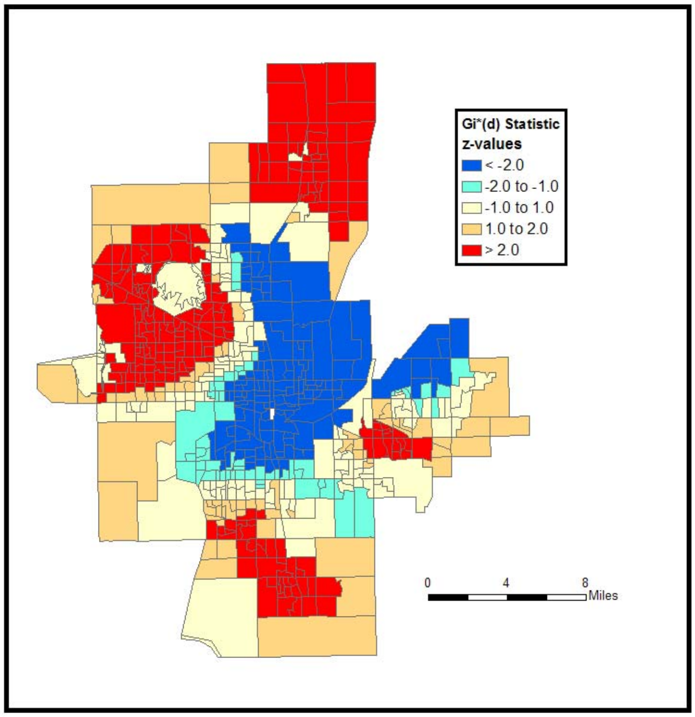


Figure 11. G_i*(d) Statistical Map of White Population

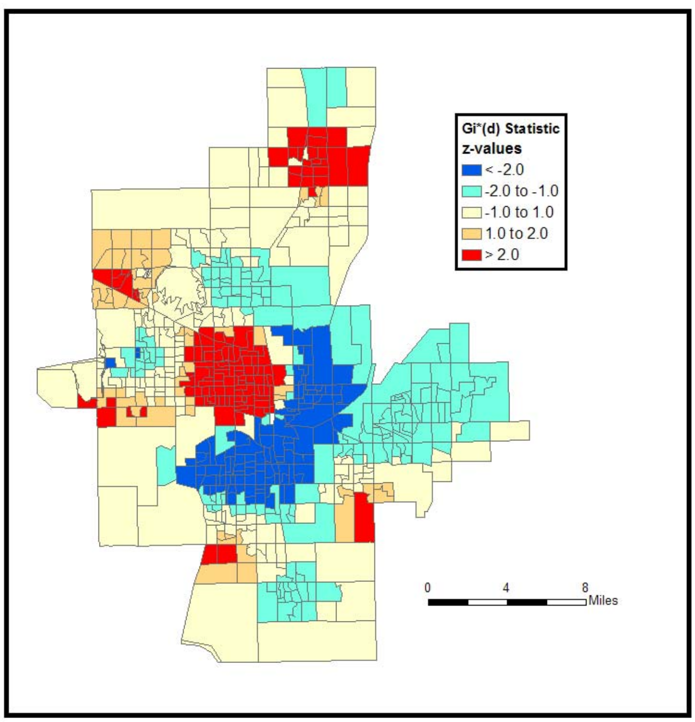


Figure 12. G_i*(d) Statistical Map of Asian Population

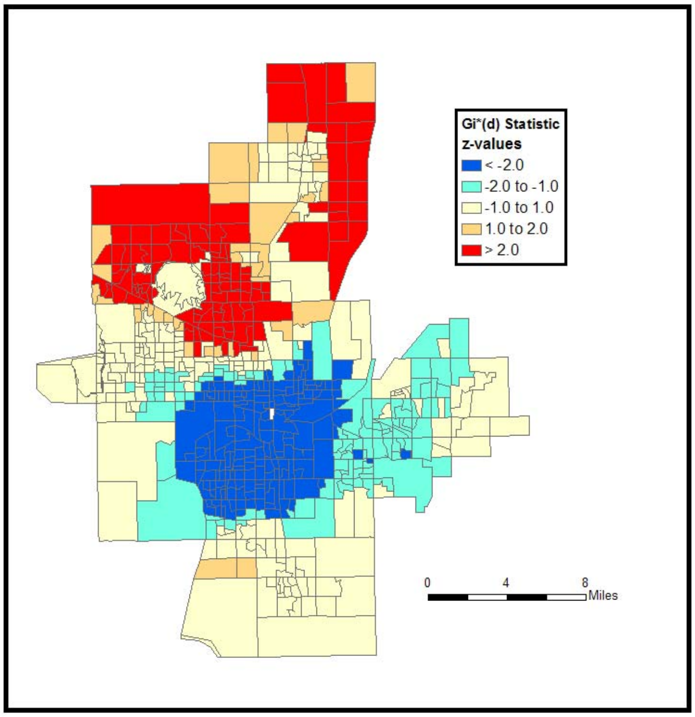


Figure 13. G_i*(d) Statistical Map of Per Capita Income

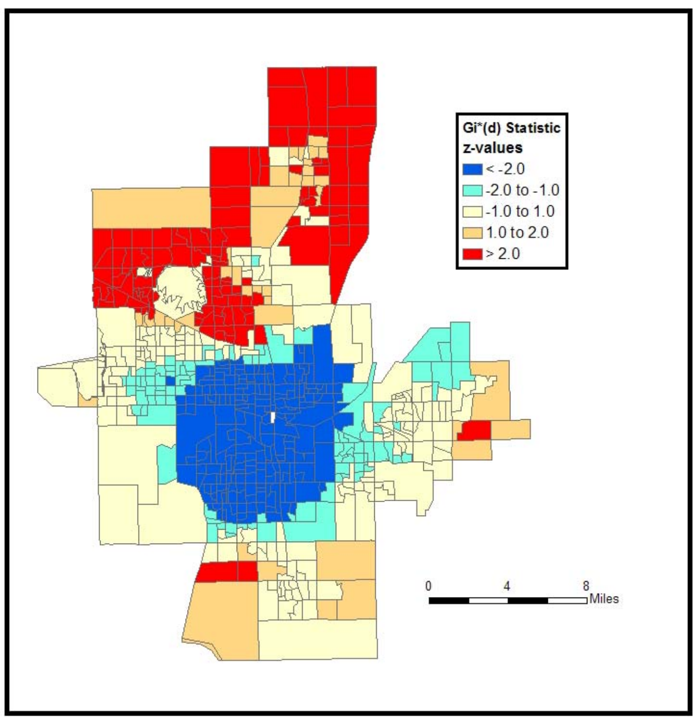


Figure 14. G_i*(d) Statistical Map of Median Household Income

Table 7. Moran's I Values for the Accessibility Measures of Community Parks, 2-mile Distance Threshold

	I	z
ln (Gravity Potential)	0.36	32.41
Travel Cost	0.68	59.24
Minimum Distance	0.43	37.7

The spatial autocorrelation maps support the conclusion that community parks have an equitable distribution across the city. These will also be sequenced and discussed according to the degree of spatial autocorrelation found with the Moran's I statistic. For ease of writing, the spatial autocorrelation maps will be referred to as cluster maps and the accessibility measure maps will be referred to as the original maps.

The spatial autocorrelation of the travel cost measure (Figure 15) is similar to the original map. The high accessibility area is one great central cluster while the low accessibility clusters are along the periphery. The travel cost cluster map is nearly the inverse of the income cluster maps. The hot spots give further evidence that the accessibility of community parks is equitable for higher and lower economic groups. That is, lower income groups have greater accessibility according to the travel cost measure. The white population clusters overlap the clusters of low accessibility.

The travel cost cluster completely overlaps the Hispanic cluster, implying high accessibility. The travel cost also overlaps most of the main central cluster of the black population. However, the cluster located in the eastern part of the study area overlaps with an area of very low accessibility. If compared with the slightly negative correlation (-.218), a larger fraction of the overall black population has greater accessibility. The

Asian clusters are scattered across the study area, supporting the low correlation value with the travel cost measure (.148).

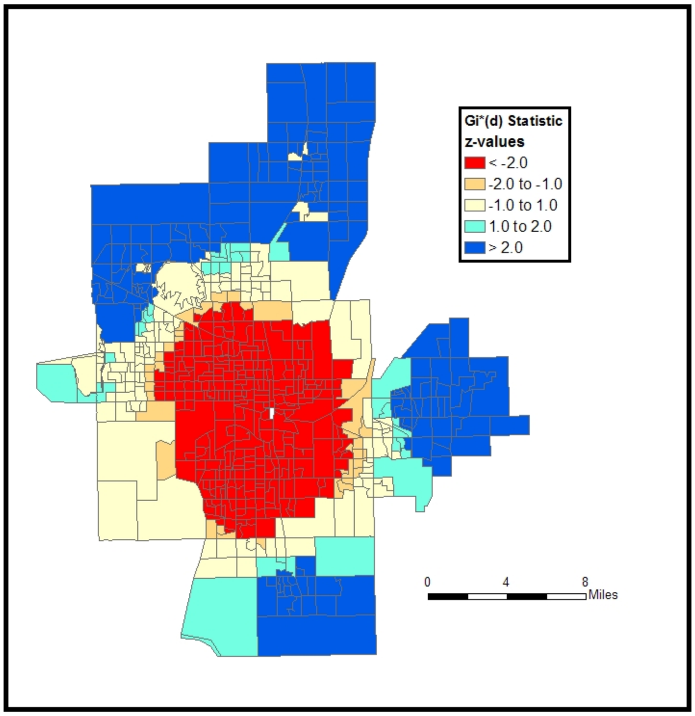


Figure 15. G_i*(d) Statistical Map of Travel Cost – Community Parks

The minimum distance map (Figure 16) shows two significant clusters of high accessibility. The southern cluster covers a large area of low income block groups as well as the Hispanic cluster. The northern cluster is located in an areas that is not strongly dominated by any of the racial, ethnic, or income groups. This happenstance accounts for the overall low correlation values between the minority variables and the minimum distance measure.

The gravity potential cluster map (Figure 17) is not unlike the minimum distance cluster map. The two high accessibility clusters of the minimum distance map are connected in the gravity potential map. Again, the block groups with a larger percentage of Hispanic persons and the lower economic groups have the greatest accessibility. None of the other variable clusters clearly overlap with this map. The results of this map substantiate the correlations found between the variables and the gravity potential measure.

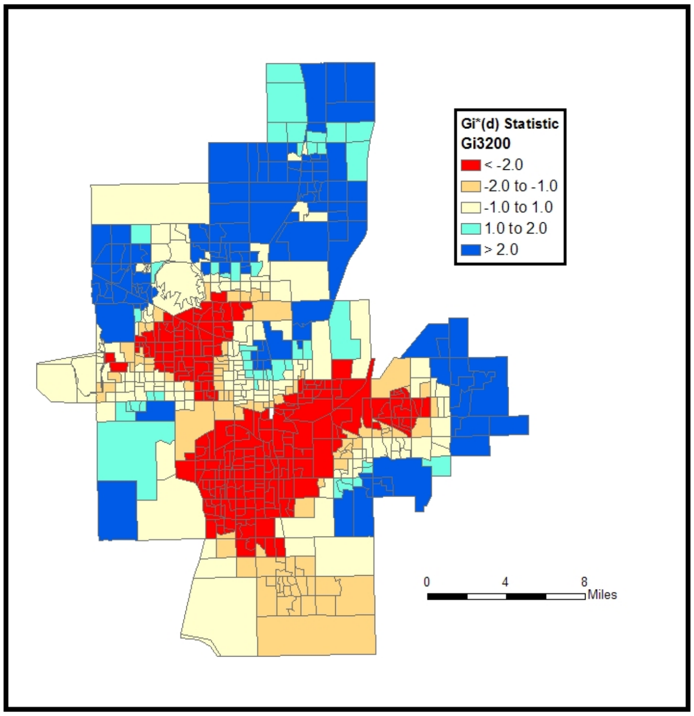


Figure 16. G_i*(d) Statistical Map of Minimum Distance – Community Parks

Applying local spatial autocorrelation statistics to the variables and accessibility measures allows one more method to assess the spatial equity of community parks. According to the analysis of the G_i*(d) statistical maps of the variables and measures, accessibility to parks is equitable for lower socioeconomic groups and the Hispanic populations in the Oklahoma City area. Using the spatial autocorrelation cluster maps, the Asian and black minority groups that live near the core of the city have high accessibility to parks while the clusters that are located along the edge of the study do not. Distribution of parks is equitable for the low-income Asian and black populations.

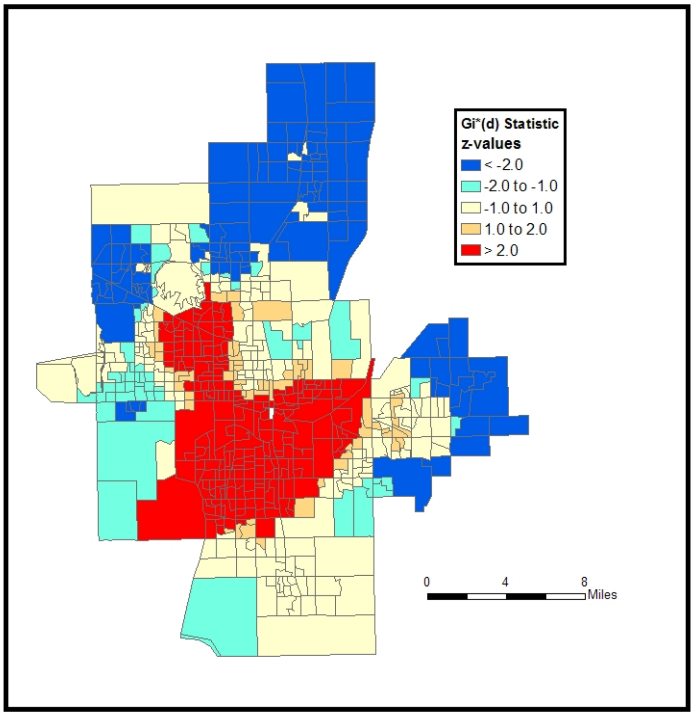


Figure 17. G_i*(d) Statistical Map of Gravity Potential – Community Parks

Neighborhood Parks

The measures used for neighborhood parks also show slight clustering with the Moran's I statistic. Identifying the locations of these clusters is imperative since the accessibility measures had no strong correlations with the variable nor did the maps reveal any obvious areas with higher accessibility. Conclusions about the accessibility of certain groups rely heavily on the overlap between the socioeconomic variable clusters and the accessibility measure clusters.

Spatial autocorrelation better helps to assess the spatial equity of neighborhood parks than the actual results of the accessibility measures. The container count and minimum distance measures had slight positive autocorrelation when tested by the Moran's I statistic (Table 8). The $G_i^*(d)$ will expose the local clusters. Since the study of the neighborhood parks is of a smaller scale of than the community parks, the detection of local pockets is more necessary. While the original maps were not very telling, the results of $G_i^*(d)$ statistic use the measures to expose the areas where neighborhood parks are abundant and where they are lacking.

Table 8. Moran's I Values for the Accessibility Measures of Neighborhood Parks, 2-mile Distance Threshold

	I	z
Container Count	0.27	24.23
Minimum Distance	0.23	20.47

The container count spatial autocorrelation results (Figure 18) reveal four distinct clusters of high accessibility to neighborhood parks. These four clusters happen to coincide with the older parts of the city. The central cluster is the core and oldest part of the city. The western cluster is the Putnam City area whose neighborhoods were first built in the 1930s. The small cluster in the north is near the Nichols Hills and the Village areas. The cluster to the east is the Midwest City-Del City area, an older suburban section of Oklahoma City. The commonality of these four clusters is they began as predominantly white, affluent suburban areas. These areas are still largely mainly white, but surrounded by block groups of more ethnic diversity.

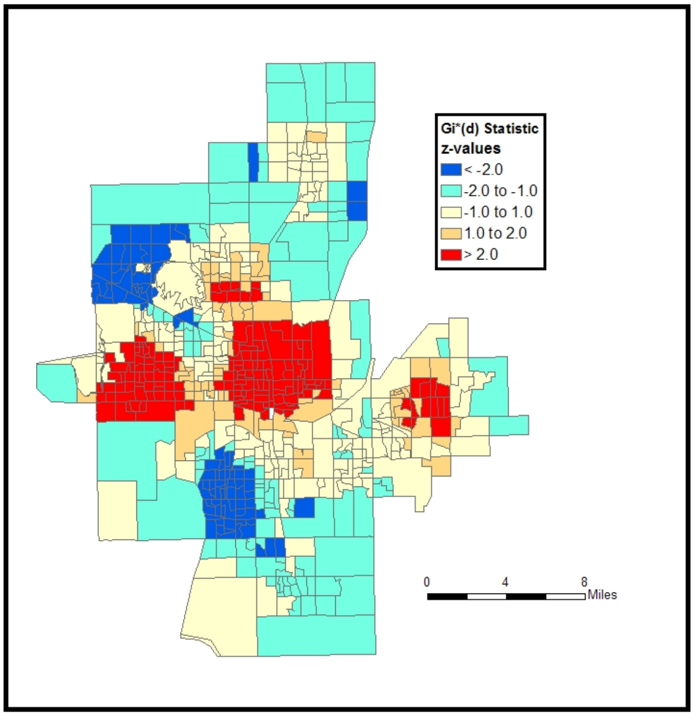


Figure 18. G_i*(d) Statistical Map of Container Count – Neighborhood Parks

The value of these results is that they identify an absence and abundance of parks. The red clusters reveal where many neighborhood parks exist, and the blue clusters reveal where none exist. For an equitable neighborhood park distribution, no red or blue clusters would be ideal, especially among the minority groups and lower economic groups. No significant clusters would mean that these areas had an even distribution of parks scattered throughout their neighborhoods.

With the exception of the Asian cluster in the central part of the study area and a portion of the black population in the eastern part of the study area, the count clusters have the greatest overlaps with the clusters of the white population. The large count cluster in the center overlies the clusters of low economic status. The lack of significant overlap agrees with the correlation coefficients. The percent of white, median household income, and per capita income all had small negative correlations with the container count.

The minimum distance spatial autocorrelation map (Figure 19) connects the clusters of the container count map and has one small cluster to the east. The large cluster overlaps more with the economic clusters and the Asian population in the central part of the city. However, the hot spots still do not appear to have any significant overlap with the racial / ethnic variables.

The evaluation of the distribution of neighborhood parks is not as straight forward as the evaluation of community parks. The results of the accessibility measures provided no strong arguments but were helpful in producing spatial autocorrelation maps. More can be determined by these maps. The container count cluster results of the $G_i^*(d)$ statistic reveal two areas where neighborhood parks are completely lacking. These two pockets fall within the higher income block groups, but this fits an equitable design since parks are not as necessary as they are for the minority and low income clusters. Nevertheless, the minority and low income groups do not have proportionally more access to neighborhood parks. Neighborhood parks are unevenly distributed among the white and minority populations, accounting for the near-zero correlation values.

Including the community parks with the neighborhood parks study completely changes the dynamic of the local spatial autocorrelation cluster maps. First, the Moran's I statistic (Table 9) shows slightly less positive autocorrelation. With the local autocorrelation statistical map, fewer clusters appear. The container count cluster map for all the parks shows two distinct areas of high accessibility (Figure 20). The central cluster captures more block groups than the container count for neighborhood parks. The

Nichols Hills and Mid-Del high cluster areas are now low cluster areas, and the Putnam City high cluster block groups now have z-values surrounding zero, indicating a random spatial pattern.

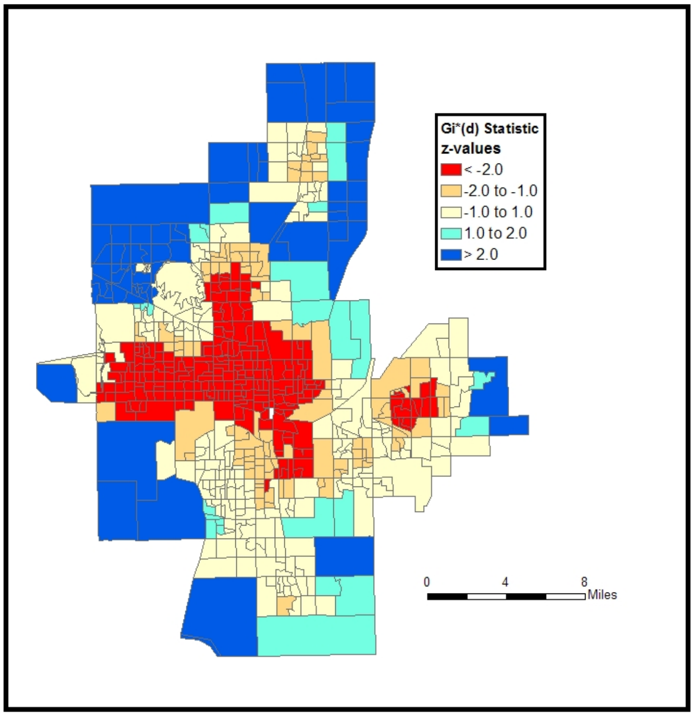


Figure 19. G_i*(d) Statistical Map of Minimum Distance – Neighborhood Parks

Table 9. Moran's I Values for the Accessibility Measures of All Parks, 2-mile Distance Threshold

	I	z
Container Count	0.22	18.59
Minimum Distance	0.21	18.36

Previously identified as a low cluster area, a hot spot appears in the southern section of town (Figure 20). A number of community parks are located within these block groups. Until this container count, the southern community parks have had little effect on the results of the accessibility measures because of their extreme southern location. The close proximity of the parks to one another causes the high spatial autocorrelation.

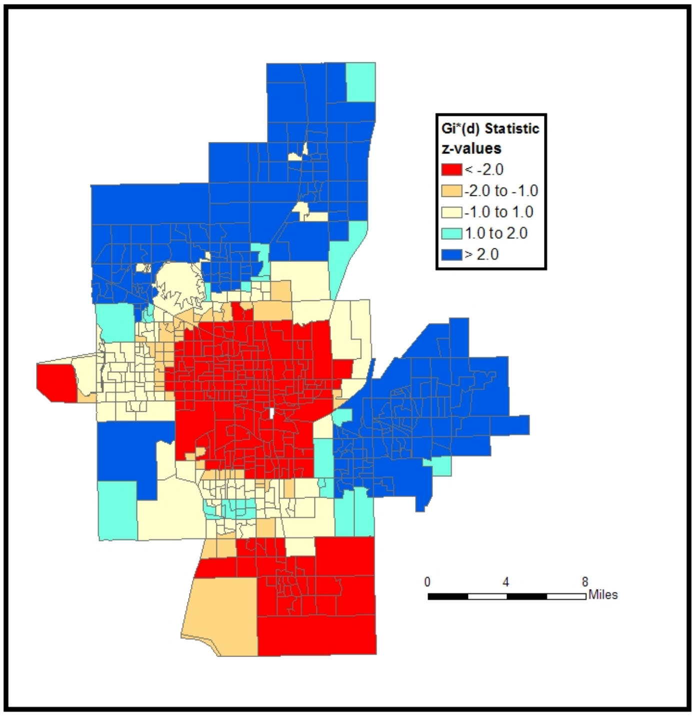


Figure 20. G_i*(d) Statistical Map of Container Count – All Parks

The inclusion of community parks improves the accessibility of the Hispanic population. The correlation becomes more positive and significant. The correlations slightly improve for the lower economic block groups while the correlation with the white population becomes more negative. Accessibility minimally improves for the Asian population. Without question, the most interesting result is the correlation coefficient for the black population. The correlation is closer to zero and loses significance with the addition of community parks.

When the $G_i^*(d)$ statistic is applied for minimum distance measure of all parks, a large clusters appears in the center of the study area (Figure 21). The cluster covers the Hispanic population and lower income areas, but it also extends north to higher income areas. Slightly improved access results for the Hispanic, black, and lower income populations; slightly less access results for the white and Asian populations. The addition of community parks offered no significant improvement to the minimum distance measure. Accessibility for the various groups essentially remained the same.

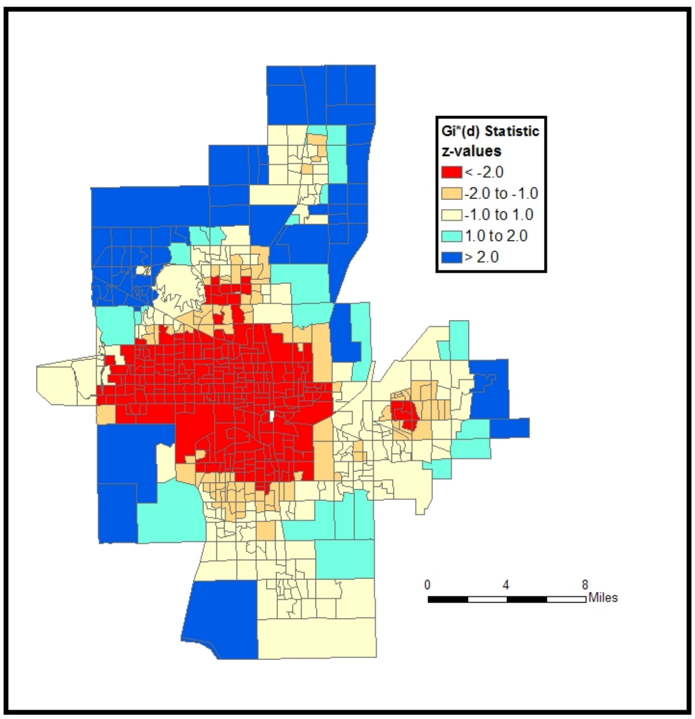
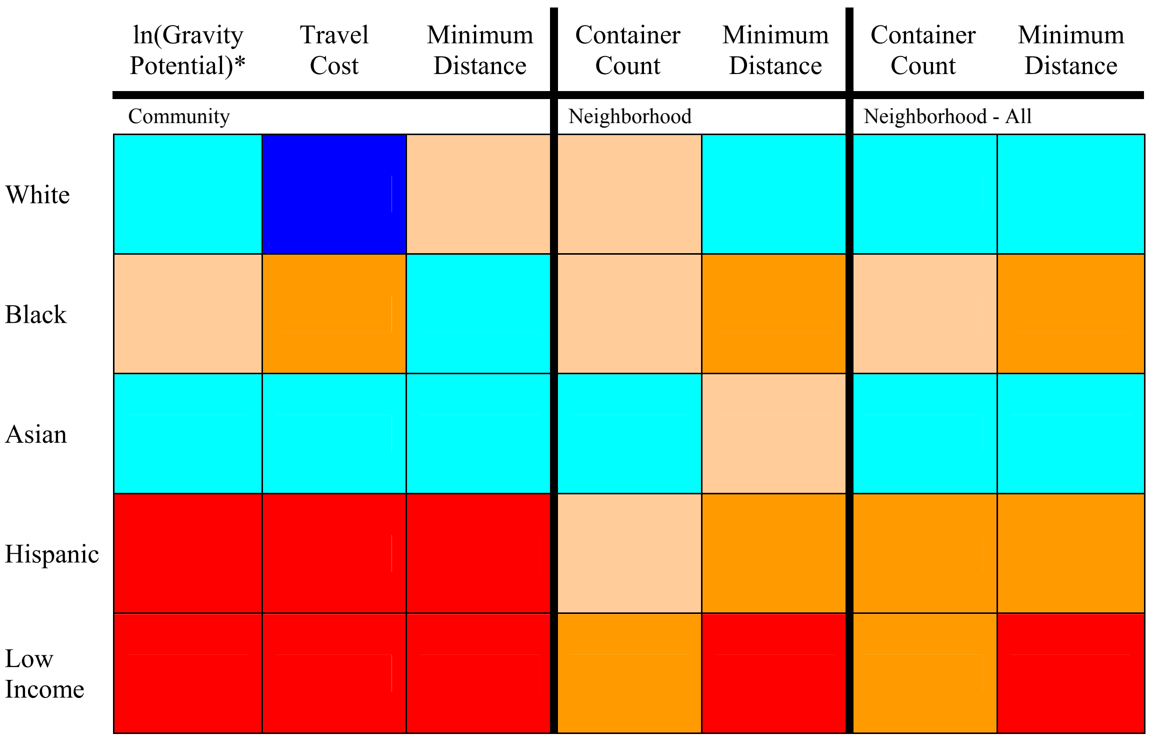


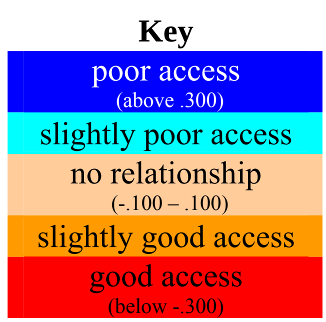
Figure 21. $G_i^*(d)$ Statistical Map of Minimum Distance – All Parks

The spatial autocorrelation results support the findings of the original accessibility measures. Community parks are distributed equitably for all groups except the black population. According to the original measures, the distribution of neighborhood parks is mildly equitable. None of the correlations were strong between the variables and the measures. The cluster maps for neighborhood parks revealed the presence of parks among older neighborhoods of Oklahoma City. Combining community parks and neighborhood parks produced minimally better accessibility results. Park accessibility for the variables is summarized in Table 10.

Table 10. Accessibility Summary Table



*The signs for this measure are opposite.



The existing park system provides adequate access for the Hispanic and lower-income populations. The lack of access for the white and Asian populations is acceptable since both are among the higher-income groups. The most ambiguous accessibility results are found for the black population. In regard to community parks, the black population has wavering accessibility, depending on the measure used. The lack of agreement of results, in the case of the black population, provides an unclear picture of accessibility. However, conclusive agreement among the results supports the accessibility findings for the other variables. Multiple measures showing greater accessibility for the "need" groups makes a strong argument for the case of equitable park distribution. The implications of these results will be further explored and developed in the following chapter.

CHAPTER V

CONCLUSION

Evaluation of Hypothesis

This research is an assessment of the existing park system within the Oklahoma City metropolitan area. Using accessibility measures provided by Talen and Anselin, the goal of this study is to determine whether the distribution parks in Oklahoma City is equitable. Equity is providing a service in proportion to need. Minority and low-income groups are considered to have a greater "need" in Oklahoma City.

In the course of the study, it has become evident that the two types of parks, community and neighborhood, need to be treated separately, particularly in respect to the services each provides. Community parks are designed for city-wide public use. Neighborhood parks are designed to be used by the local population and to be accessible by pedestrians.

Using block groups as the geographic unit of study, the accessibility measures were calculated and then tested against the socioeconomic variables. I expected to find that the wealthier northwest section of the city would have greater access to parks and that minority and lower income sections to have significantly less access. According to the results of accessibility measures, community parks in Oklahoma City are distributed equitably in regard to the Hispanic population and the lower income groups. The results for the accessibility of block groups with larger black populations were ambiguous. By lack of clearly defined accessibility, the black population does not have adequate access to community parks. The Asian population clusters are arranged in a manner that places the lower income cluster in the center of the study area and the higher income white population along the edge of the study area. Because the lower income Asian groups have greater access than the higher income Asian groups, the park distribution can be considered equitable for this minority population.

Applying three different measures of accessibility to study the distribution of community parks produced similar results. Based on the locations of parks in relation to the socioeconomic clusters, there is equitable distribution of community parks. Accessibility to neighborhood parks paralleled the accessibility results of community parks. Although the neighborhood park correlation results were not as strong the community park correlations, when the results were used to test for spatial autocorrelation among the block groups, deficiencies in the locations of parks were exposed.

Limitations of the Study

The applications of the accessibility measures were not as effective for the study of the distribution of neighborhood parks. Neighborhood parks are designed for a localized service area and are on such a small scale that the measurements could not produce an accurate assessment of accessibility. The container count method is of limited value due to the use of a buffer around the centroid of the block group. The buffer was effective for the smaller block groups, but it lost meaning as the block groups exceeded the buffer's radius.

Since the location of community and neighborhood parks relative to various population blocks serves as the focus of the current study, numerous opportunities for further study exist. Clearly, community parks vary in size and function. Some are designed as open spaces around lakes while others are arranged as playing fields for various sports. The accessibility measures could be modified to account for park characteristics. Size, quality, and facilities could count toward weighting each park individually. Interpretation of the accessibility measures would then require a qualitative approach.

This study focuses solely on block group demographics and the locations of two types of parks. In contrast, the recent trend of the National Recreation and Park Administration (Mertes and Hall 1996) is to look at the unique characteristics that define a community and to sustain a park system accordingly. The NRPA uses a series of formulas that takes into account supply and demand to produce park classifications according to size and levels of service. In this study, residents were assigned "need" based on their racial / ethnic and income status, regardless of park use or desired recreational opportunities. To incorporate NRPA standards, the demands of citizens would be considered more when measuring accessibility.

Application of Study

One of the purposes of this research is to see if the existing park system in Oklahoma City is achieving “a balanced and adequate system of parks” (*OKC Plan 2000-2020*, 57). The results of this study show that parks are distributed equitably among the Hispanic and low-income groups. Two specific reasons account for the equitable distribution of parks. First, because of their central location and proximity to downtown, the Hispanic population and low-income groups have access to the parks that are centrally located as well as being equidistant to the parks on the perimeter. The development of downtown Oklahoma City will continue to increase the accessibility for these groups. The low-income and Hispanic groups have the best access to the parks and greenways that have been developed along the Canadian River that runs just south of downtown and just north of the Hispanic population cluster.

Second, many parks were built in affluent, white neighborhoods when Oklahoma City was young. Through the course of time, the white population moved to the suburbs and was replaced by more ethnically and economically diverse populations. The high access cluster in the center of the city now consists of a large Asian and black population. However, the black population maintains a segregated cluster that spreads over to the east and north, adversely affecting this group’s accessibility to parks.

The lack of access for the black population will become a major issue given the urban expansion plans of Oklahoma City. In the *OKC Plan 2000-2020*, land use designated for urban development is all to the west, north, and south of the study area, and the black population is located in the east (Appendix D). Under the Directions for

Parks and Open Spaces, the first goal is to "create stable and attractive neighborhoods by developing parks that are enjoyable, visually appealing, safe, and *easily accessible*" (57, emphasis mine). Unless Oklahoma City modifies its plan to place new parks solely within new residential developments, the black population's accessibility to parks will suffer.

The Parks, Recreation, and Open Space Plan (*OKC Plan 2000-2020*) calls for a survey to reveal the type of parks and facilities desired by Oklahoma City residents. Using the findings of the survey, the next step in the plan is to "identify unneeded parks, determine appropriate uses for the properties, and take appropriate action to accomplish the reuse of redevelopment of the properties" (57). Parks that seemingly do not contribute to the recreational needs of a neighborhood could be modified for a different type of land use. Parks that have the potential to enhance the neighborhood could be landscaped and improved by adding recreational equipment. The results and methods of this research can help to identify the "unneeded parks" and help to determine the most equitable locations for future parks.

Oklahoma City is one of several cities implementing a metro-wide trail network. One of the goals of the trail system is to coordinate with the city's parks (*Oklahoma City Trails Master Plan* 1997). Thus, additional studies of parks should incorporate the Oklahoma City trail network and the proposed development of a system of linear parks. This study provides a platform for examining how existing parks feed into the proposed trail network and how the completed trails will improve the overall accessibility to community parks.

Also in Oklahoma City's Plan is the recurring theme of "acquiring, developing, and maintaining parks and open space." Yet, no methods are given as to how the city will choose to acquire and develop future parks or how it will maintain its existing system. Although all the parks in the study area do not fall under Oklahoma City's jurisdiction, the city is powerful enough to ensure an adequate and equitable distribution park system for the entire metro area. As Oklahoma City continues to grow and expand, the methods outlined in this paper can be repeated and applied to evaluate the effect of proposed parks.

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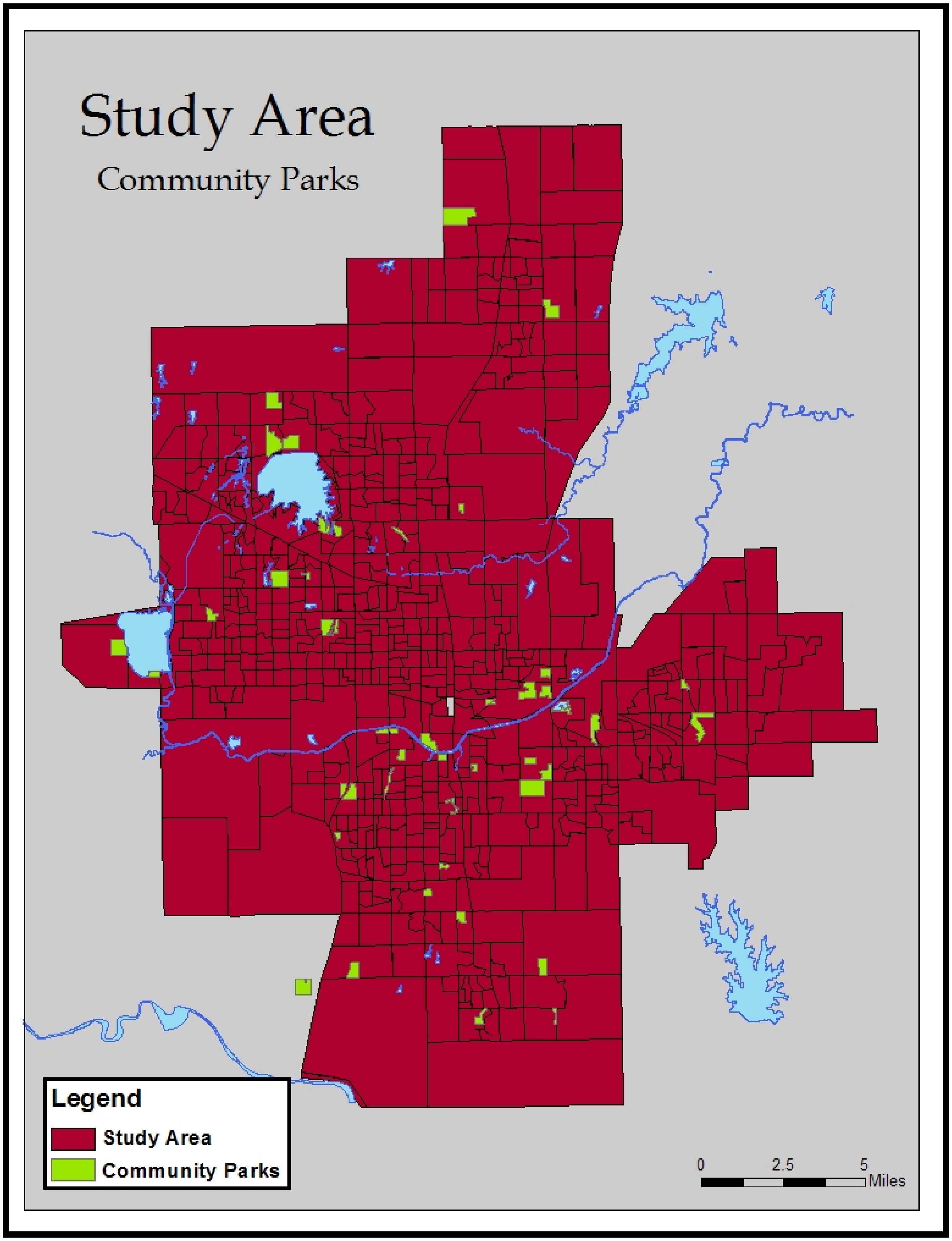
APPENDIX A

Maps of Community and Neighborhood Parks


Study Area
Community Parks
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Study Area
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2.5
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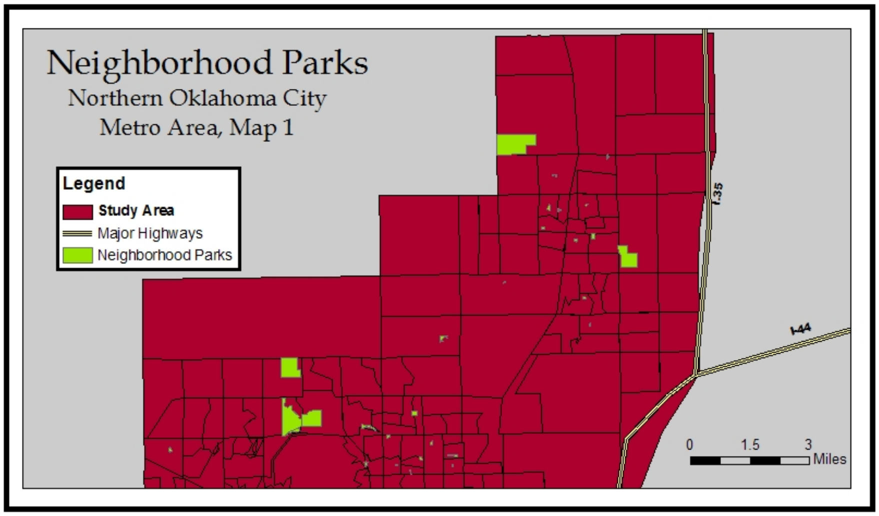
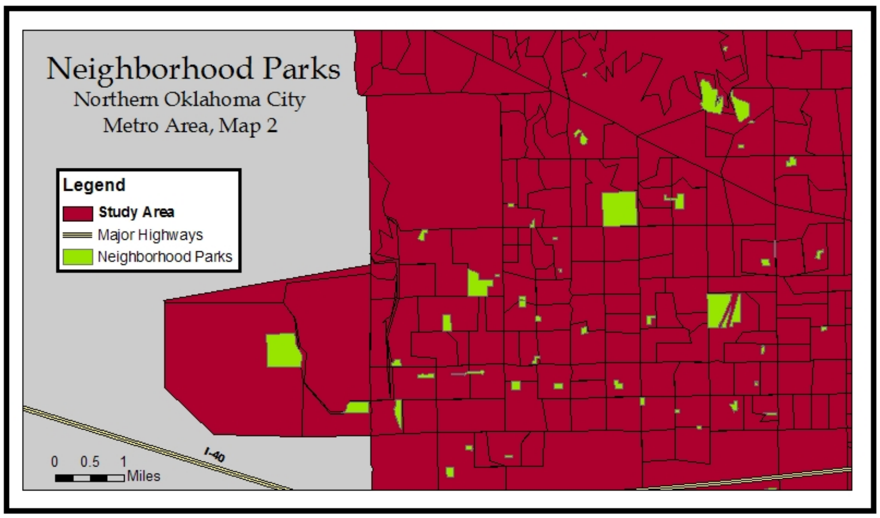

Neighborhood Parks
Northern Oklahoma City
Metro Area, Map 1
Legend
Study Area
Major Highways
Neighborhood Parks
I-35
I-44
0 1.5 3
Miles


Neighborhood Parks
Northern Oklahoma City
Metro Area, Map 2
Legend
Study Area
Major Highways
Neighborhood Parks
I-40
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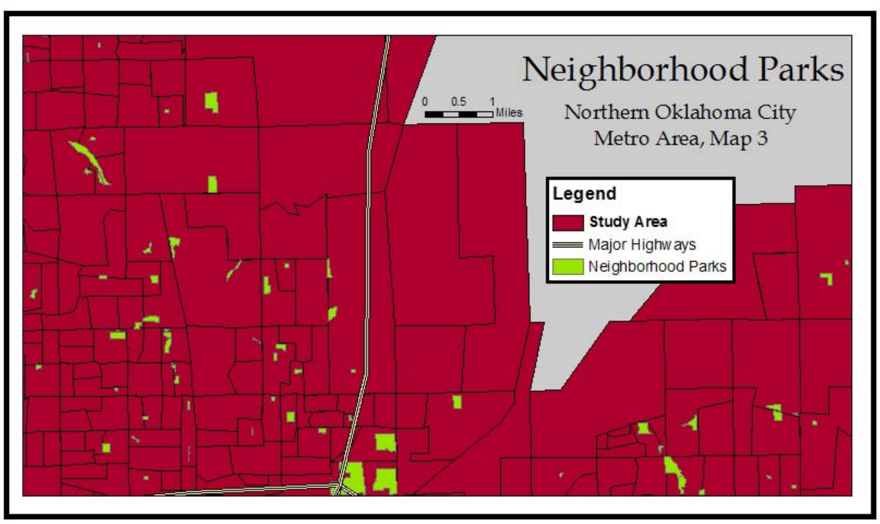
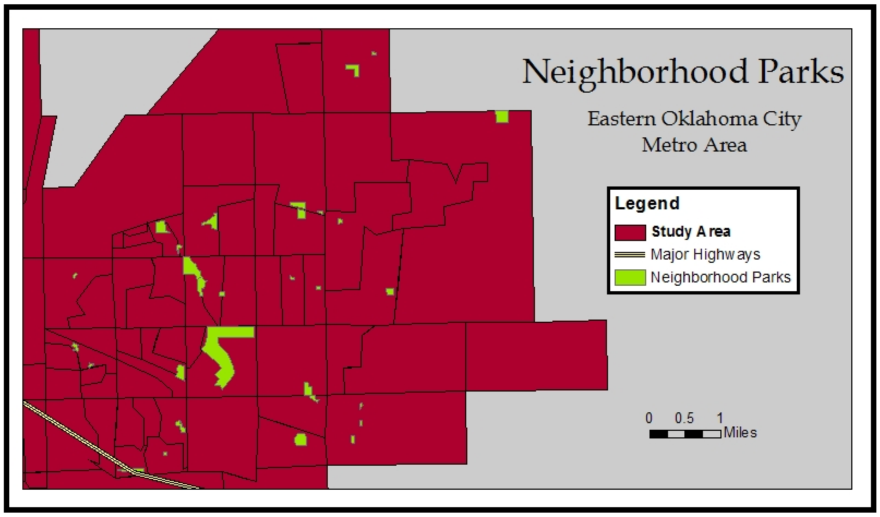
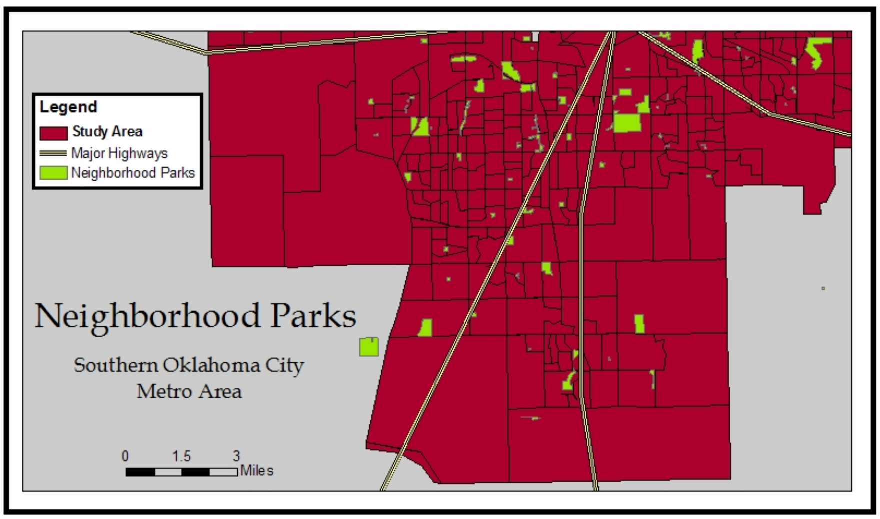
Miles

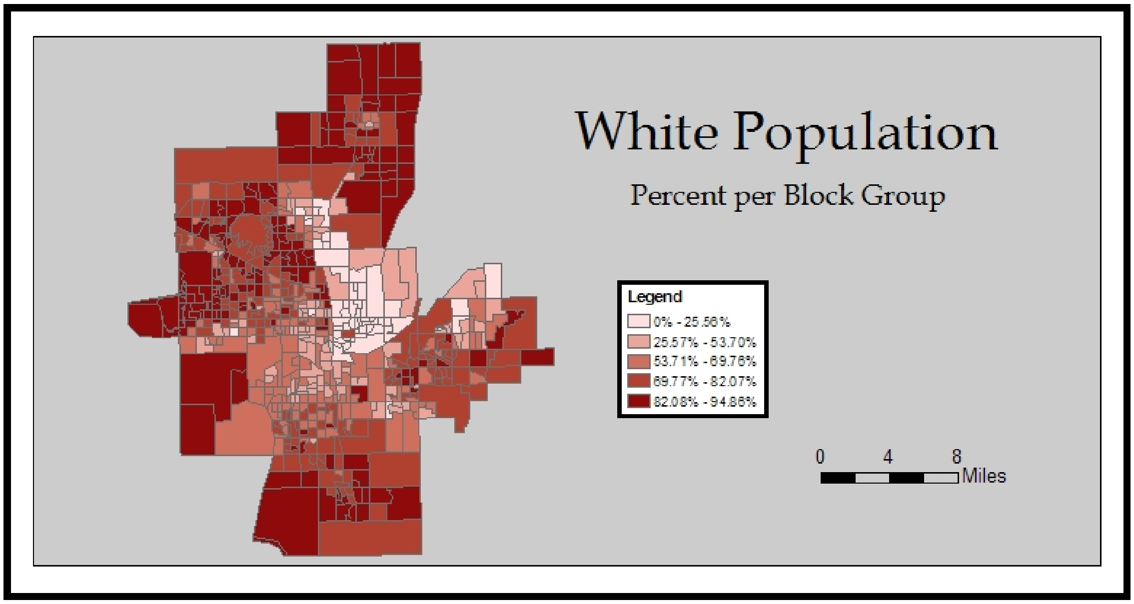

Neighborhood Parks
Northern Oklahoma City
Metro Area, Map 3
Legend
Study Area
Major Highways
Neighborhood Parks
0 0.5 1
Miles

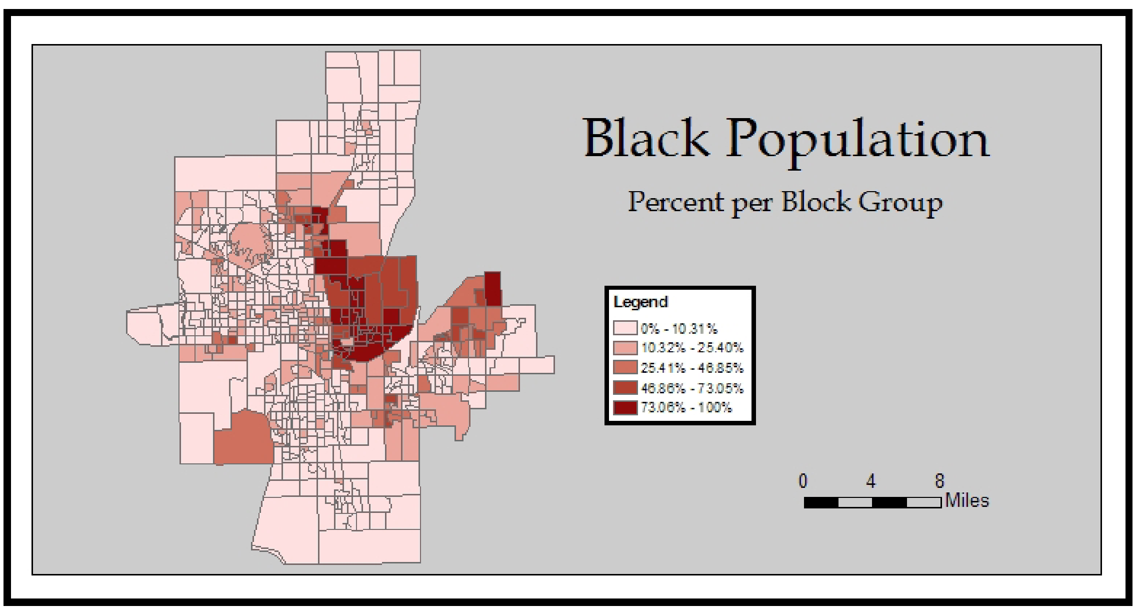

Neighborhood Parks
Eastern Oklahoma City
Metro Area
Legend
Study Area
Major Highways
Neighborhood Parks
0 0.5 1
Miles

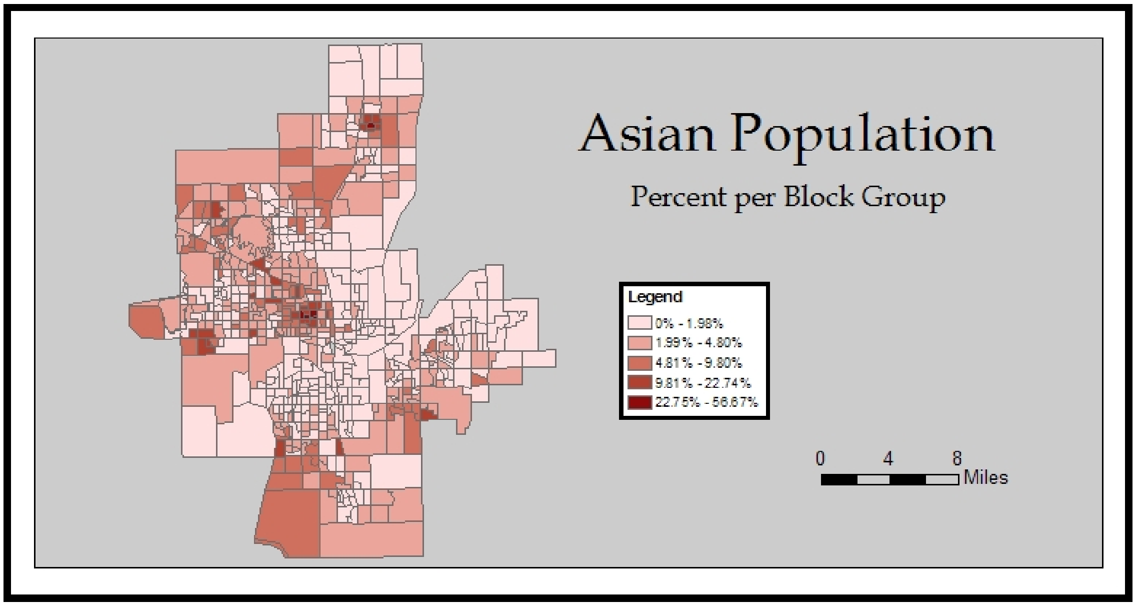

Legend
Study Area
Major Highways
Neighborhood Parks
Neighborhood Parks
Southern Oklahoma City
Metro Area
0 1.5 3
Miles

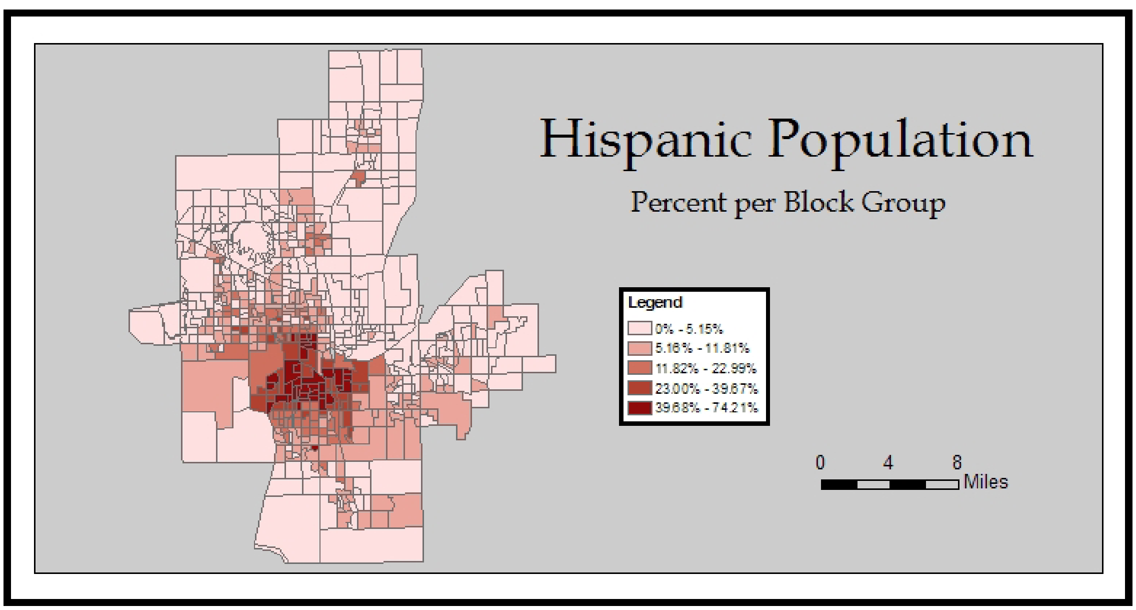
APPENDIX B

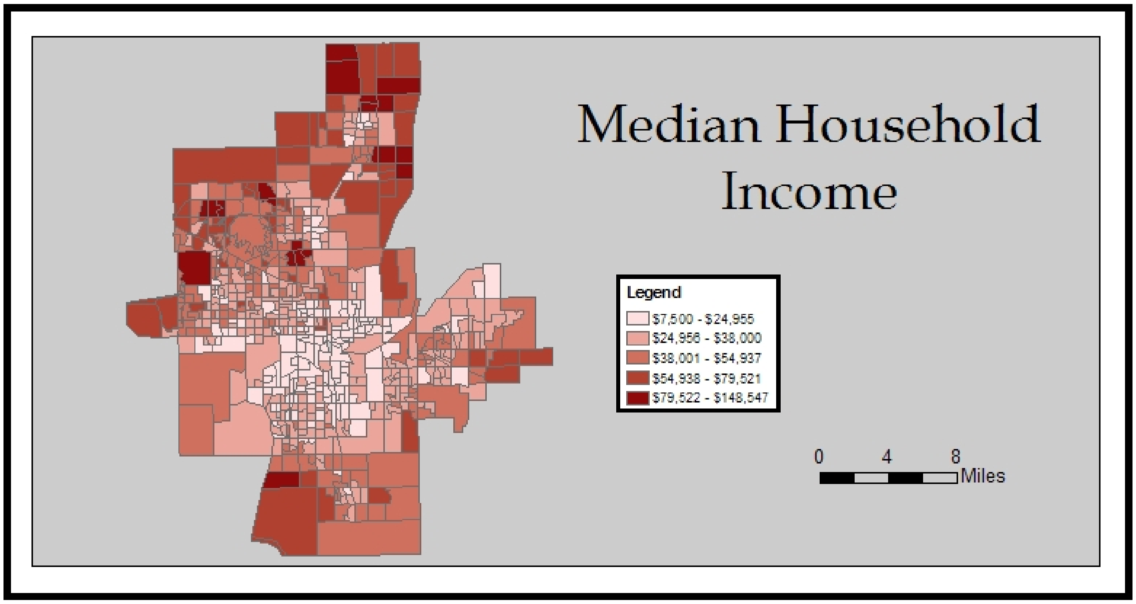
Distribution Maps of Study Variables

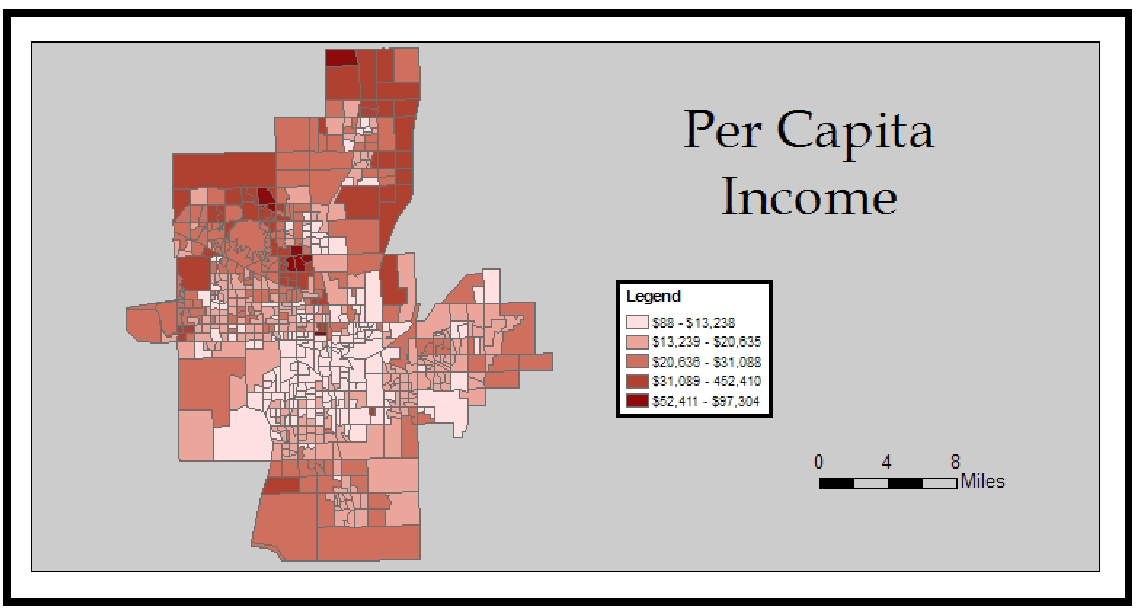

White Population
Percent per Block Group
Legend
0% - 25.56%
25.57% - 53.70%
53.71% - 69.76%
69.77% - 82.07%
82.08% - 94.86%
0 4 8
Miles


Black Population
Percent per Block Group
Legend
0% - 10.31%
10.32% - 25.40%
25.41% - 46.85%
46.86% - 73.05%
73.06% - 100%
0 4 8
Miles


Asian Population
Percent per Block Group
Legend
0% - 1.98%
1.99% - 4.80%
4.81% - 9.80%
9.81% - 22.74%
22.75% - 56.67%
0 4 8
Miles


Hispanic Population
Percent per Block Group
Legend
0% - 5.15%
5.16% - 11.81%
11.82% - 22.99%
23.00% - 39.67%
39.68% - 74.21%
0 4 8
Miles


Median Household Income
Legend
$7,500 - $24,955
$24,956 - $38,000
$38,001 - $54,937
$54,938 - $79,521
$79,522 - $148,547
0
4
8
Miles


Per Capita Income
Legend
$88 - $13,238
$13,239 - $20,635
$20,636 - $31,088
$31,089 - 452,410
$52,411 - $97,304
0
4
8
Miles

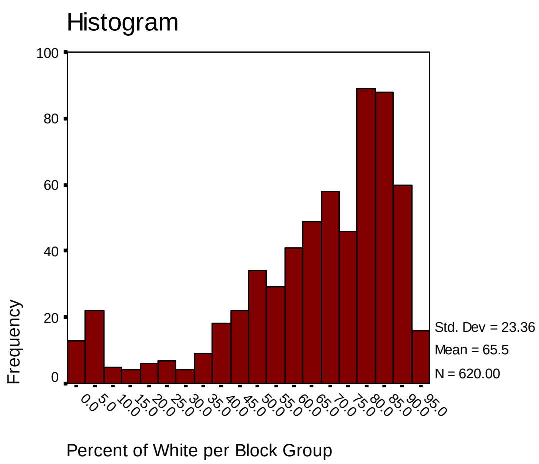
Appendix C

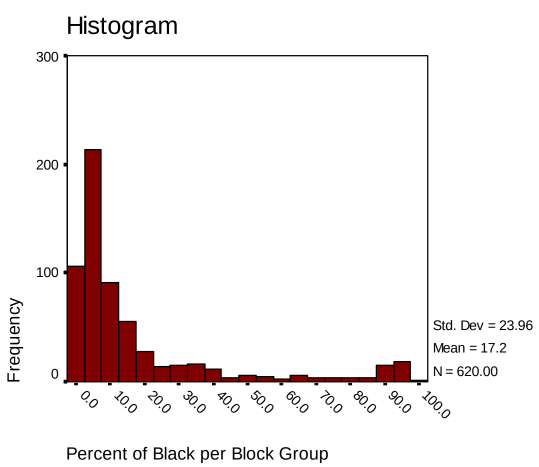
Exploratory Analysis of Variables

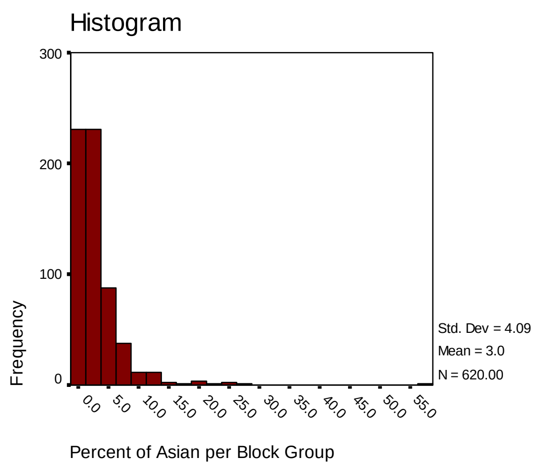
Tests of Normality

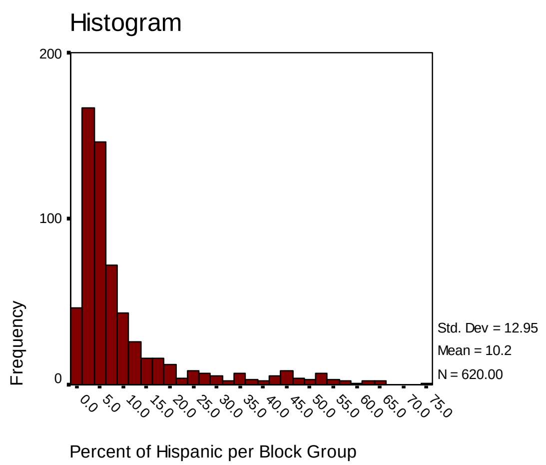
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pct. White	.183	620	.000	.712	620	.000
Pct. Black	.252	620	.000	.654	620	.000
Pct. Asian	.233	620	.000	.591	620	.000
Pct. Hisp.	.246	620	.000	.670	620	.000
M H I	.135	620	.000	.879	620	.000
P C I	.129	620	.000	.822	620	.000

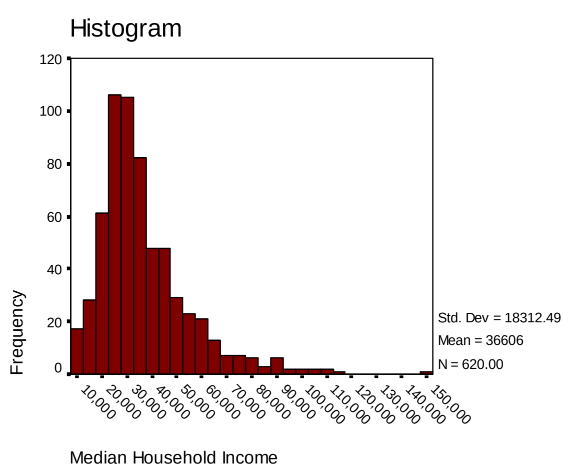
a. Lilliefors Significance Correction

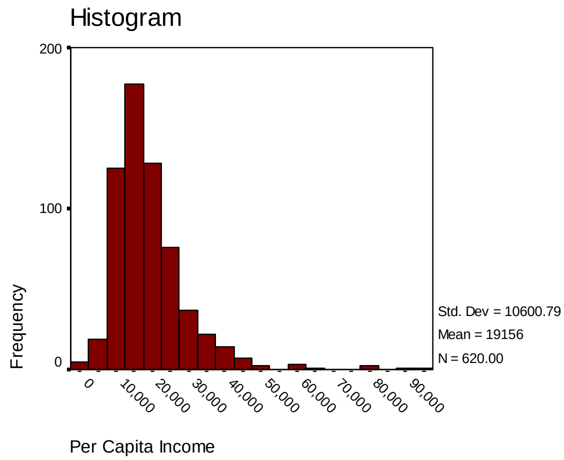





Histogram
300
200
100
0
Frequency
Std. Dev = 4.09
Mean = 3.0
N = 620.00
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
Percent of Asian per Block Group


Histogram
200
100
0
Frequency
Std. Dev = 12.95
Mean = 10.2
N = 620.00
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
75.0
Percent of Hispanic per Block Group


Histogram
120
100
80
60
40
20
0
Frequency
Std. Dev = 18312.49
Mean = 36606
N = 620.00
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
110,000
120,000
130,000
140,000
150,000
Median Household Income

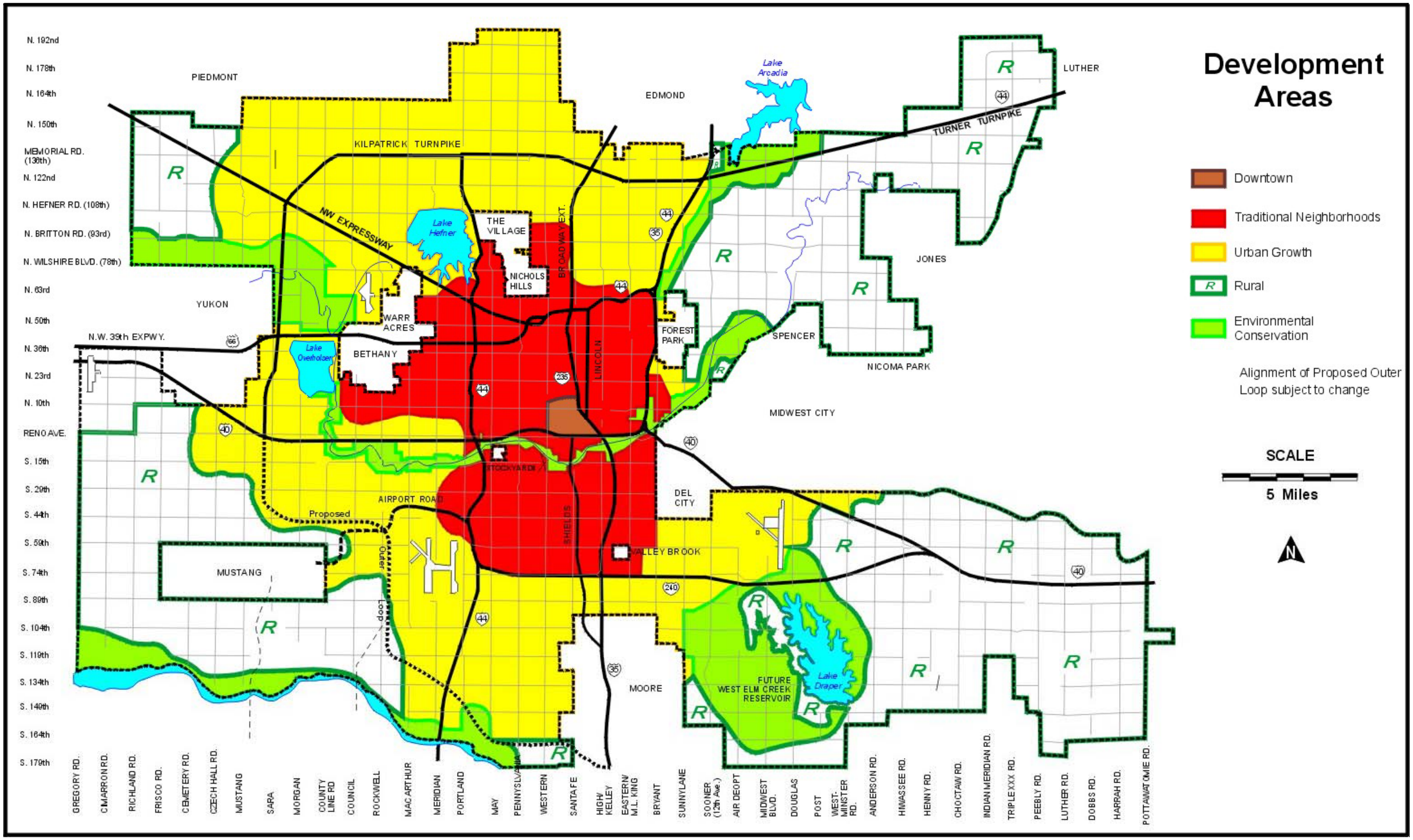


	Skewness	Kurtosis
Pct. White	-1.245	0.964
Pct. Black	2.153	3.701
Pct. Asian	5.551	54.409
Pct. Hispanic	2.37	5.353
Median Household Income	1.656	4.214
Per Capita Income	2.505	11.625

APPENDIX D

MAP OF DEVELOPMENT AREAS

OKC PLAN 2000-2020



Source: OKC Plan 2000-2020

VITA

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