12-2017

Spatial Analysis of Ethnic and Racial Segregation in the Chicago Metropolitan Area, 2000 - 2014

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By

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A THESIS

Presented to the Faculty of

The Graduate College at the University of Nebraska

In Partial Fulfillment of Requirements

For the Degree of Master of Arts

Major: Geography

Under the Supervision of Professor John Clark Archer

Lincoln, Nebraska

December 2017

Spatial Analysis of Ethnic and Racial Segregation in the Chicago Metropolitan Area, 2000 - 2014

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University of Nebraska, 2017

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Racial segregation has long been a great concern in the United States. Scholars study and measure racial segregation over different time periods to trace the changing patterns of racial segregation. Chicago, as the nation's third largest city, also ranked on top of the most segregated cities. Previous studies measured racial segregation in Chicago only numerically; few studies have used geospatial statistic methods to identify racial segregation patterns in the Chicago metropolitan area. This study uses "Hotspot Analysis"

(Getis Ord Gi*) to identify Chicago's most recent segregation patterns among four major ethnic and racial groups: White, African American, Hispanic and Asian. In addition, racial cluster patterns at census tract level are also measured to assess the spatial change of segregation among each studied racial group within the Chicago metropolitan area from 2000 to 2014. The results reveal that Chicago since 2000 has become less segregated, but that the African American population remains highly segregated from other racial groups. Moreover, high clusters tend to concentrate near or within Cook County and the overall clustering trend has also intensified.

Key words: Racial Segregation, Cluster, Hotspot Analysis, Chicago

Acknowledgements

First and foremost, I would like to thank my advisor, Dr. J. Clark Archer, you are a brilliant and knowledgeable person who challenged me as a geographer and supported me as a student. Thank you for being patient with me through all the drafts and keeping me grounded. I would like to thank my committee members – Dr. David Wishart and Dr. Rodrigo Cantarero for their suggestions and support. I want to give a specially thank to Dr. Paul Hansen, thank you Paul for helping me and providing me so many great opportunities, I have learned so much during the past two years. I am also indebted to Dr. Yunwoo Nam, thank you for helping me on my work and study.

I would also like to acknowledge my co-worker Brian Ye as the second reader of this thesis, and I am gratefully indebted to your very valuable comments on this thesis. Thank you, Chen Chen, Jin, Jianlin Liu, Qihao Sun, you guys have made graduate school so much fun and meaningful to me.

Finally, I must express my very profound gratitude to my parents and to my family for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

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Chapter 1: Introduction

1.1 Overview

Racial and ethnic segregation patterns are gathering more attention from policy makers, planners, and scholars as the US becomes an increasingly multi-ethnic society (Frey & Myer, 2005). The changes of ethnic patterns within a metropolitan area could highly affect its local economic structure and the distribution of public resources. This thesis is a study of major ethnic groups in the Chicago metropolitan area and of changes in racial segregation patterns between 2000 and 2014. For the study, racial segregation was assessed among four major ethnic groups: non-Hispanic white populations, non-Hispanic black populations, non-Hispanic Asian populations, and Hispanic populations.

Compared to the previous study of patterns within the city of Chicago, few scholars have focused on ethnic and racial segregation in the larger suburban and exurban region around the inner core of the metropolitan area of Chicago. Segregation measures reported at the metropolitan area differ from those measures associated with central cities located within metropolitan areas (Frey & Myer, 2005). The geographical boundary of this study covers all areas influenced by the concept of "Chicago," which includes the city of Chicago plus all nearby suburban clusters linked to the central city. In this thesis, racial segregation is measured at the census tracts level for the Chicago metropolitan area from 2000 -- 2014. The data used in this thesis were collected for three-time slots, from the 2000 Census, the 2010 Census, and the 2014 American Community Survey (ACS).

Measuring racial segregation is not limited to numeric numbers of evenness, since utilizing Geographic Information Systems (GIS) can amplify the spatial dimension of analysis in order to identify the geographical scale where segregation exists most clearly. GIS and quantitative methods have merged together in spatial science, which has been labeled by Tim Cresswell as "geocomputation." Geocomputation is used in human geography to focus on geographical phenomenon and to support spatial related theories, which helps spatial scientists interpret the dynamic nature of human space relationships (Cresswell, 2013). This study uses the GIS method to measure and evaluate the racial segregation of each ethnic group spatially and to look for patterns and trends.

The segregation patterns of Chicago were studied only until 2010, therefore, the latest demographic analysis is expected to identify changes since the 2010 Census Bureau. Racial segregation today is a pattern formed by human activities. It is important to understand the geography of social ecology and make society aware of the change in segregation. This research overcomes the difficulties in measuring the geographic segregation pattern spatially. The traditional numeric methods of studying racial segregation were based upon formulas and numbers which provided results, but were not able to identify the geographical pattern. The core innovation of this study is utilizing the traditional method to measure the evenness between different racial groups, and using the geospatial method to present the clustering patterns of each racial group.

1.2 Brief Background

Chicago is a typical American city that probably has been studied the most by scholars of American geography. Unlike New York City or Los Angeles, Chicago's physical land lies flat. Besides Lake Michigan, urban growth can spread in all other directions (Hudson, 2003). According to the U.S. Census Bureau's population estimates, the Chicago metropolitan area's population in 2014 was 9,554,598, including 6,322,644 non-Hispanic Whites, 1,613,578 African Americans, 2,044,331 Hispanics and 583,089 Asians. The total population of the Chicago metropolitan area makes it the third largest metropolitan area in the United States (U.S. Census Bureau 2012). However, although the total population has slowly grown in the Chicago metropolitan area since 2000, the population growth ratio was still below the nation's average. Compared to New York City and Los Angeles, Chicago's ample physical space did not help with its population growth. More importantly, previous research indicated that Chicago remains one of the most segregated cities in the US. (Cutler 2006).

Racial segregation in Chicago has been a prominent research topic since the great sociologist Ernest W. Burgess proposed his famous "Concentric Zone Theory" of urban spatial structure in 1925 (Park, Burgess, McKenzie, and Janowitz 1925). The theory states the spatial relationship between the socio-economic status of households and the distance from the Central Business District (CBD), and therefore residential zones are being classified and separated by the income factor. As population movements became more frequent in Chicago, minorities started to migrate into Chicago and the size has expanded quickly. Prior to 1960, Chicago was a white dominated city with less colored

people. The ethnic patterns in the Chicago metropolitan area changed dramatically during the 1960s; the African American population grew rapidly during that time. As the demand of employment increased, the Hispanic population began to grow after 1970. Meanwhile, the white population began to decline, so that the numerical population gap between white and nonwhite groups continued to shrink. Chicago soon became a more diverse and also more segregated city than before (Hudson 2001).

1.3 Study Area

The data used in this study covers the period from 2000 to 2014, and involve two different geographical boundary configurations pertaining to the decennial censuses of 2000 and 2010. In order to diminish the importance of the Modifiable Areal Unit Problem (MAUP), this research uses the 2010 Chicago metropolitan boundary defined by the U.S. Census Bureau at census tract level for all maps and analyses (Figure 1.1). According to the U.S. Census Bureau, the Chicago-Joliet-Naperville IL-IN-WI MSA from the 2000 census was renamed to the Chicago-Naperville-Elgin IL-IN-WI MSA in 2010, and two new metropolitan divisions were introduced, including Chicago-Naperville-Arlington Heights, IL and Elgin, IL. The 2010 boundary included 14 counties from Illinois, Indiana and Wisconsin. LaPorte County, IN and Kankakee County, IL, which were within the 2000 Chicago metropolitan area, were excluded from this study. With these exclusions, all demarcations of the Chicago metropolitan area used in this thesis are based on the 2010 county level.

Besides the metropolitan area boundary change, there are changes applied to the census tracts between the two censuses. Due to the growth and decline of population, census tracts often split or merge from one decennial census to the next. In order to measure the segregation pattern for the same geographic boundary system, the 2000 census tracts were reallocated into the 2010 census tract boundary system. The 2000 Chicago-Joliet-Naperville metropolitan area includes 2215 census tracts within 16 counties, where as the 2010 Chicago-Naperville-Elgin metropolitan area contains only 2094 census tracts within 14 counties. There were a total of 699 census tracts changed due to splits, mergers, and boundary redrawing. To avoid the inaccuracy of using the data divisions from various times, merged census tracts were simply combined in the course of this research. For census tracts that were split or redrawn, populations were recalculated and redistributed based on the proportion of the land area changed. The 2014 Chicago metropolitan area boundary remains the same as the 2010 boundary at both census tract level and metropolitan area level (U.S Census Bureau 2012).

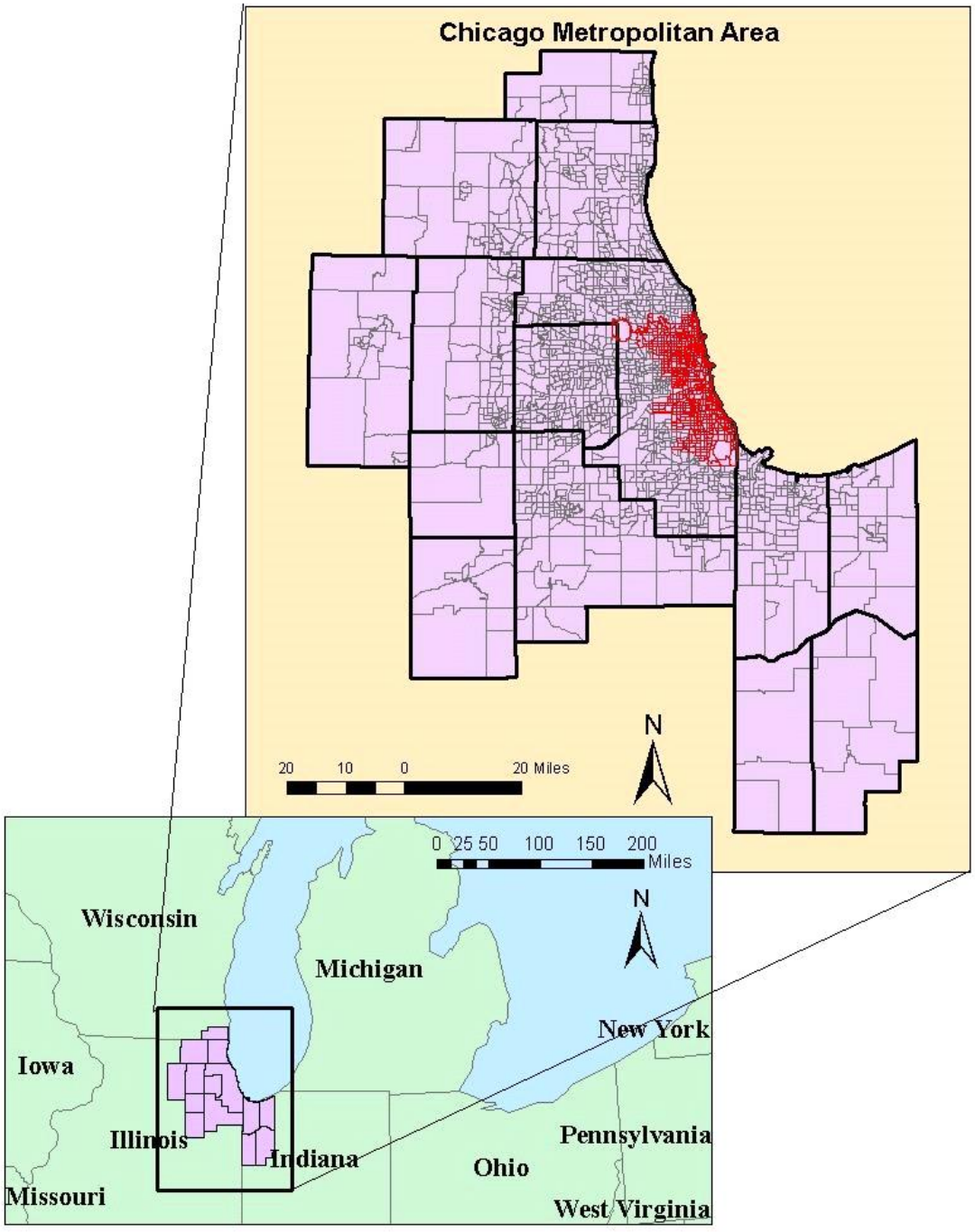

Figure 1.1 The location of Chicago city limits and its metropolitan area. Source - U.S. Census Bureau

1.4 Research Objectives

The principle objectives of this research are (1) to identify the current spatial pattern of racial segregation in the Chicago metropolitan area, (2) to measure how the segregation pattern changed over the study period 2000 - 2014, and (3) to assess the significance of the patterns and trends identified. Racial segregation is measured in two aspects of evenness and clustering. It is necessary to compare whether the numerical evenness corresponds to the spatial pattern of clustering. The value of evenness is calculated based on the index of dissimilarity for comparing the distributions difference of ethnic groups. The pattern of clustering is calculated based on the Getis-Ord Gi* spatial statistic and mapped with ArcGIS software. The result of clustering is called “hot spots” and the spatial patterns and trends will be identified and explored.

1.5 Thesis Organization

This thesis has been organized into five chapters. Chapter 1 overviews the issue of racial segregation within the study area, as well as the background information. A brief introduction of data and methods used were also included in this chapter. Chapter 1 summarizes the research objectives after this introductory discussion. Chapter 2 introduces the origins of racial segregation, as well as the causes and expansion of segregation. The measures of racial segregation are also examined in this chapter. Chapter 3 further discusses each ethnic group and utilizes different methods to measure the ethnic and racial segregation between them. Chapter 4 continues chapter three by discussing and analyzing the different patterns of segregations based upon the results of

evenness and clustering patterns. Finally, chapter 5 includes the conclusion of the research, and also explores the limitations encountered during the study, together with suggestions for further research.

Chapter 2: Review of Literature

2.1 Overview

This chapter centers on the theoretical basis of racial segregation including the origin, process, and trends, as well as the methods of measuring racial segregation. When scholars first began to discuss racial segregation patterns, maps were less commonly used than theories and numbers. Engaging calculation and mapping helps to understand how human movement may affect racial segregation patterns within a dynamic society.

Racial segregation tends to begin in urban areas with large numbers of migrants. As Chicago increased its population and aerial size, the distribution of population was controlled by multiple factors, and ethnicity and race have been major factors that influence people's locational choices. People of the same race are apt to be more concentrated than people of different race. When a racial group becomes extremely monotonic, they can be identified as a segregated group. Racial segregation has always been considered to contain pejorative meaning even though scholars have attempted to study racial segregation phenomena objectively and found that the level of segregation depends on numerous factors. Thus, causes of racial segregation differentiate the property of racial segregation where some factors are subjective, and some are passive. This chapter discusses the historical development of Chicago's racial pattern that caused various aspects of racial segregation.

2.2 Human Nature and Segregation

In humanistic geography, space and place are the basic concepts for the world. A place is an object that can be seen, where space is an abstract that contains meaning. Space and place include all activities in the world and have been used to represent aspects of nature, culture, and society, and both spatial patterns and places have been seen as outcomes of all processes (Cresswell 2013). In the growing society, the behavior of man to other human beings is called human nature. Human nature includes a series of reactions known as thoughts, feelings, actions, and attitudes. Human nature allows people to classify population based on similarities. It is also human nature that people with similarities tend to form social groups and make movements toward each other. Thus, classification is an instinctive reaction that comes from our human nature. Major classifications of social groups are race, culture, language, and wealth (Park & Burgess, 1971). Although classification did not necessarily cause segregation, as Chicago increased in population, the distribution of population tended to be controlled by factors such as race, culture, and economy.

The Burgess Concentric Zone Model (1925) was one of the earliest and most powerful theories of urban social structures. Burgess modeled Chicago in a set of concentric circles, presenting the urban expansion of Chicago from downtown to its suburbs. The Concentric Zone Model was applied to Chicago in the 1920s to summarize the spatial distributions of social groups, and was perhaps the first model that explained the significance of social orderings. Burgess used different zones to identify each social group locale based on the order from the inner core to the outer limits of Chicago, which

are: the loop, also described as the Central Business District (CBD), the factory zone, the transition zone, the working-class zone, the residential zone and the commuter zone (Figure 2.1). As Chicago continued its development and expansion, the demand for residential lands become high and the land price also increased. The Concentric Zone Model illustrates the correlation between the wealth of residential area and the distance from the CBD, which was derived from the underlying forces of residential differentiation in Chicago. Moreover, economic competition and ecological approach separates human beings into different social groups. It is human nature that human beings have the ability to classify and respond to the structure of social organizations. The human feature of responses involves thoughts, feelings, actions, and attitudes which make each individual different from each other, therefore each person's human traits and habits are obviously different (Park & Burgess 1971). When people make selections towards their residential areas, the decisions are based on preferences of social class, economic issues, and races, and those preferences create the segregation patterns within Chicago (Sandoval 2011).

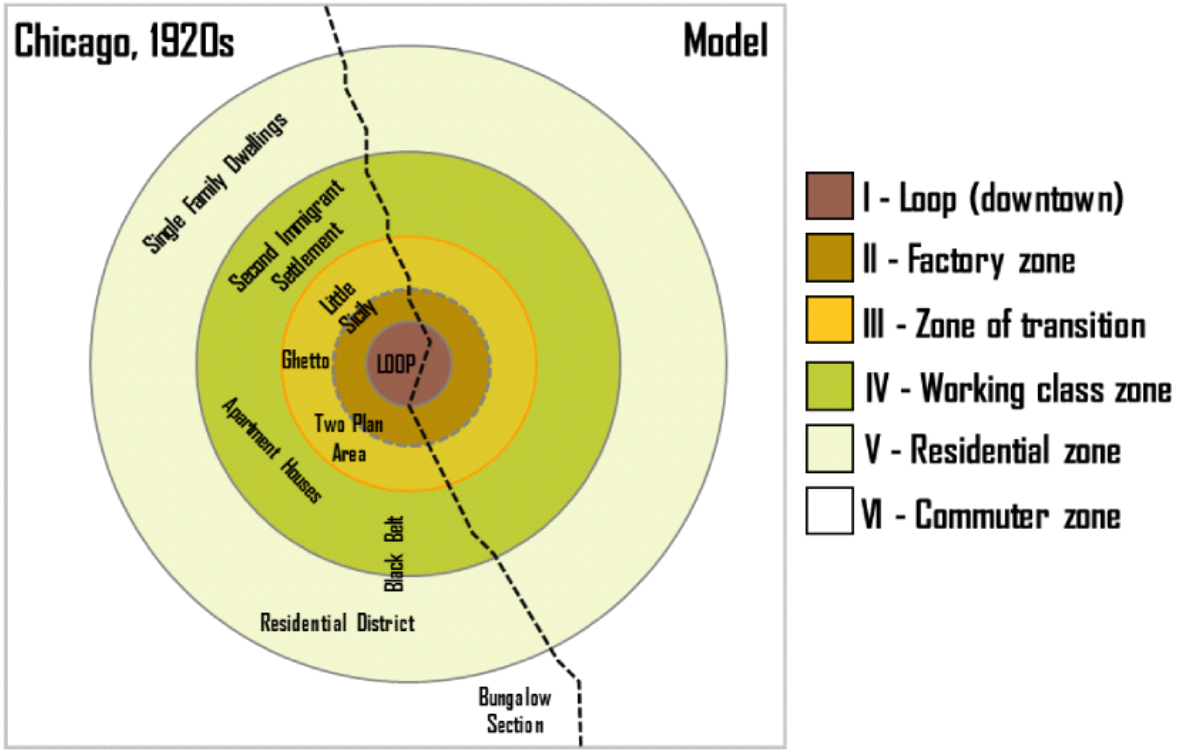

Figure 2.1 Burgess's Concentric Zone Model of urban spatial structure (Source: Rodrigue 2017)

2.3 Causes of Segregation

It is apparent that racial segregation has a significant impact on Chicago's social structure and the lives of people. Factors that cause racial segregation vary, but the most sensitive and serious factor that is often studied by social scientists is discrimination. Although racial segregation and discrimination are fundamentally different, the fact remains that minority groups are being geographically separated in space with a resulting limitation of communication between each group. In the study of social relations of races, prejudice is a more detailed description for discrimination. It demonstrates the phenomenon of rejecting out groups (Blalock 1970). Prejudice is usually held by the

majority group and focuses on minorities. The phenomenon of prejudice is caused by multiple dimensions of factors, such as anxiety, frustration, authoritarianism, rigidity, alienation, status concern, conservatism, and conventionalism. Besides the psychological factors, social background factors such as education, occupation, religion, social mobility, and regions can also produce prejudice (Blalock 1970).

Prejudice can result in racial segregation by the dominant white society, and minorities at this level can easily be considered threatening. Hubert Blalock's racial threat theory explains that the degree of discrimination relates to the relative size of minority groups. As minority groups increase their sizes or visibility, the majority perceives an increasing threat to their security. The threats also extend to social resources; the majority population encourages racialized policies to protect their existing power and privileges, which is reflected as prejudice. The prejudiced majority often create feelings and preferences for their condition, and often develop stereotypes about minorities (Blalock 1982).

One of the factors that can affect people's preferences is racial turmoil. David H. Kaplan and Frederick Douzet (Kaplan & Douzet 2011) identified two patterns of racial segregation that may increase racial turmoil. One is that demographic change may cause clustering patterns together with spatial mismatch, which links to racial segregation. That may drive collective ethnic violence. The other is that rapid demographic change often combines with ethnic contact to catalyze collective ethnic violence.

Besides discrimination, economic resource differentiation is another factor that can cause racial segregation. As mentioned above from Burgess's Concentric Zone

Model, the growth of Chicago formed different residential zones and resulted in differentiated residential price bidding. Higher income families, which are predominantly white, end up living in wealthier neighborhoods. This leads to most minorities being racially separated simply because they cannot afford to live in the same more expensive neighborhoods as whites (Kaplan and Woodhouse 2004).

Another force of racial segregation, which has a different implication, is minority preference. Minority populations often voluntarily self-separate from the majority group and refer to maintain their own minority zones. Toblers's first law of geography states that "Everything is related to everything else, but near things are more related than distant things," and he explains that people with the same level of income, social status, and race are more likely to be ecologically and culturally in common (Klippel, Hardisty and Li 2011). Therefore, minority populations with similar cultural backgrounds prefer to stay within their own group, which causes reinforced racial segregation (Allen and Turner 2005).

Although most studies about racial segregation are negative in tone, the factor of minority preference allows scholars to discuss the segregation issue from a distinct perspective. Ceri Peach (Peach 1996) criticizes the misunderstanding of the word segregation by people. Peach endeavors to view racial segregation from both positive and negative perspectives. Segregation is another way to identify the concentration of an ethnic group. That concentration allows the group to maintain its social cohesion. It maintains cultural values, it strengthens social networks, and it allows the passing of critical thresholds for the support of institutions and shops (Peach 1996).

That is, it is necessary to maintain a diverse society, and racial segregation has simply been stereotyped as a pejorative word. Racial segregation begins in urban areas due to social adjustment reasons, and it is not incident as the society continues to expand. Racial segregation itself is caused by numerous factors and formats both positive and negative results. The key issue is whether the level of racial segregation falls into an appropriate range. Racial segregation in Chicago allows the city to have its own diverse culture, but on the other hand, as Chicago expanded during the past decades, the racial segregation level has developed into a serious pattern.

2.4 Racial Segregation in Chicago

The racial structure in the Chicago metropolitan area today was framed during the 1980s when African Americans, Hispanics, and Asians became the three largest minority groups in Chicago (Hudson 2006). As of 2015, the U.S Census Bureau shows that these three minority groups make up approximately 44.5% of Chicago's total population (U.S Census Bureau ACS 2015).

John Hudson's (2006) *Chicago: A Geography of the City and its Region* provides an overview of Chicago, including the history and the growth of the city. Hudson specifies the change in Chicago's population and its ethnic patterns over the past century. The city growth of Chicago ended around 1950, and then the suburbs of the city quickly began to grow and framed the expansion of the metropolitan area. A growing city like Chicago was framed by people with different cultural and social backgrounds. Segregation often relates to social resources such as employment, schools, transportation,

police protection, recreation, merchandising, amenities, and other services. Moreover, a rapid growth of one race without proportionate dispersal can intensify the clustering pattern and increase racial segregation (Allen and Turner 2012; Logan, Stults, and Farley 2004). This is more likely to occur if large numbers of immigrants settle in the same neighborhoods as their relatives and friends.

One of the most recent studies that identifies Chicago's racial segregation pattern is from Onesimo Sandoval's (2011) article "Neighborhood Diversity and Segregation in the Chicago Metropolitan Region, 1980-2000." Sandoval used a real case to emphasize the neighborhood racial diversity and segregation pattern of the Chicago region from 1980 to 2000. By using the Theil entropy score, he assessed the increase of racial diversity and the new spatial patterns of segregation within the Chicago metropolitan area. The method was also used to identify which neighborhood factors were strongly associated with neighborhood racial diversity. Moreover, the study could measure the segregation for the region, central city, and suburbs. Sandoval argues that the word segregation can better represent the residential settlement and analyzed the two factors that cause segregation: discrimination and social economy. Meanwhile, scholars William A.V. Clark (1986) and George Galster's (1988) viewpoints were introduced. Clark's concluded that economic constraints, social preferences, and environment have more proportionate influence on segregation rather than discrimination (Clark 1986). However, Galster argues that discrimination is the driving factor that causes restricted residential mobility choices (Galster 1988). Based on the two views, Sandoval gives a more specific development of neighborhood diversity and segregation. He believes that immigration

causes the increase of diversity, and introduces the spatial assimilation model to explain the residential change. The model supports a contention that humans tend to move to neighborhoods with less crime and better social resources as they become more assimilated to the majority culture and human and social capital. Sandoval uses the spatial assimilation model to assert that the racial segregation is based more on the social class level rather than discrimination.

Another argument Sandoval brings out in his research is that suburban segregation tends to decrease in suburban areas compared to the central city. There are better environments in suburban areas and new housing developments in these areas do not have a racial discrimination history, so racial segregation remains low, which supports the spatial assimilation model.

The data and methodology Sandoval used in his research was based on the US census tracts between 1980 and 2000. The geographical data came from the Neighborhood Change Database by *Geolytics* , so that all census boundaries were normalized to the 2000 census tract boundaries. Sandoval used five racial groups: non-Latino white, non-Latino black, non-Latino Asian, non-Latino other, and Latin with the entropy score as the measurement. The result of the score range between 0 and 1 where 0 represents a homogeneous tract and 1 represents a heterogeneous tract.

The results from Sandoval's study were based on 1817 census tracts in the Chicago area. The result for each racial group shows disparities: the average diversity score shows an increase, which means that the Chicago area has experienced a more heterogeneous period. Also, the segregation score declined through the city and the

region. Sandoval's research points out that the majority of segregation in the central city can no longer be explained only by white and nonwhite separation, but rather separation involving each of the ethnic groups. In other words, each ethnic group tended to get more clustered than before.

Sandoval's study assesses and measures the diversity pattern and segregation trend of Chicago metropolitan area from 1980 to 2000. It includes strong data support and analysis for the future study of Chicago's ethnic trends.

2.5 Demographics in Chicago

2.5.1 White Population

Between 1880 and 1930, Chicago's population grew by an average of 500,000 per decade within the city limit. Chicago in 1910 was still an immigrant city, and most immigrants were white. At that time, more than 75% of its population were either immigrants or had at least one foreign born parent. The European immigrants between the late 19th century and early 20th century contributed most of the white population for the entire Chicago metropolitan area. When the European immigrants first came to Chicago, they tended to grow their own ethnic groups and ghettos were formed, but those ghettos were quickly dispersed as those European immigrants quickly moved away from the inner city. Germans and Irish came first to Chicago and spread throughout the whole city and continued to expand towards the suburbs. Italians and Russians arrived later but also dispersed into various parts of the metropolitan area. Polish immigrants, just like other white immigrants, got clustered when they first arrived in Chicago during 1860s,

but soon spread toward different directions. However, the continued migration from Poland lasted for over a century and the Polish immigrants ended up developing a strong residential clustering pattern in Chicago (Hudson, 2006).

Year	White Population
1880	916513
1890	1512449
1900	2266311
1910	2895909
1920	3484699
1930	4601608
1940	4744209
1950	5155577
1960	6007805
1970	6461712
1980	5667087
1990	5487771
2000	5382738
2010	5204496

Table 1. White population in the study area from 1880-2010. Source: U.S Census Bureau

Although the white population is still the majority group in Chicago, it is no longer dominating the city. The percentage of the white population dropped since 1950 even though the total population of whites remained as the majority group. Until the 2010 census, the white population made up close to 60% of the total population, and minority groups of African – Americans, Hispanics and Asians together made up over 40% of the total population. To track the white population change, Table 1 shows the total white population within the 14 counties of the Chicago metropolitan area from 1880 to 2010. It is easy to tell that the white population since 1880 demonstrated a continued growth trend until the population reached its peak value of 6,461,712 in1970. However, as the table

shows above, the white population continually decreased after 1970 until 2010. The population decrease did not affect the white population majority in Chicago, whereas the recent 2014 data shows a slight increase of the white population, which reflects that the population decrease was temporary.

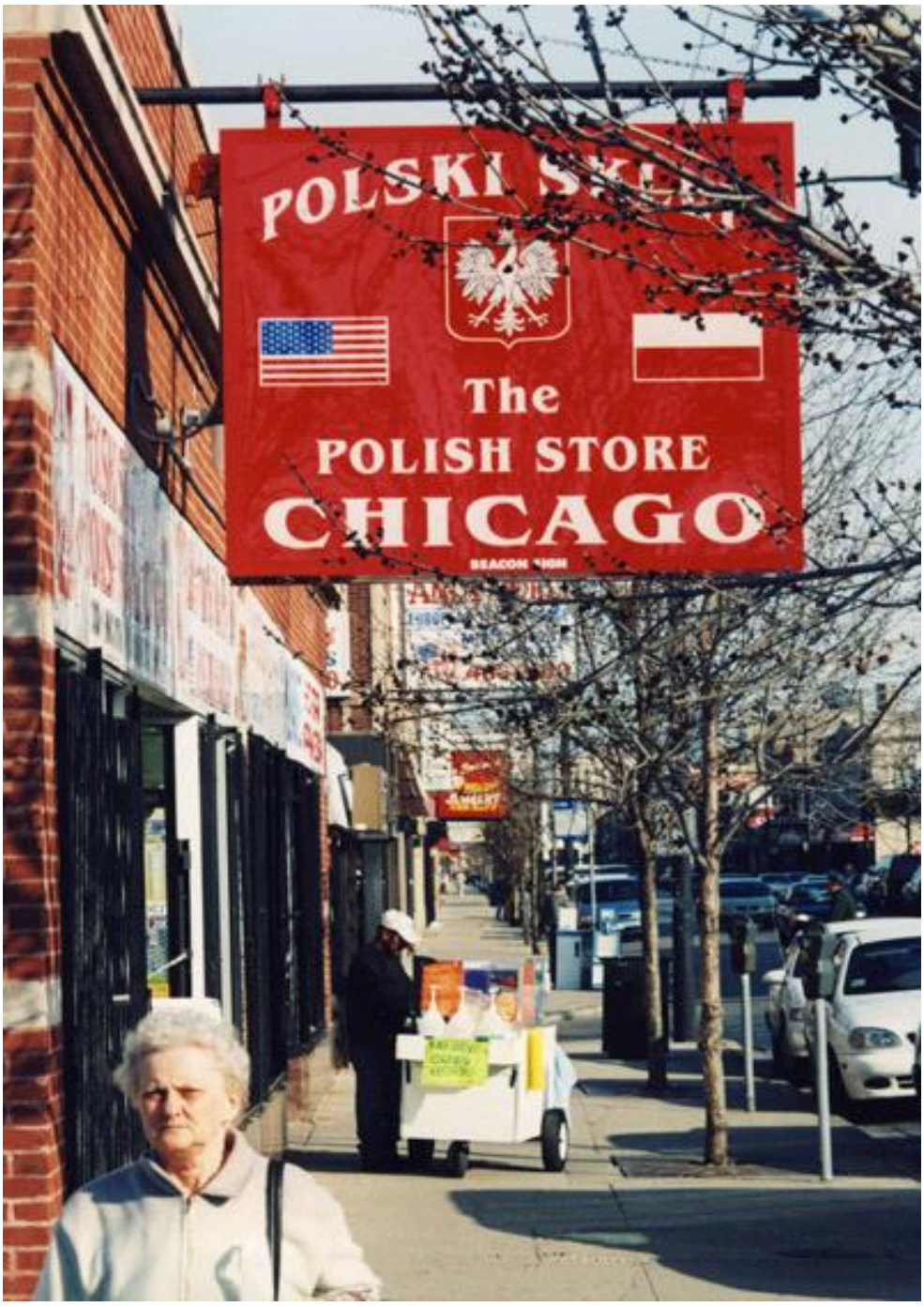

Figure 2.2 Polish Village's commercial strip along Milwaukee Avenue, Chicago. Source: Pogorzelski, Daniel, 2004

2.52 African American Population

Although the African American population only made up approximately 7.4% of the total population in the Chicago metropolitan area by 1930, the number increased rapidly after World War II, and the growth extended until the1980s. Historically, the sharp growth of the African American population between 1940 and 1980 was known as The Second Great Migration. There were roughly five million African Americans who moved from the south to the north and west, and Chicago was one of the top destinations for African American migrants (Gregory 2009). The Second Great Migration dramatically transformed Chicago's racial settlement pattern. In 1940, African Americans resided in dispersed census tracts in the South Side. During the migration, ghettos were formed and expanded from those census tracts, so segregation between whites and African Americans became more serious (Gregory 2009).

As table 2 presents, the African American population expanded roughly five times between 1940 and 1980. The population growth paused in 1990, and then raised slowly in 2000 to 1,666,929. However, the 2010 census showed the African American population declined again, with more black people moving out of Chicago.

Year	African American Population
1930	274,102
1940	330,420
1950	629,541
1960	978,591
1970	1,345,965
1980	1,546,561
1990	1,529,793
2000	1,666,929
2010	1,613,652

Table 2. African American population in the study area from 1930 - 2010

During the 1950s, African Americans made up about 15% of the total population, and the black migration continued to grow west of downtown and the south coast. Based on the growth of African Americans in Chicago, the city quickly became diverse. John Hudson describes the details of when African Americans rapidly increased their population in his book, *Chicago: A Geography of the City and its Region*:

> *"By 1950, African -Americans were overwhelmingly the most important population subgroup from the edge of the downtown area south to 71st St. The concentration was heaviest in the mile-wide zone between State Street and Cottage Grove Avenue. Thirty census tracts in this elongated zone had more than 5,000 black residents each, and the total African-American population of the thirty tracts was 207,000. Fewer than 3,000 whites lived in the same area*." (Hudson 128)

The 1960s was the decade of the greatest growth of Chicago's African American population, and the clustering of the black population with the decrease of the white population began to form the racial segregation pattern of Chicago. As of 2000, there were more than one million African Americans living within the city of Chicago, and that number accounted for 40% of Chicago's total population. However, African Americans only make up one-fifth of the Chicago metropolitan area population. The significance of the clustering pattern for African Americans keeps African Americans segregated from

other ethnic groups and the central city remains concentrated (Hudson 2001). The largest concentration of African Americans remains on the south side of Chicago, where it extends from the transportation arteries to the city limits and to the southern suburbs. Also, some other concentrations are also located west of the city center. Hudson also identifies other small black neighborhoods in Evanston, Joliet, and Waukegan. Gary, Indiana, which is now the largest suburban black community in the United States, contains more than four-fifths of the total local population. Similar patterns also apply to Maywood, located on the west side of the city and containing more than 80% of African Americans (Hudson 2001)

Allen and Turner studied black and white segregation by measuring the proportion of the black population. Higher segregation relates to a greater proportion of blacks in urban centers. High percentages of the black population cause the high clustering. Allen and Turner mention this segregation outcome as due to perceived racial threat, and this hypothesis supports a high minority percentage with low socioeconomic status. However, counties with higher percentages of foreign born blacks tend to have a lower segregation pattern. (Allen and Turner 2012)

Residential segregation patterns for African American population are slow to change, but they are changing in comparison to the 1960s. Black neighborhoods on both the west side and the south side of Chicago are experiencing a population decrease, even compared with whites, Hispanics, or Asians. The African American group is the only group that is experiencing a net population loss.

2.5.3 Hispanic Population

Besides the African American population, the Hispanic population today is also another large minority group not only in Chicago, but in the entire country. Hudson (2006) mentions the growth of the Hispanic population in Chicago in chapter 14 of his book Chicago: *The A Geography of the City and Its Region*, and he identified that the rapid growth of the Hispanic population began in the 1970s. Hispanic people first moved to north and south Chicago because of the new residential areas built throughout the period. Further expansion of the Hispanic population occurred during the 1980s and 1990s towards the suburban areas with new housings. The Mexican population made up more than 70% of the Hispanic population. Hudson explains the Mexican settlement pattern according to the demand of employment:

> *"The growth of Mexican populations in the suburbs is a product of many trends, including the broadening variety of occupations in which Mexican immigrants are employed. Mexicans are one of the few foreign-born groups that live in rural areas. Where many are employed in agricultural occupations. They are well represented in the construction, transportation, and manufacturing industries of the suburbs and fill many jobs in the service and retail-trade sectors as well.* (Hudson 180)"

The term "Hispanic" was first used officially in the 1970 census (Humes, Jones, & Ramirez 2011). The U.S. Census Bureau indicated in 1970 that the term "Hispanic" refers to a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race (Humes, Jones, and Ramirez 2011).

At the end of the Second Great Migration, there were only 368,593 Hispanics residing within the metropolitan area. The Hispanic population made up about 21% of the total population, making Hispanics the second largest ethnic group after the white population in the Chicago metropolitan area.

Year	Hispanic Population
1970	368593
1980	634236
1990	896245
2000	1500278
2010	1957088

Table 3 Hispanic Population in Chicago metropolitan area

The segregation pattern for the Hispanic population shows an opposite phenomenon in comparison with African Americans. Hispanics are more likely to be segregated in the less populous counties, and this pattern is especially significant to the white population. Small groups of Hispanics and lower percentages of Hispanics cause higher segregation rates. Inversely, segregation is less when lower percentages of Hispanics live in poverty and higher percentages are high school graduates, homeowners, or work as managers or professionals. Counties with less foreign born and recent immigrants are also less segregated.

The Hispanic segregation pattern is strongly linked to small groups with low income. For both African Americans and Hispanics, segregation is related to their socioeconomic status (Allen and Turner 2012).

2.5.4 Asian Population

Asian population as new immigrants are unlike other three ethnic groups. White population and African American population have been settled in Chicago for a long period of time and self-identified as American. Hispanic population is mostly made up by Mexican population. In compare to other ethnic groups, the history of Asian population is

fairly short, and majority of Asians were not born in the United States so that many of Asians still self-identify themselves as non-American (Hudson 2006).

As European nationalities declined from 95% in the 1950s to 59% in 2000, the Asian population increased. The rapid growth of Mexican migrants and continued growth of Asian immigrants, along with the lack of replacement of European migrants, caused the great decline of the white population. Different from the rapid increasing of the Hispanic population, the increase of the Asian population is steadier and more recent (Hudson 2003). Table 4 shows the Asian population growth trend since 1950. As of 2010, the size of the Asian population in Chicago is roughly ten times larger than in 1950. On one hand, Asian immigrants maintained high growth because of their relatively small population size in comparison with other racial groups. On the other hand, Asian immigrants had to travel much longer distances to arrive in Chicago from Asian countries. Hence, as Asian immigrants currently exceed 5% of Chicago's total population, their growth rate will continue to decline with steady increase of the total Chicago population.

Year	Asian Population
1950	4,575
1960	23,050
1970	69,448
1980	145,404
1990	248,726
2000	385,926
2010	526,866

Table 4. Asian Population in the Chicago metropolitan area

It is surprising that Asian immigration has grown just as fast as Hispanic immigration during the recent decades. Different from the majority Hispanic population made up mainly of Mexican immigrants, Asian immigration is distributed evenly among

several distinctive cultures. For example, the Philippines, India, China, Vietnam, and South Korea each account for between 3 and 4.5% of foreign-born Americans (Bodvarsson and Van den Berg 2009). Beginning in 2000, the Asian population increased nearly 35% and quickly became the third largest minority group in Chicago (American Community Survey 2015). Many of the Asian immigrants are Chinese. Chinatown, in the near south side of Chicago Loop, is their largest concentration area. Like the Hispanic population, the Asian population in the 1950s was only about 4,575, and has grown since the 1960s. Korean, Filipino and Indian populations started to settle near the north side of the city and continued to expand towards the north and western suburbs (Hudson 2006).

Unlike the Hispanic population and the African American population, Asian groups tend to be concentrated in suburban areas north and west of the city with most of white-collar social class (Hudson 2006). More importantly, Asians tend to be dispersed rather than clustered. Obviously, racial segregation based on the discrimination factor weighs less important for the Asian group.

Figure 2.3 The Pui Tak Center in Chinatown, built in the Chinese style during the 1920s. Source: Chicago Chinatown Chamber of Commerce

Chapter 3: Methods and Data Analysis

3.1 Overview

This chapter explains the data collection process of the study and introduces methods used to measure segregation to achieve the objectives mentioned in chapter 1. Data used in this research were derived from the U.S. Census of Population for 2000 and 2010, and from the U.S. Census Bureau American Community Survey (ACS) for 2010-2014. The census data for this research were collected and modified by the author. All the calculations and the organization of the initial census data were completed in Microsoft Excel and then imported into ArcGIS 10.4.1 from the Environmental Systems Research Institute (ESRI). All shapefiles were downloaded from the U.S. Census Topographically Integrated Geographic Encoding and Referencing (TIGER). In this chapter, I present the spatial distribution of each ethnic group together with their background information to provide an overall framework for investigation and analysis. Moreover, I use a dissimilarity index and hot spot analysis to measure the segregation of each group studied. The dissimilarity index measures the evenness between two ethnic groups within the Chicago metropolitan area, and the hot spot analysis identifies the clustering pattern for each ethnic group to identify patterns of clustering by neighborhoods.

3.2 Research Area and Data Development

As mentioned in Chapter 1, the research focuses on the 2010 Chicago-Naperville-Elgin metropolitan area that crosses three states and covers 14 counties, including 2,210 census tracts. The city of Chicago is also included and compared to the entire metropolitan area for discussion.

All data obtained for this research came from the U.S. Census Bureau for the 2000 and 2010 Censuses of Population, and from the 2014 American Community Survey (ACS). The demographic data collected include population, race, and ethnicity at census tract level. The format of all demographic data was downloaded as Microsoft Excel Comma Separated Values Files (.csv). The TIGER polygon shapefile containing all census tracts from the 2010 Census for the Chicago metropolitan area was also obtained from the U.S. Bureau of the Census website. Excel files were first modified and interpolated and then imported into the shapefile using ArcMap. The excel table imported into ArcMap was exported into dBase format for editing and displaying. Census tracts were then table-joined into the shapefile for data display and field calculation.

3.3 Ethnic Distribution

3.3.1 White population

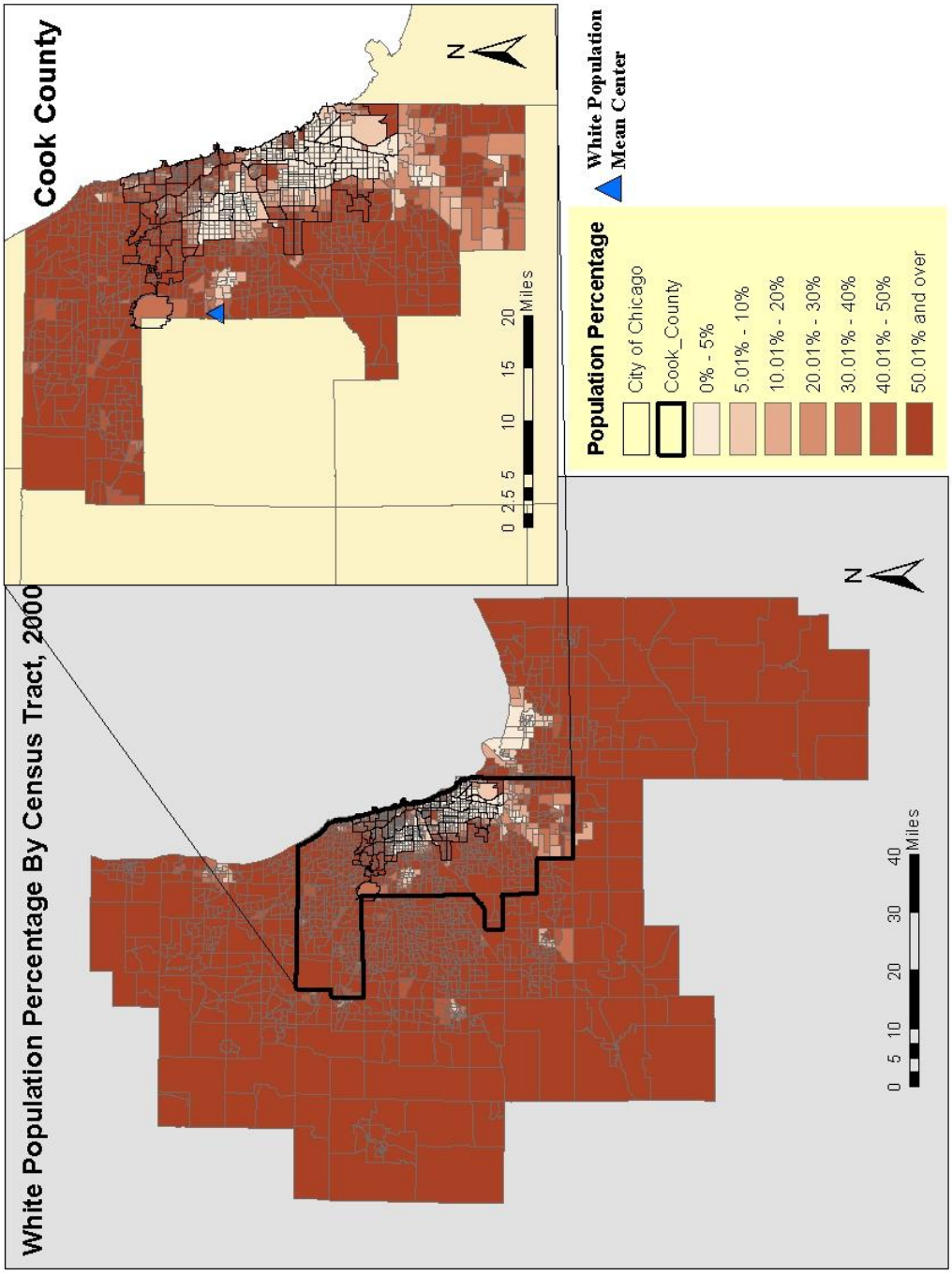

Figure 3.1 Chicago white population by percentage, 2000. Source: Census, 2000

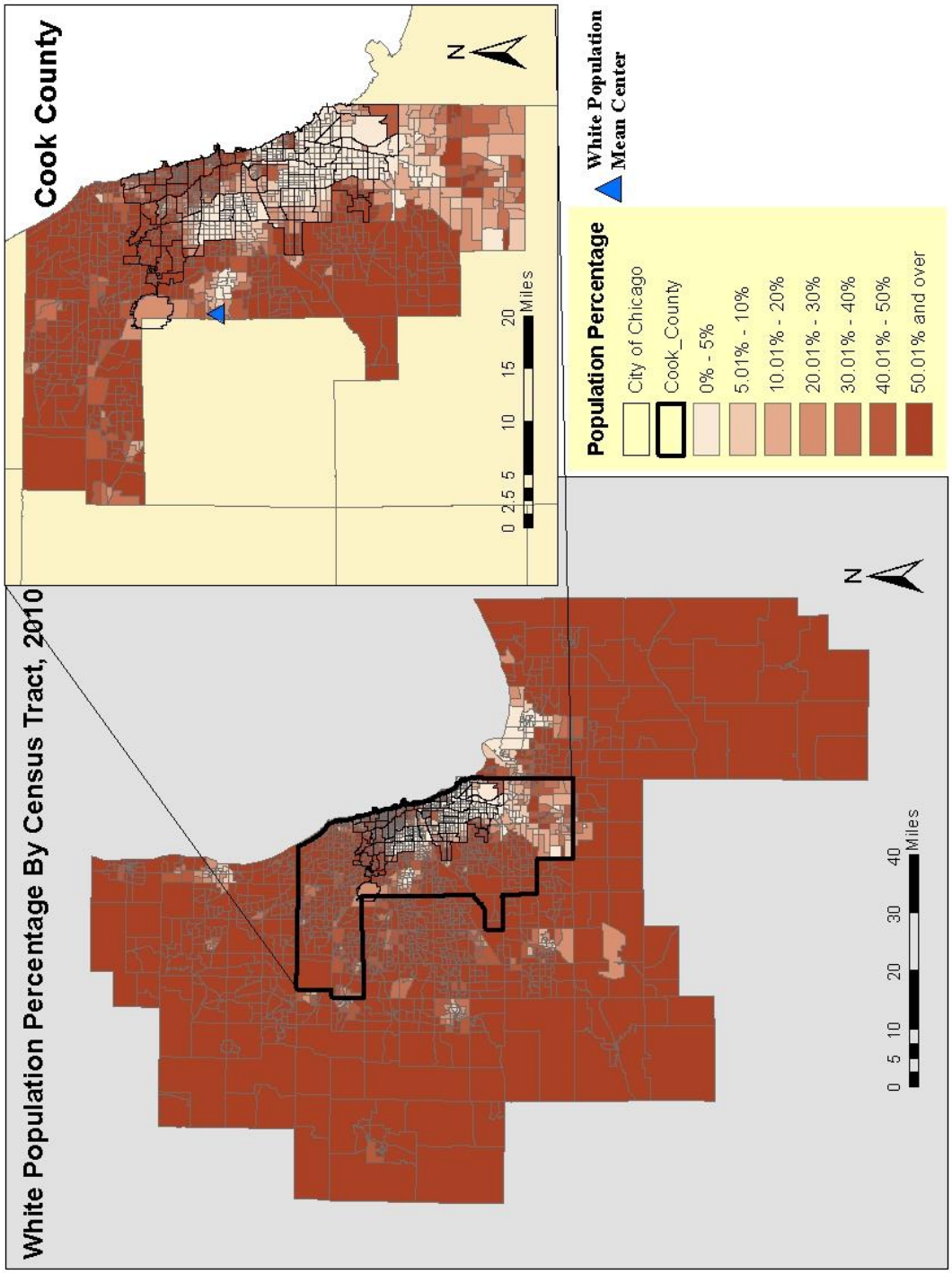

Figure 3.2 Chicago white population by percentage, 2010. Source: Census, 2010.

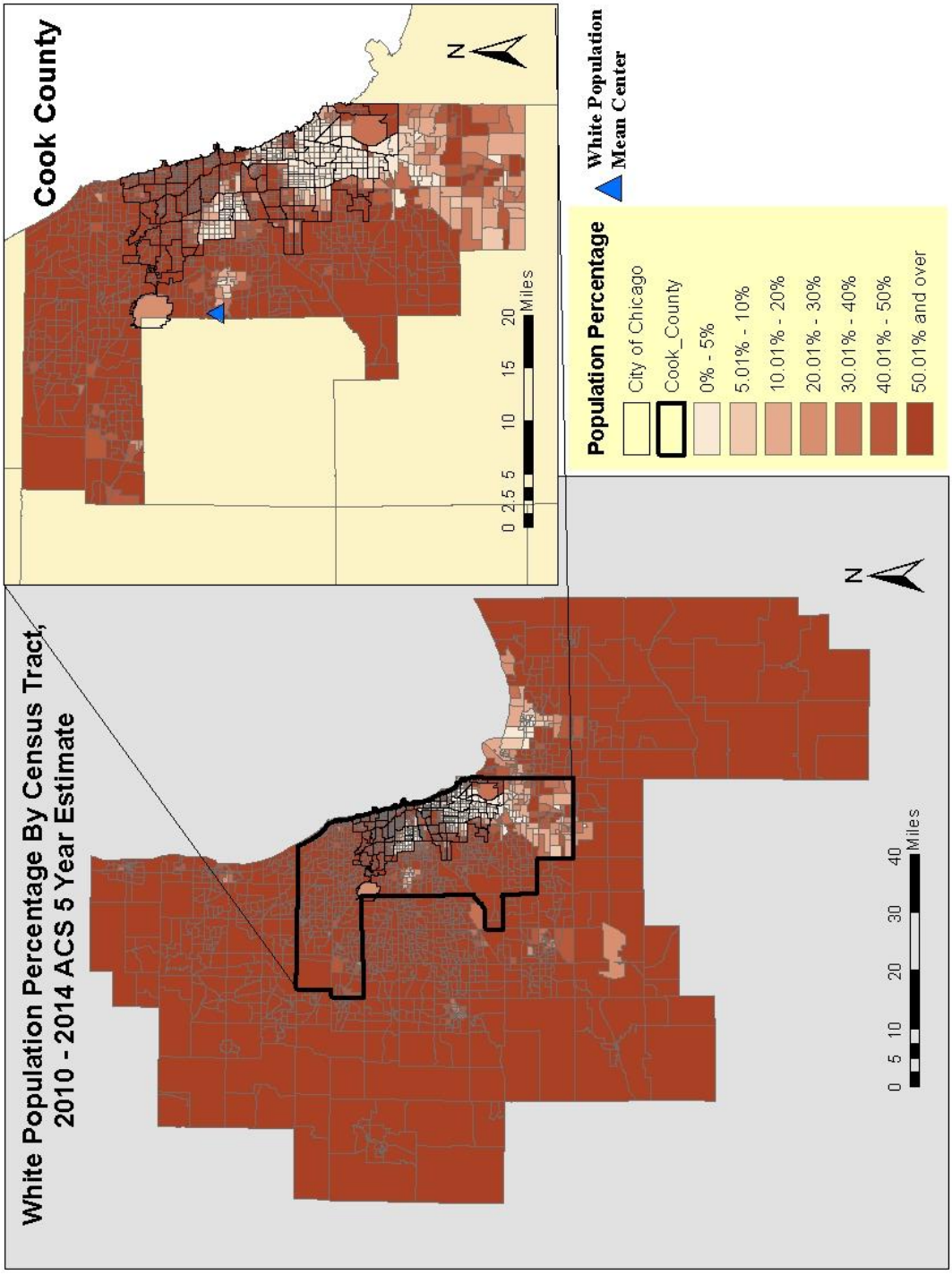

Figure 3.3 Chicago white population by percentage, 2010-2014 five-year estimate

3.3.2 African American Population

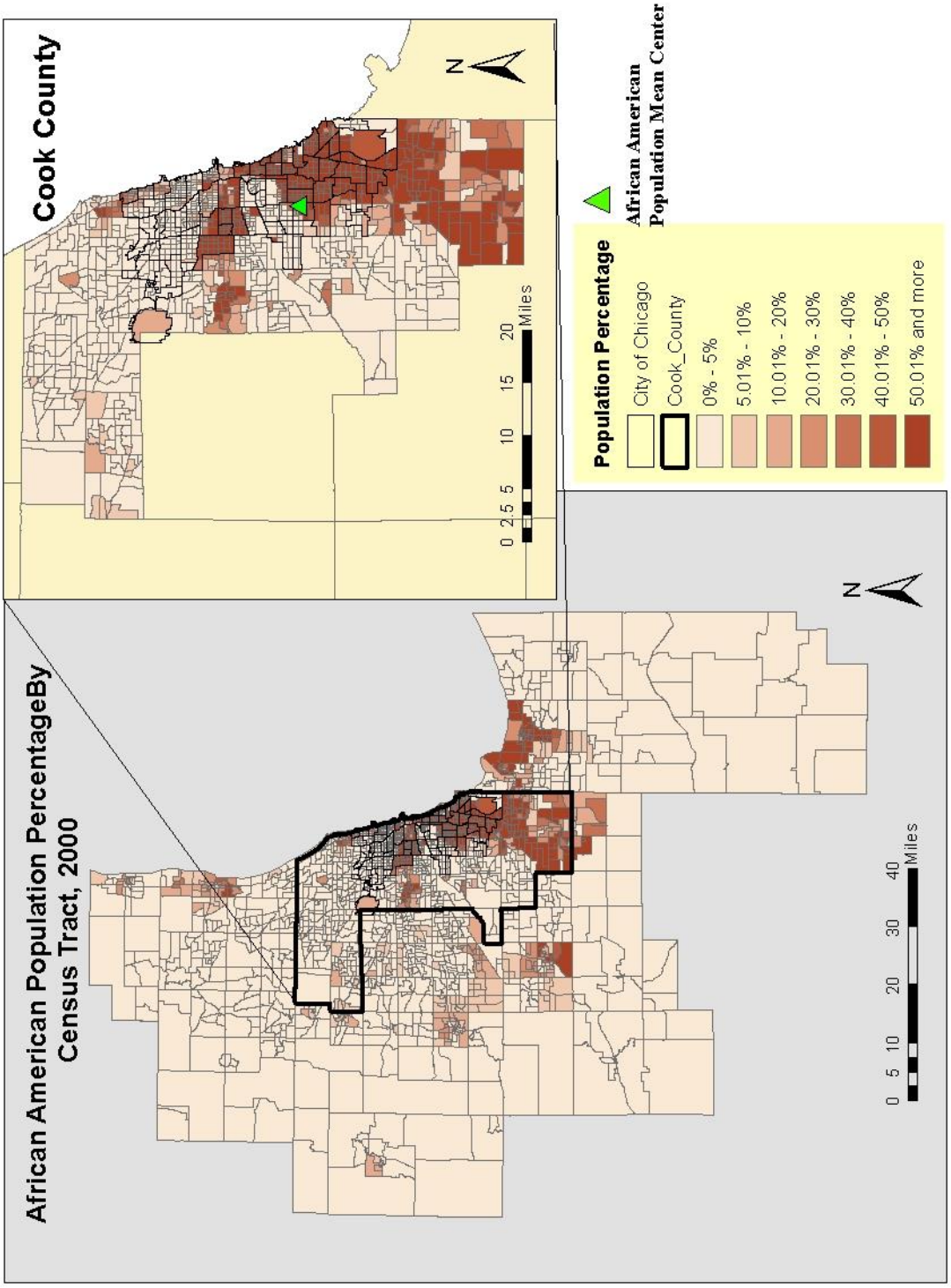

Figure 3.4 African American population by percentage. Source: Census, 2000

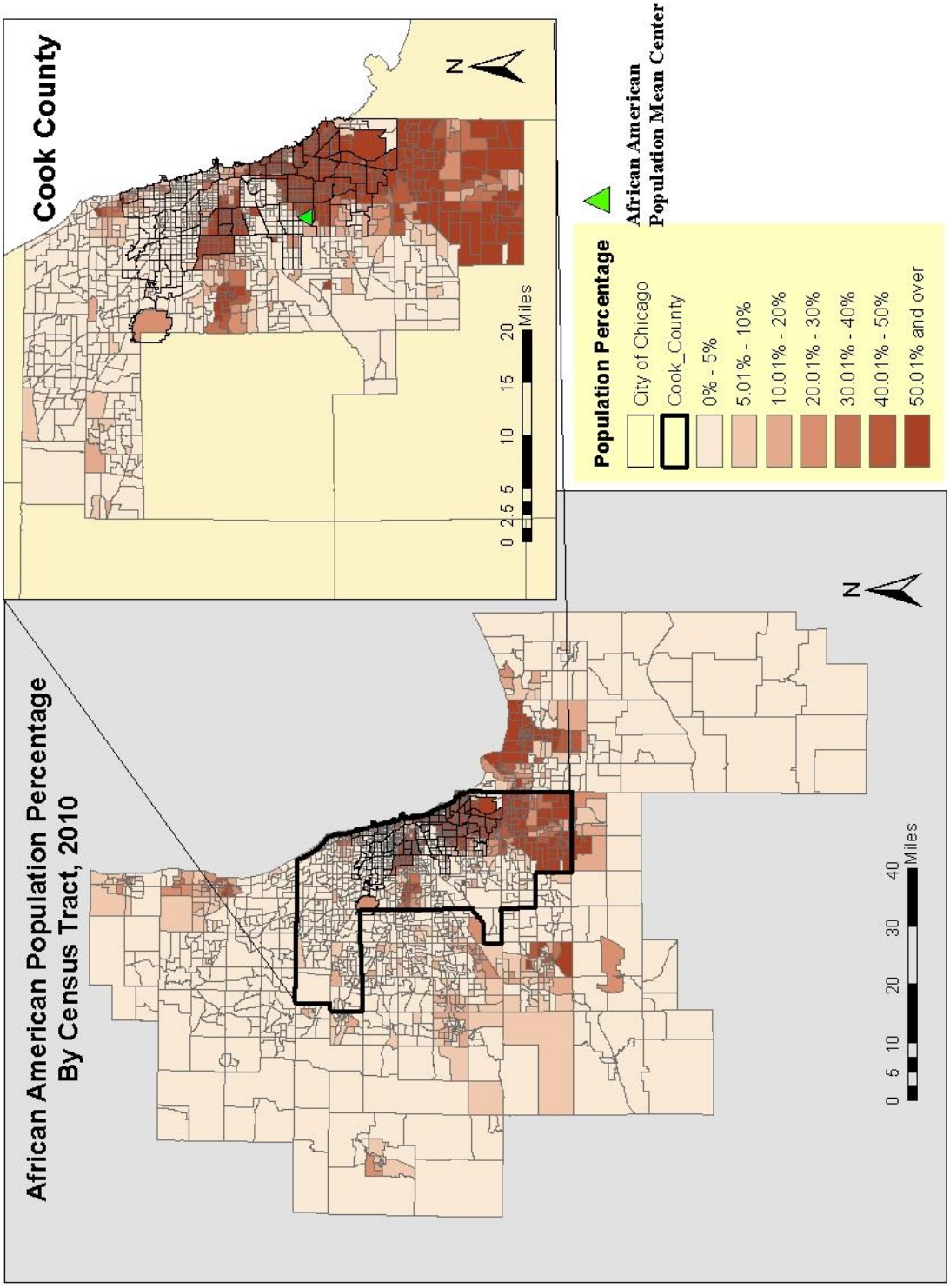

Figure 3.5 African American population by percentage. Source: Census, 2010

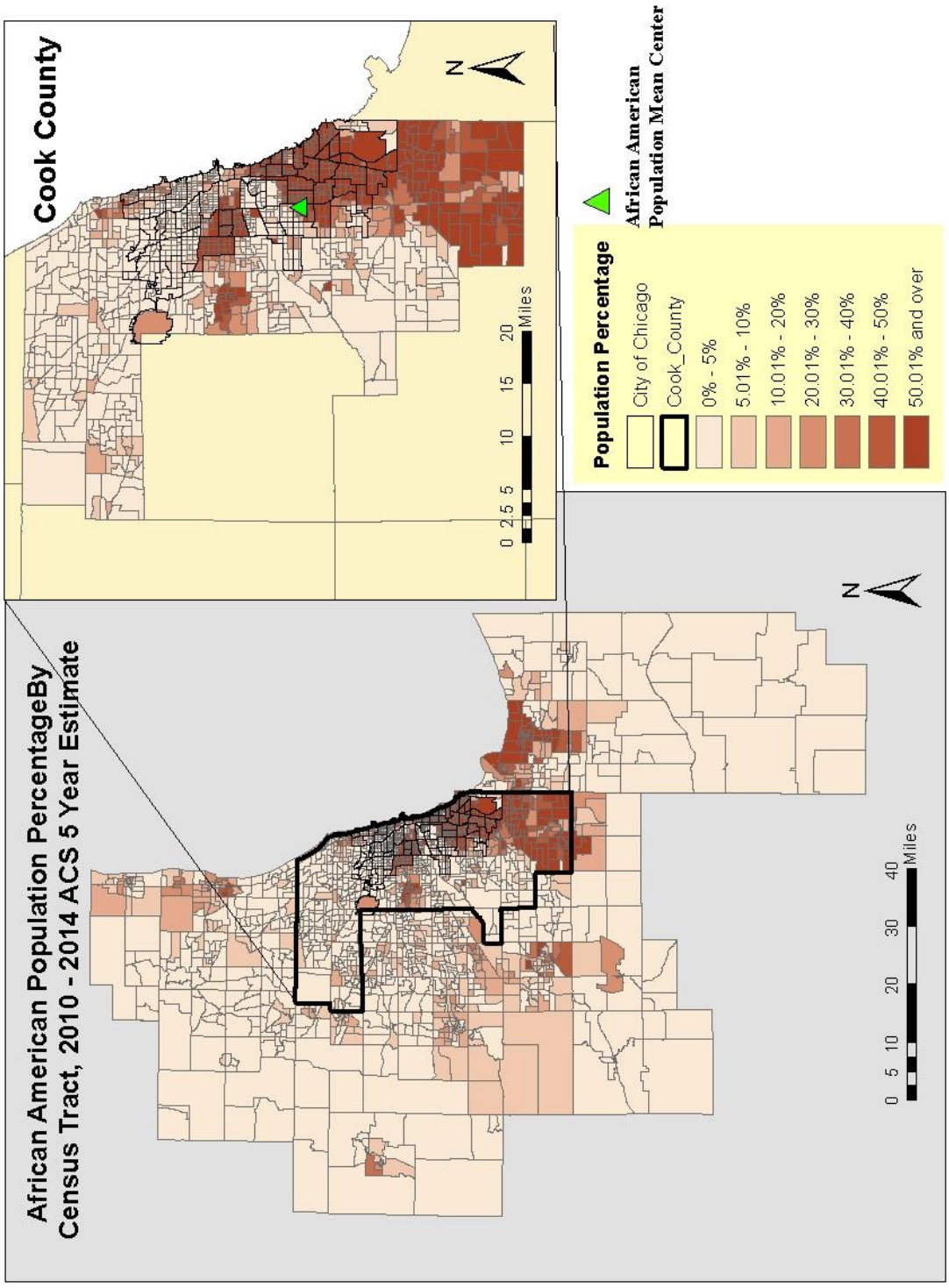

Figure 3.6 *Chicago African American population by percentage, 2010-2014 five-year estimate. Source: American Community Survey*

3.3.3 Hispanic Population

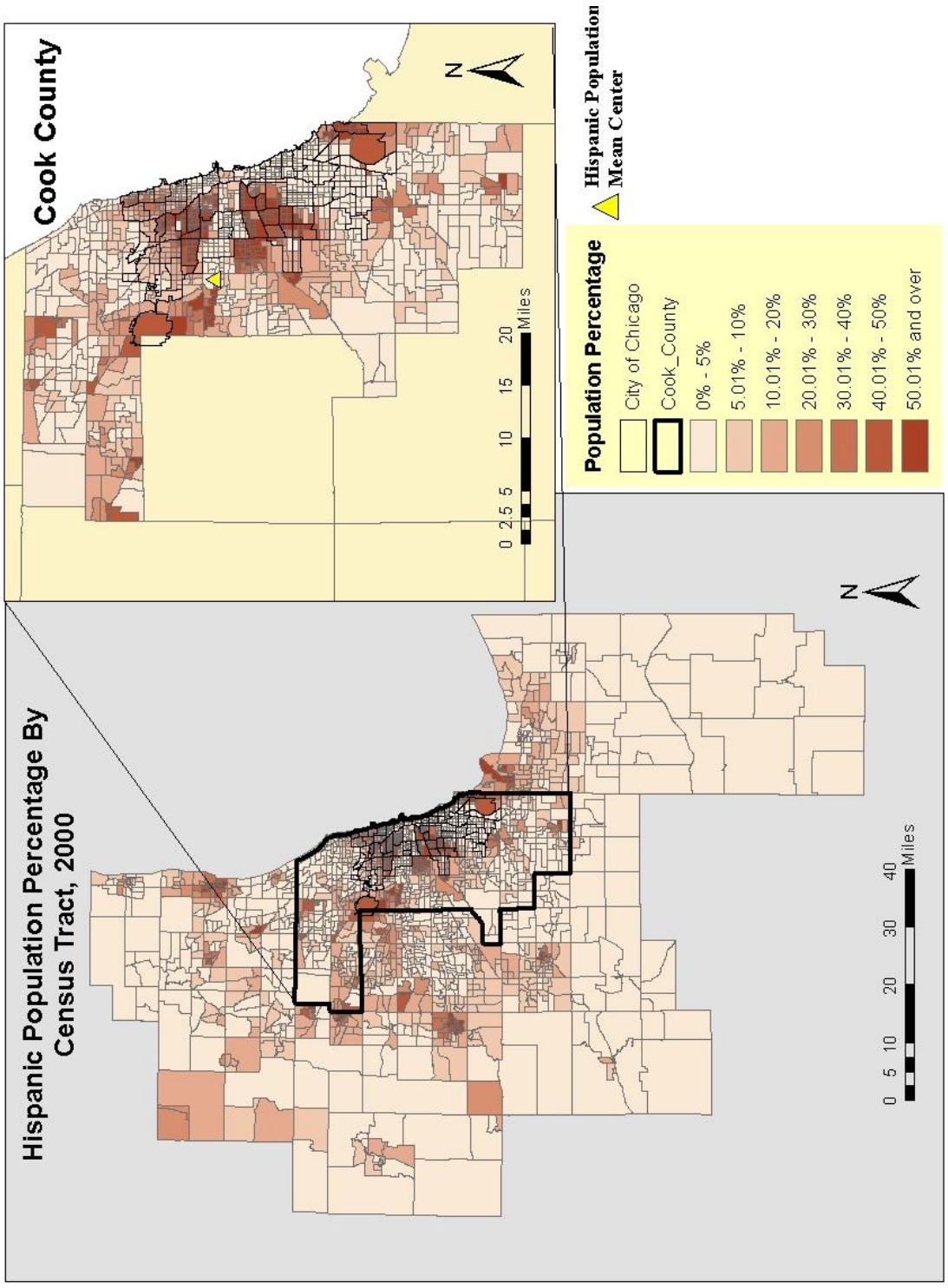

Figure 3.7 Hispanic distribution by percentage. Source: Census, 2000

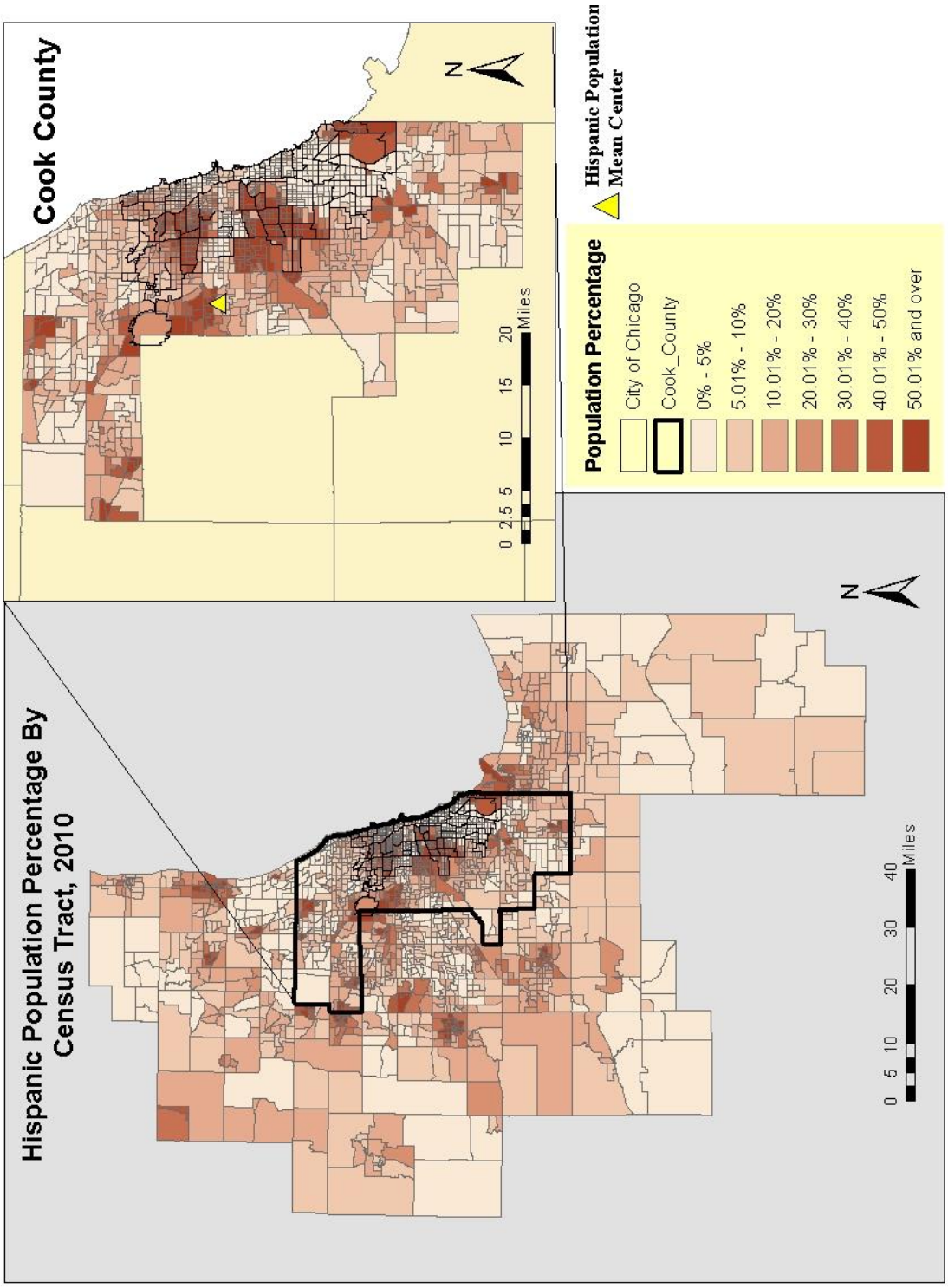

Figure 3.8 Hispanic distribution by percentage. Source: Census, 2010

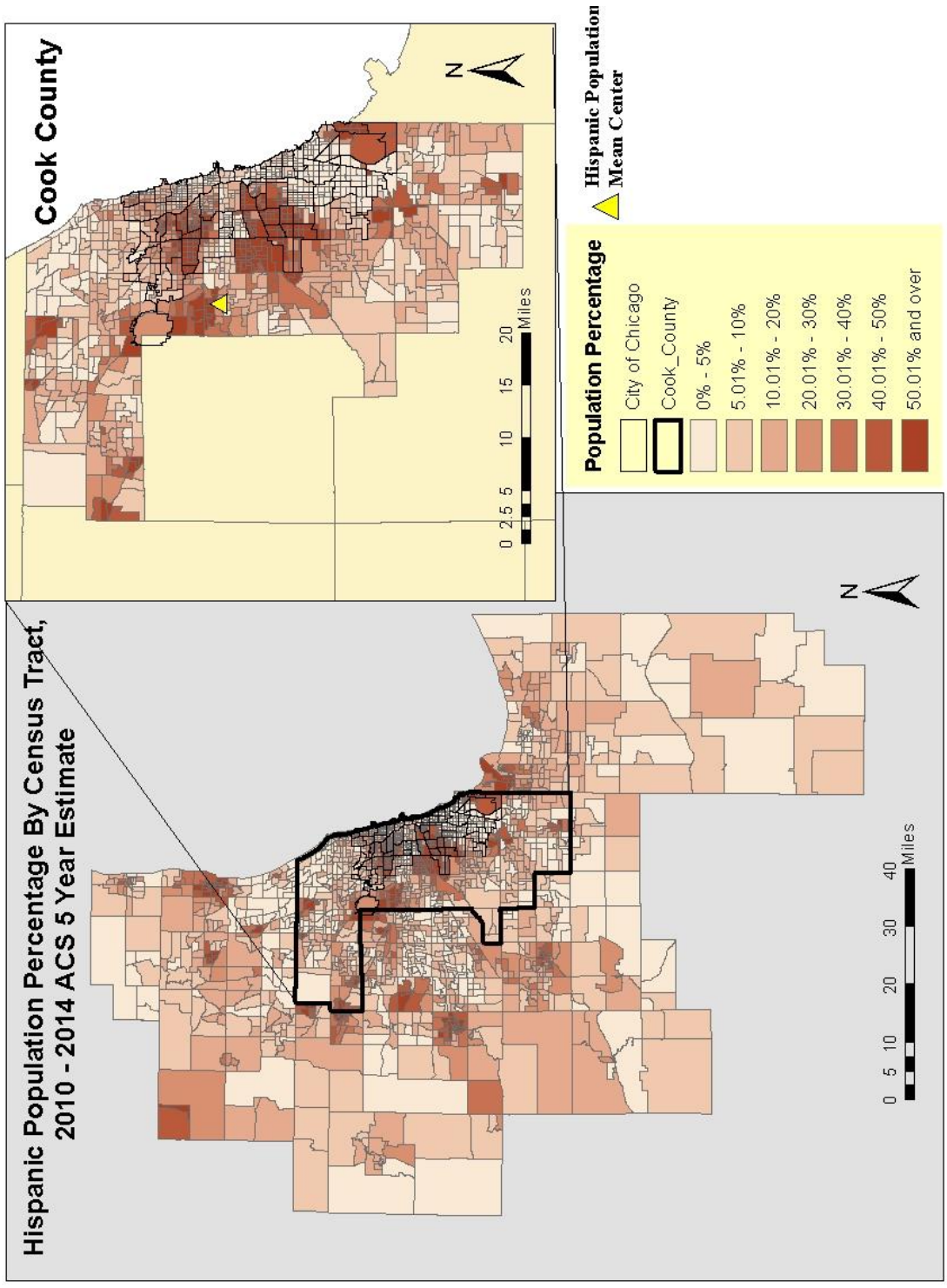

Figure 3.9 Chicago Hispanic population by percentage, 2010-2014 five-year estimate. Source: American Community Survey

3.3.4 Asian Population

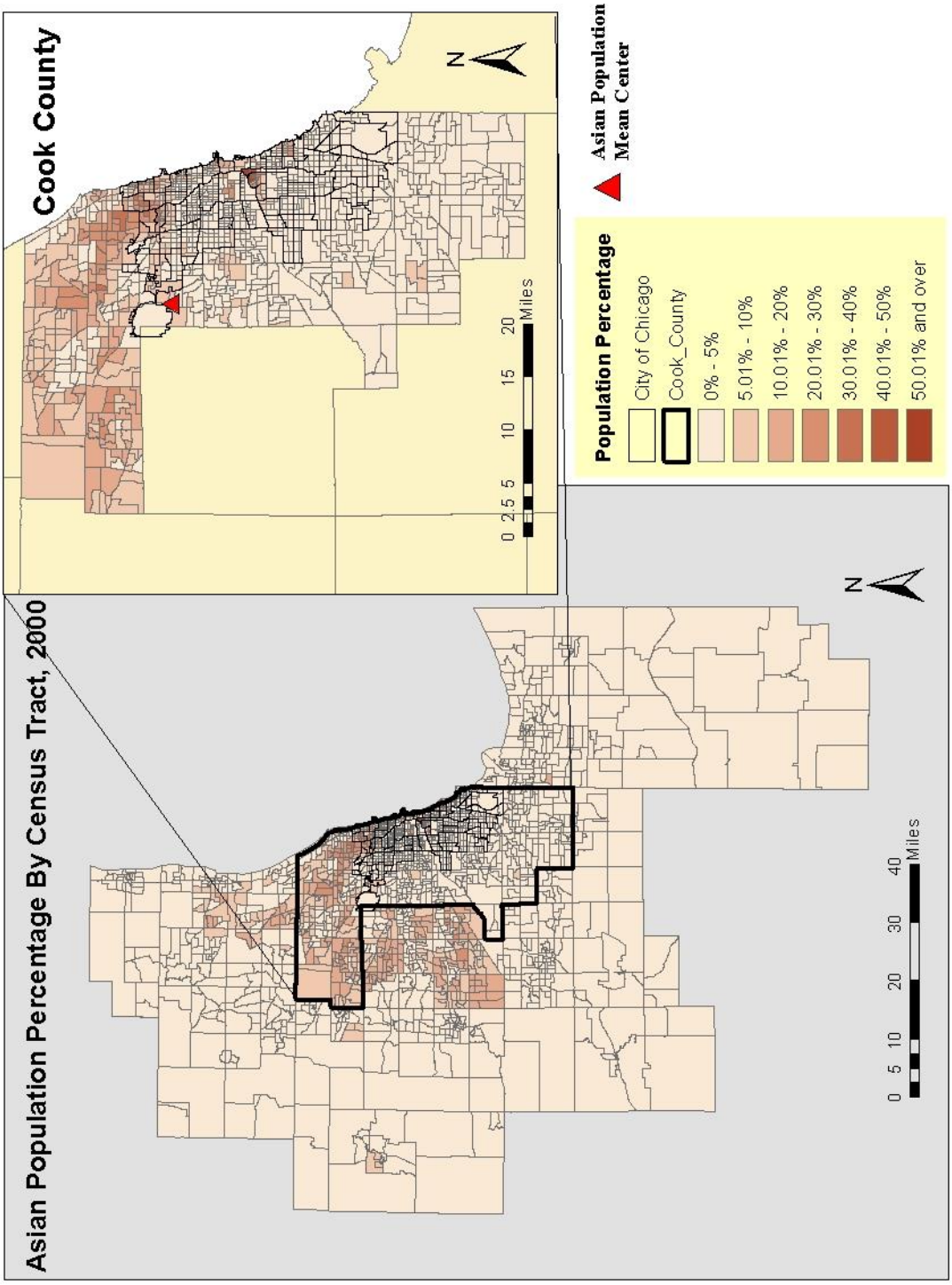

Figure 3.10 Asian population by percentage. Source: Census, 2000

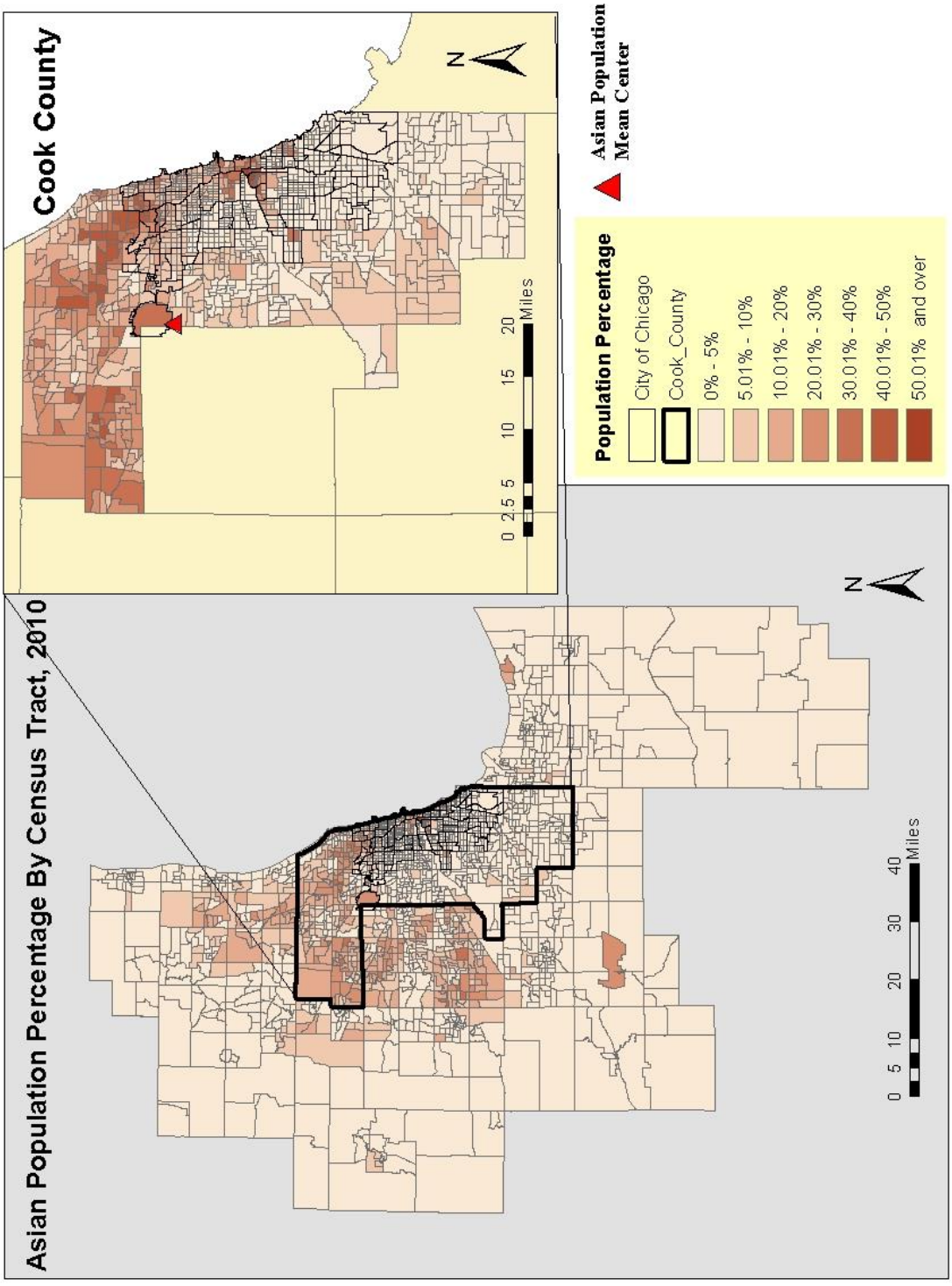

Figure 3.11 Asian population by percentage. Source: Census, 2010

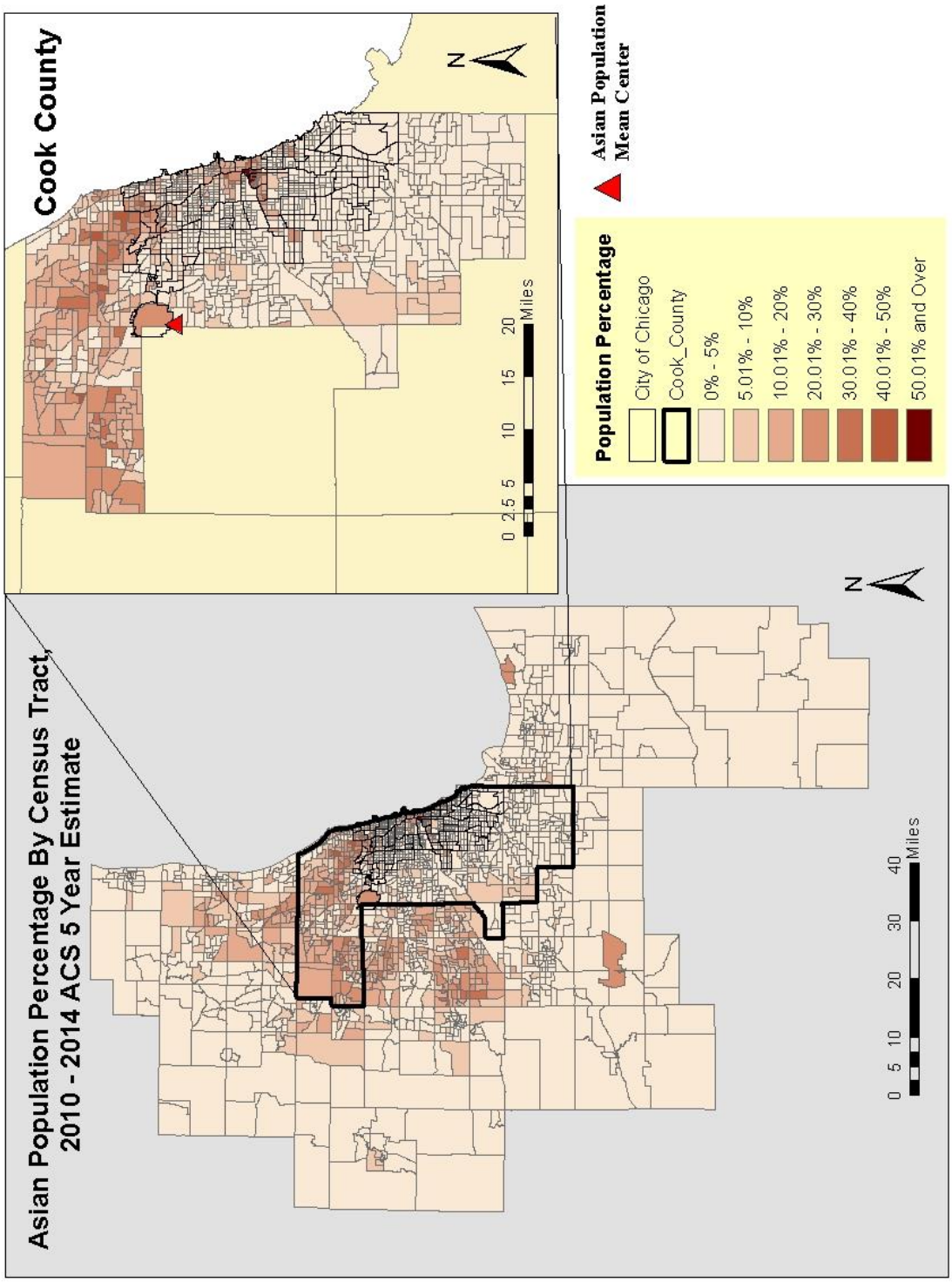

Figure 3.12 Chicago Asian population by percentage, 2010-2014 five-year estimate. Source: American Community Survey

3.4 Measures of Segregation

From an examination of figures for each ethnic group, it is easy to tell that there have been slight changes for each ethnic group since 2000. The most common method to measure the overall pattern of population change is to use the population mean center, also called the population centroid. The population mean center minimizes the sum of all the squared distances to the dispersed population (Plane and Rogerson 1994). Figure 3.16 presents the population mean center change for each ethnic group from 2000 to 2014. According to the map, white and Hispanic populations have mean centers located at the west of the inner city. The Asian population mean center is located northwest of the inner city, and the African population mean center is located on the south side of the inner city and is relatively farther away from the mean centers for the other three groups. Over time, from 2000 to 2010-2014, all ethnic groups' population mean centers have shifted westward in a direction which is farther away from the inner city of Chicago.

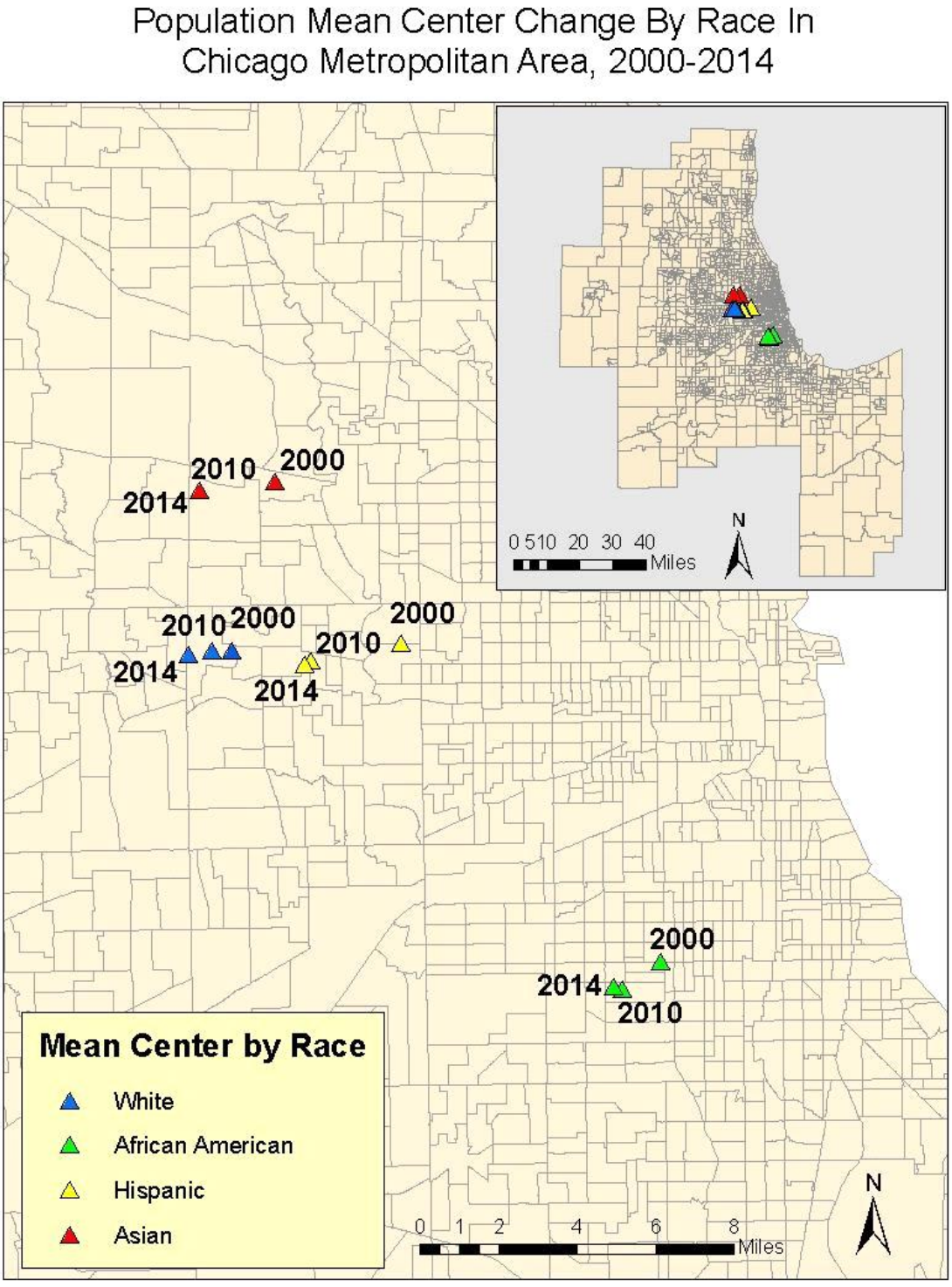

Figure 3.13 The change of population mean center from 2000 to 2014

3.5 Research Methodology

3.5.1 Index of Dissimilarity

The population mean center trends demonstrate the geographic movement of ethnic groups within the Chicago metropolitan area. Population movement can cause changes of racial segregation between each of the groups. In order to measure racial segregation, this research uses different dimensions that involve evenness and clustering to measure segregation both numerically and spatially.

The measure of evenness used in this study refers to the possible unequal distribution between two ethnic groups. It is the relative measure between minority and majority members as measured for the metropolitan area as a whole (Weinberg, Iceland, and Steinmetz 2002). This research uses the dissimilarity Index to measure the racial segregation between two ethnic groups. Conceptually, a dissimilarity index measures the percentage of a group's population that would have to change residence for each census tract to have the same percentages of that group and a comparison group over the entire metropolitan area overall. The equation of dissimilarity index is shown as:

$$D = 1/2 \sum_{j=1}^{n} \left| \frac{x_j}{X} - \frac{y_j}{Y} \right|$$

Where x_j and y_j refer to the number of people in each ethnic group and X and Y in each census tract, and X and Y are the total population of group X and Y for the entire Chicago metropolitan area, j is the number of census tracts. The value of the dissimilarity

index ranges from 0 to 100, where 0 represents that the two ethnic groups in a specific area are evenly distributed in relation to one another, and a dissimilarity index value of 100 means that one ethnic group lives 100% exclusively from another group, which forms an apartheid situation. (Weinberg, Iceland, and Steinmetz, 2002)

According to the Diversity and Disparities, a dissimilarity of index value of 60 or above is considered very high. Values from 40 to 50 are usually considered a moderate level of segregation, and values of 30 or below are considered low. In this research, the dissimilarity index between the following ethnic groups was measured: white/African American, white/Hispanic, white/Asian, African American /Hispanic, African American /Asian, and Hispanic/Asian (Logan 2011*)*.

3.5.2 Hot Spot Analysis

The dissimilarity index measures the evenness between two ethnic groups for the entire Chicago metropolitan area, and indicates how extreme the segregation between two ethnic groups who are relatively segregated from one another might be, while clustering identifies the pattern of where high proportions of each racial group are concentrated.

This research uses the hot spot analysis tool in ArcMap to calculate the Getis-Ord Gi* statistic for identifying census tracts with high values adjacent to other tracts also with high or different values. The equation of the Getis Ord local statistic is given as:

$$G_i^* = \frac{\sum_j w_{ij}(d)x_j - W_i^*\bar{x}}{s\{[nS_{1i}^* - W_i^{*2}]/(n-1)\}^{1/2}}$$

Figure 3.14 Getis Ord Gi equation. Source: Rogerson 2010*

The Getis-Ord Gi* equation identifies whether a census tract *i* and its surrounding census tracts have a higher population proportion than the average values on a variable x. As Figure 3.17 demonstrates, s is the sample standard deviation of variable x, and the fixed neighborhood threshold *d* for this research is set as 15,280 meters to ensure each census tract has at least one neighbor to validate the statistical properties of the test. Therefore, $w_{i,j}(d)$ receives a spatial weight of 1 when census tract j is within the threshold distance of *d* from census tract *i*, and $w_{i,j}(d)$ receives a spatial weight of 0 when features fall outside of the threshold distance (Ord and Getis 1995). The outcomes of Gi* statistic are z-scores, p-values, and confidence level bin (Gi_Bin), which tells where features with high or low values cluster spatially (Allen & Turner, 2012).

The Gi* statistic is returned for each feature in the dataset as z-scores, which indicates how many standard deviations an observation is from the mean. For statistically significant positive z-scores, the larger the z-score is, the more intense the clustering of high values (hot spot). For statistically significant negative z-scores, the smaller the z-score is, the more intense the clustering of low values (cold spot). The resultant p values

identify the probability of the resulting spatial pattern being random. In this study, the p-values are numerical approximations under the assumption of a normal distribution of measured values. To correspond with z-scores and p-values, the results of confidence levels measure the level of the z-scores and p-values by percentage.

In this case, all calculations of the hot spot analysis used to identify the spatial pattern were completed by the ArcGIS software, with the null hypothesis of the population proportion of each census tract to the entire census tracts within the study area of Chicago equally likely. The total of 2210 census tracts are the features of the statistic with the value of population proportion within each feature. The hot spot analysis compares a census tract from a neighborhood to the entire study area of Chicago metropolitan area. If all surrounding neighborhood census tracts contain high values, then the selected census tract is considered a hot spot. To confirm the significance of hot spots, there are three levels of confidence at 90%, 95% and 99%. The 90% level involves a critical z-score of 1.65 at the significance level 0.1, the 95% level involves a critical z-score of 1.96 at the significance level of 0.05, and the 99% level involves a critical z-score of 2.58 at the significance level of 0.01. Confidence levels are associated with z-scores and p-values: the more extreme the z-scores get, the smaller the p-values are, and the more statistically significant the confidence levels will be to reject the null hypothesis.

3.6 Objectives

The first objective of this research is to use the index of dissimilarity to measure the segregation between pairs of two ethnic groups for each identified year and seek to

measure the changes between years. The second objective focuses on identifying where high clusters tend to happen for each ethnic group by using the hot spot analysis tool in ArcMap. Finally, after identifying the racial segregation indices and clusters, it is important to analyze the pattern and the meaning of the results.

3.7 Chapter Summary

The methodologies of the dissimilarity index and hot spot analysis in this study increase the accuracy of racial segregation measurement. All data information collected from the U.S Census Bureau was in a Microsoft Excel spreadsheet and displayed in ArcMap software. Data analysis involved generating tables, graphs, figures, and maps from ArcGIS, Microsoft Excel, and Word. Moreover, a set of maps show the population distribution of each racial group in 2000, 2010, and 2014 by displaying the collected data. Finally, a hot spot analysis was conducted using the Getis-Ord Gi* statistical method. Results and analysis from these methodologies are presented and discussed in chapter 4.

Chapter 4: Analysis and Results

4.1 Overview

This chapter presents the results of the analysis described in chapter 3. Results are presented in maps, figures, and general discussions. The index of dissimilarity is calculated and presented in a chart with multiple categories to separate each racial group and compare the index of each selected year. The hot spot analysis is presented as a set of maps created for each year and each individual racial group. Maps depict the clustered pattern geographically by census tracts in assorted colors. The resultant colors are displayed as red, blue, and yellow where red indicates the hot spots, blue represents the cold spots, and yellow indicates the not significant census tracts.

4.2 Analysis of Results

4.2.1 The Index of Dissimilarity

As mentioned in chapter 3, the index of dissimilarity measures the evenness of residential patterns between two ethnic groups within the metropolitan area. Figure 4.1 shows the results of the index from 2000 to 2014. High index values indicate high separation between black and Asian and black and white populations. These two comparison groups contain a dissimilarity index that exceeded 80 in 2000. Although the numbers have slightly dropped in 2010 and 2014, index values over 70% still depict very high segregation. The black and Hispanic index dropped from 76.75% in 2000 to 69.92% in 2014. The Hispanic and Asian index remains at a constant level of 63%, which is just reaching the high segregation level. The white and Asian index also experienced a very minor change in

dissimilarity index value, but the ratio remains within a range of 45% and 47%, which is considered a moderate segregation level. However, the index between white and Hispanic dropped from a high segregation index of 60.64% in 2000 to a moderate level of 46.23% in 2014.

The evenness from the dissimilarity index indicates that segregation still exists between any two racial groups in Chicago. The segregation level between different racial groups presents differently. The segregation levels between two groups are different and changes for some groups are obvious. The index of dissimilarity shows African Americans as the most segregated group. The Asian population remains at a relatively constant segregation level with other ethnic groups; the dissimilarity index for Asians and other groups rarely changes. Besides that, there is a significant trend showing that whites and Hispanics are becoming less segregated since 2000, which means that the two groups tend to move towards each other with less exclusion.

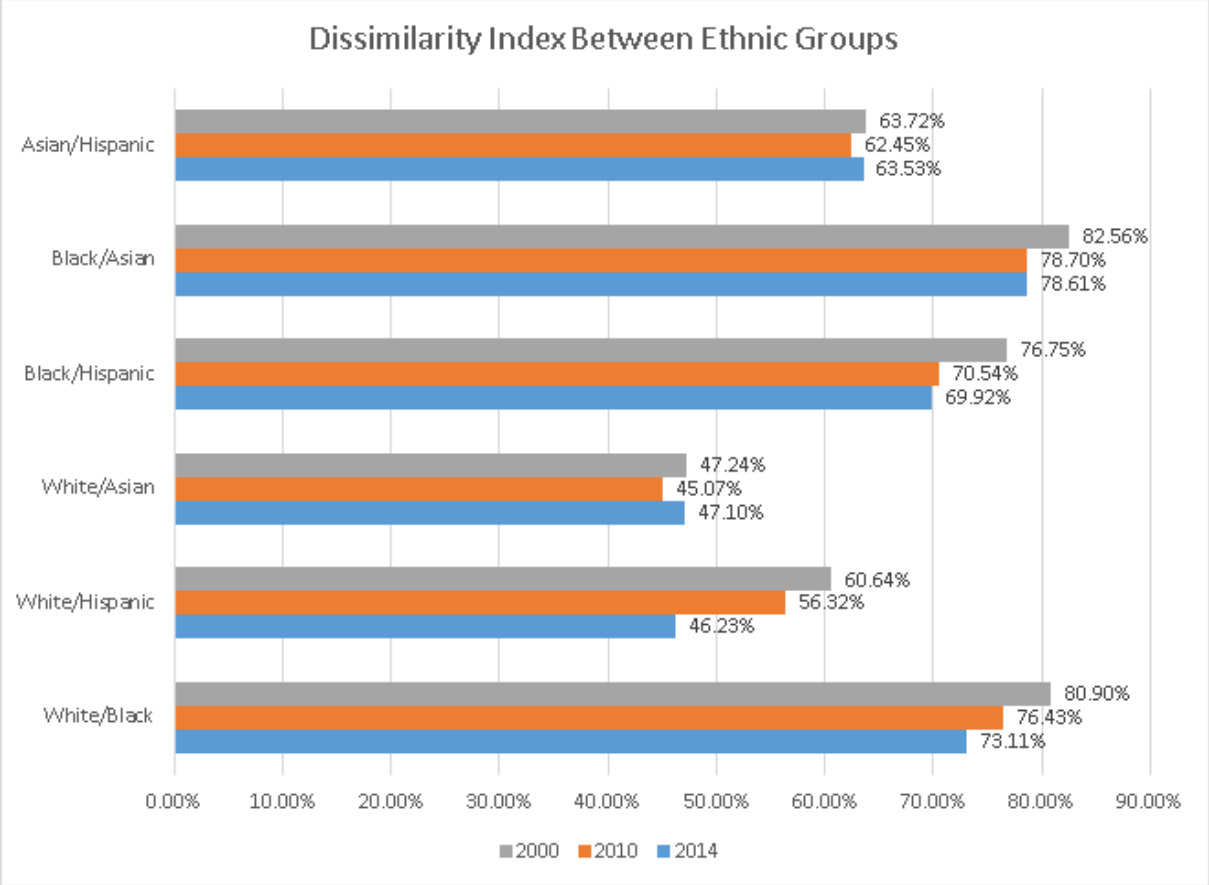

Figure 4.1 Dissimilarity index between two ethnic groups during the years 2000, 2010, and 2014. Source: U.S. Census Bureau

4.2.2 The Clustering Pattern

The subsequent hot spot analysis revealed significant areas of clustering for high proportions of each ethnic group in the Chicago metropolitan area. Figure 4.2 shows the level of significant clustering of high proportions of the white population in 2000. The map indicates that in the year 2000, high proportions of the white population tended to cluster at the outside of the Chicago city limit, specifically around the north and western edge of Cook County as well as the partial northern Indiana. It is with a 99% confidence that the census tracts in darkest red belong to a statistically significant cluster of high

values, so that the null hypothesis of the population proportion of each census tract to the entire census tracts within the study area of Chicago are equally likely. The total of 2210 census tracts are the features of the statistic with the value of population proportion within each feature. The hot spot analysis compares a census tract from a neighborhood to the entire study area of the Chicago metropolitan area. In comparison, there are significantly high cluster of low proportions of the white population (cold spots) within almost the entire city of Chicago. The white population clustering pattern for 2010 is shown in Figure 4.3. While the majority of whites remain highly clustered at the edge of Cook County, there are also high proportions of whites clustered at the northern edge of the city. This pattern became more significant in 2014. Figure 4.4 presents the hot and cold spots of white population proportions in 2014, showing high proportions of whites clustered around the entire northern edge of Chicago. In comparison to the 2000 and the 2010 maps, cold spots at the northern part of the metropolitan area that existed in both 2000 and 2010 were no longer significant in 2014.

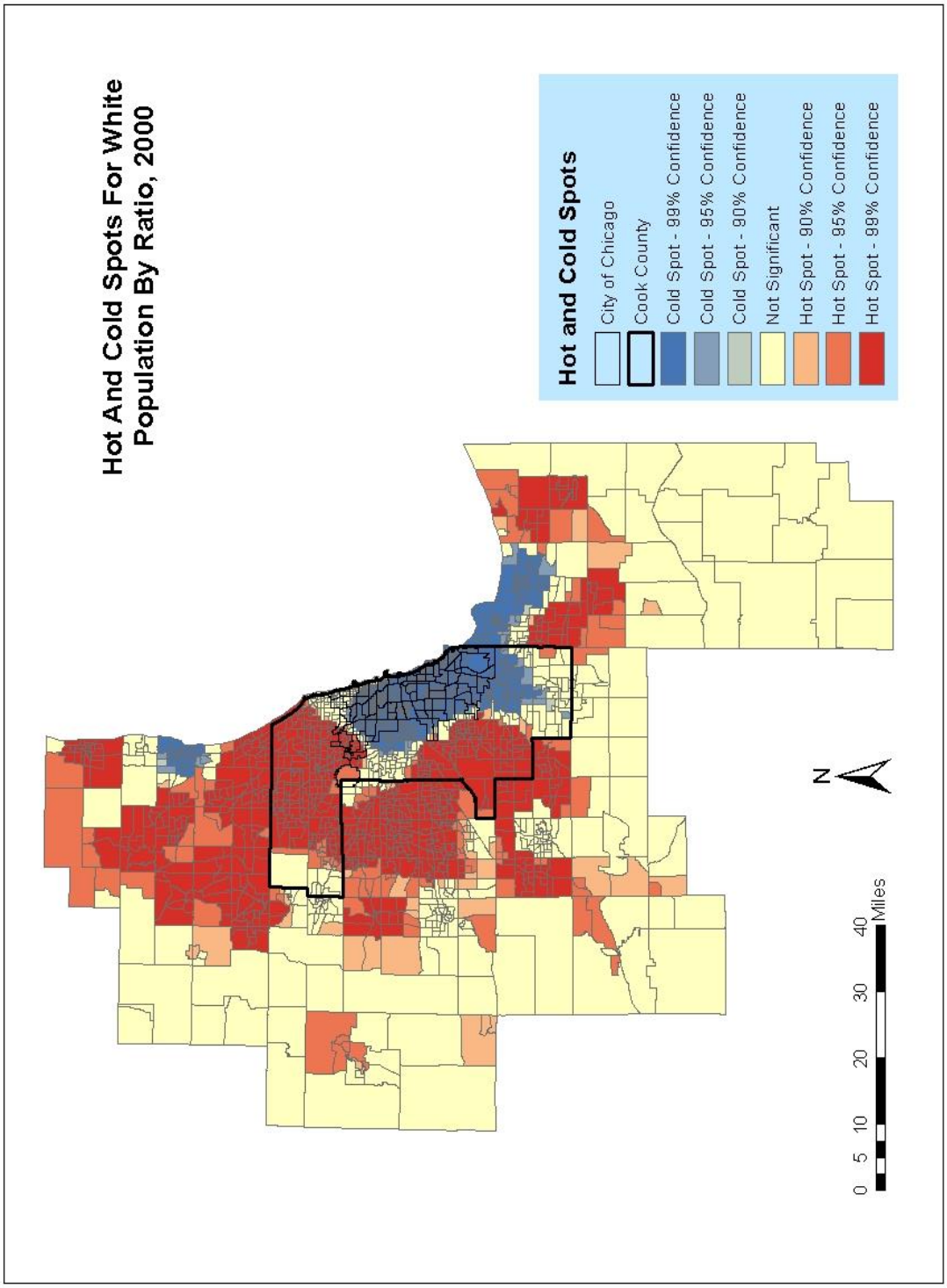

Figure 4.2 Hot and cold spots for the white population in Chicago, 2000

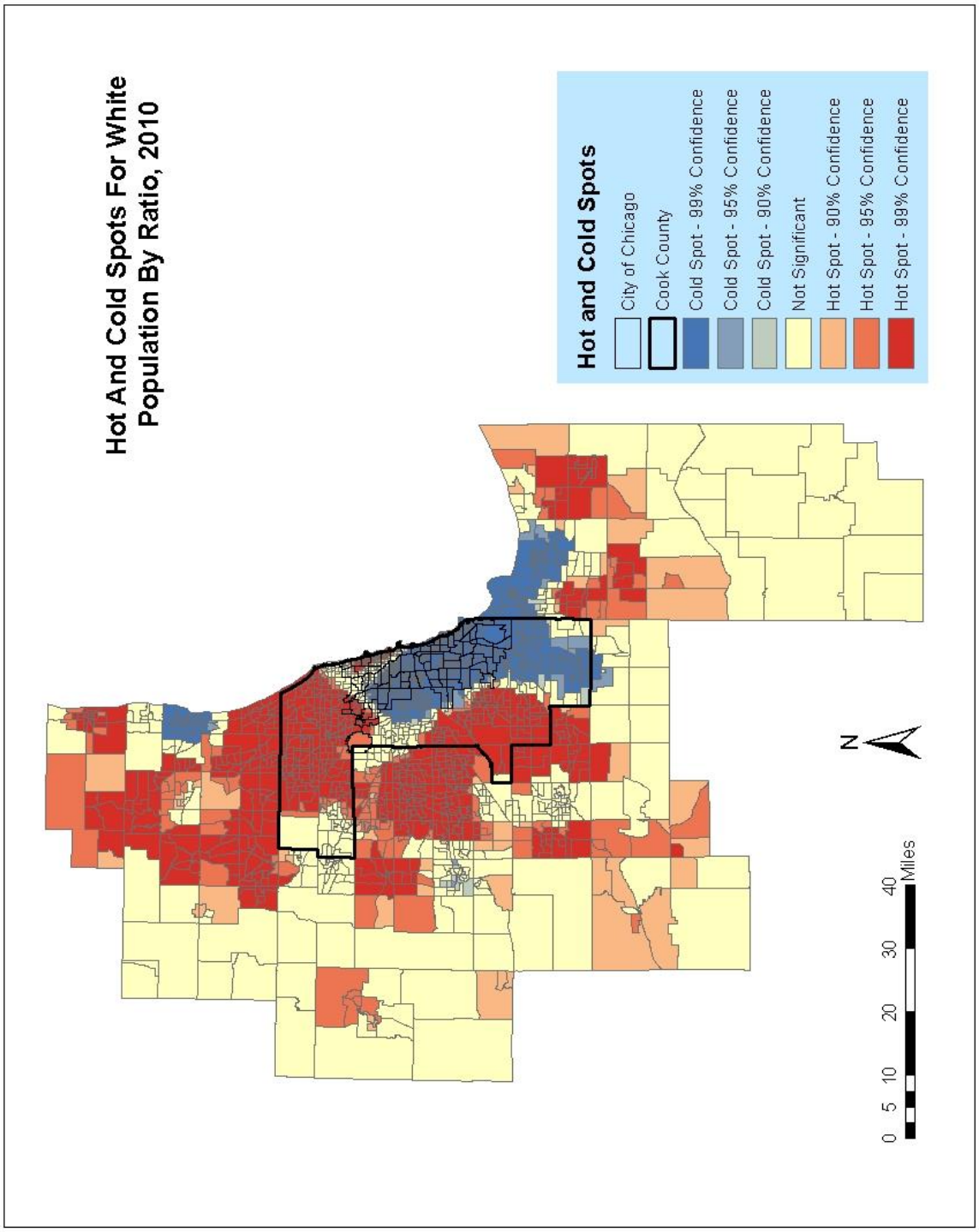

Figure 4.3 Hot and cold spots for the white population in Chicago, 2010

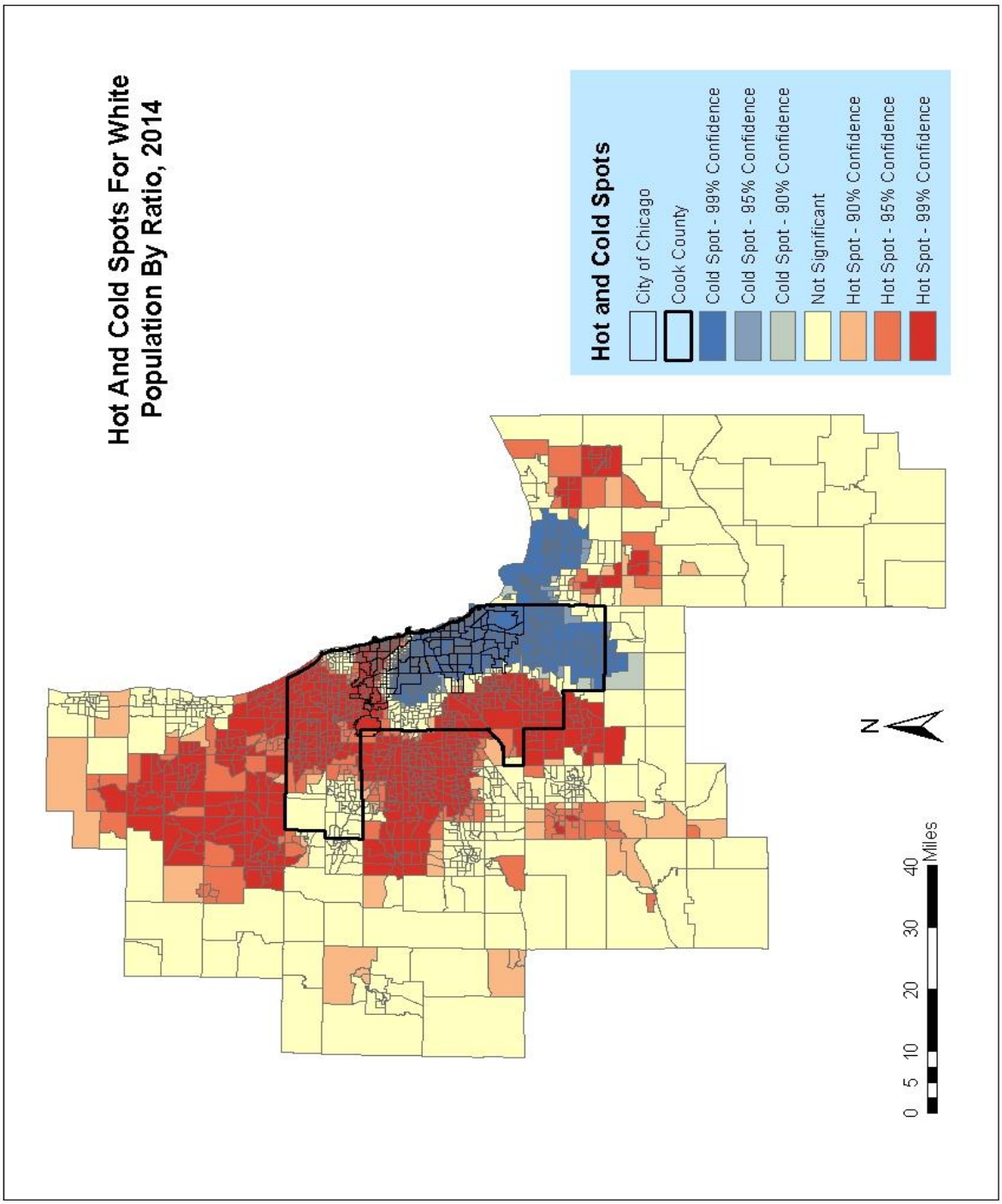

Figure 4.4 Hot and cold spots for the white population in Chicago, 2010-2014 five-year estimate

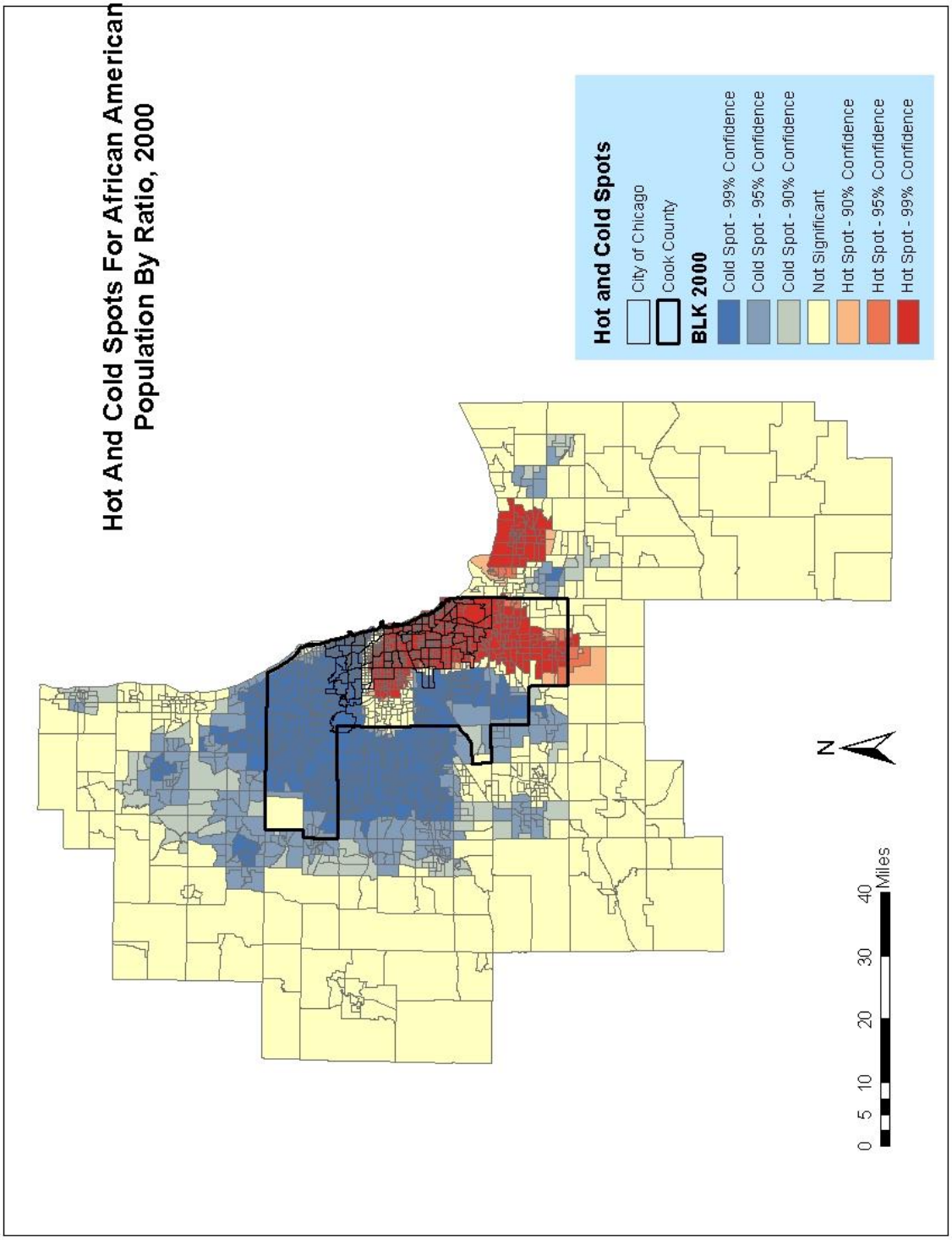

Figure 4.5 Hot and cold spots for the African American population in Chicago, 2000

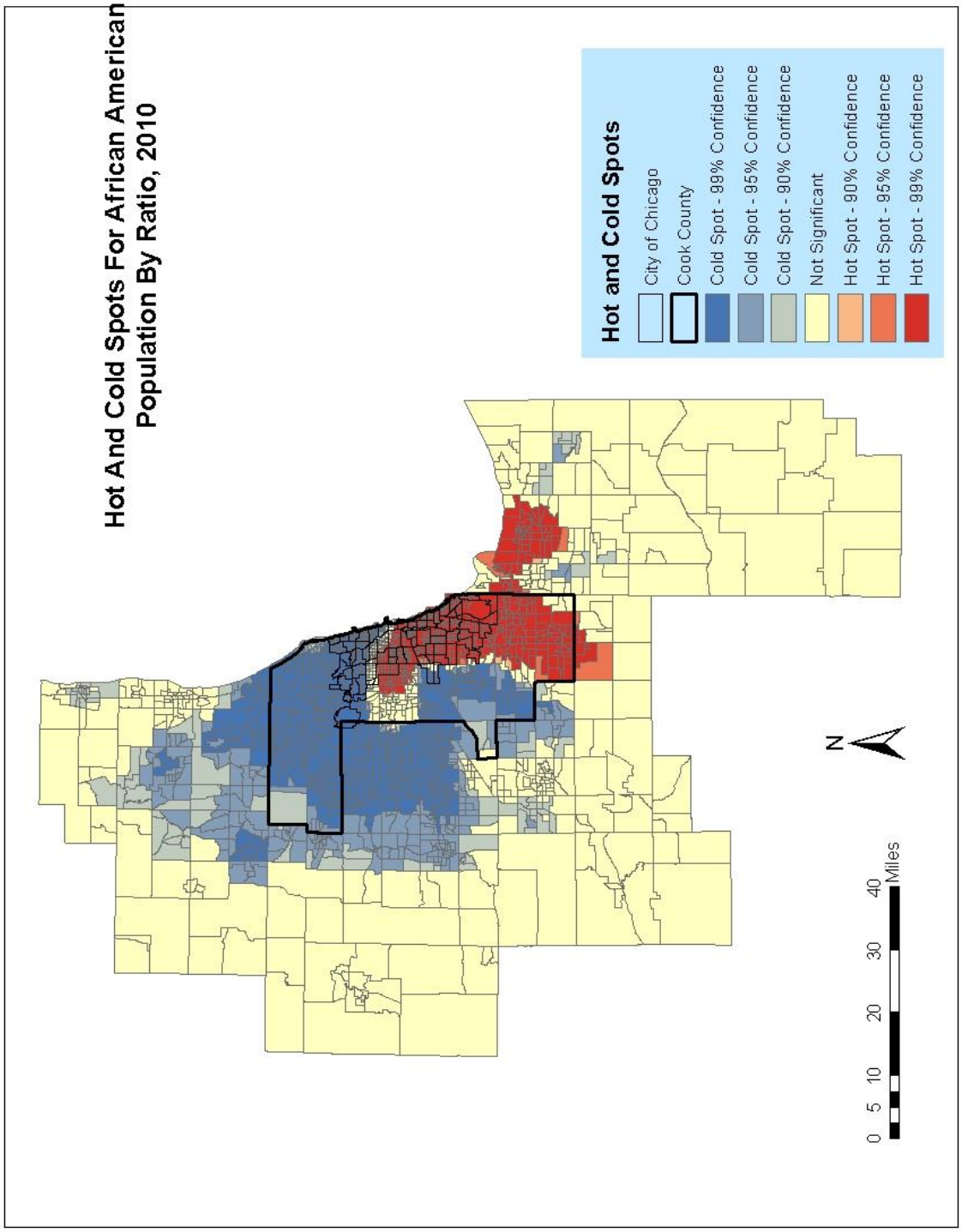

Figure 4.6 Hot and cold spots for the African American population in Chicago, 2010

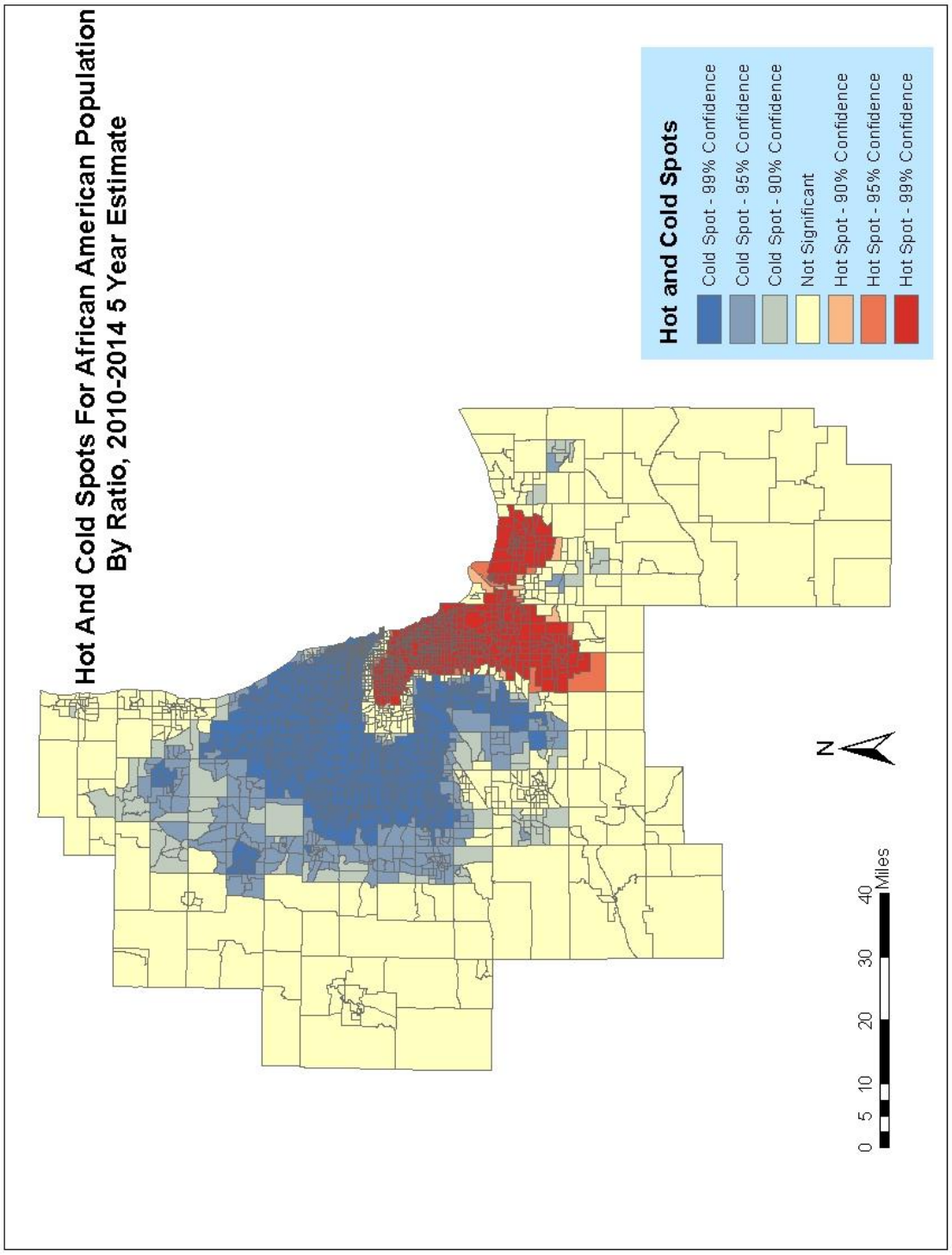

Figure 4.7 Hot and cold spots for the African American population, 2010 – 2014, five-year estimate

Figure 4.5 shows a pattern of significant clustering of high proportions of the African American population in 2000. The map indicates that high proportions of African Americans are clustered at the near north-of-Chicago downtown area and the hot spots continued to south Chicago and extended along Lake Michigan to northern Indiana. The biggest change happened between 2000 and 2010, where both hot spots and cold spots expanded. Figure 4.6 and figure 4.7 present the 2010 and 2014 African American clustering maps. The clustering pattern of African Americans in the 2010 and 2014 maps slightly expanded, exceeding the east edge of Cook County along Lake Michigan.

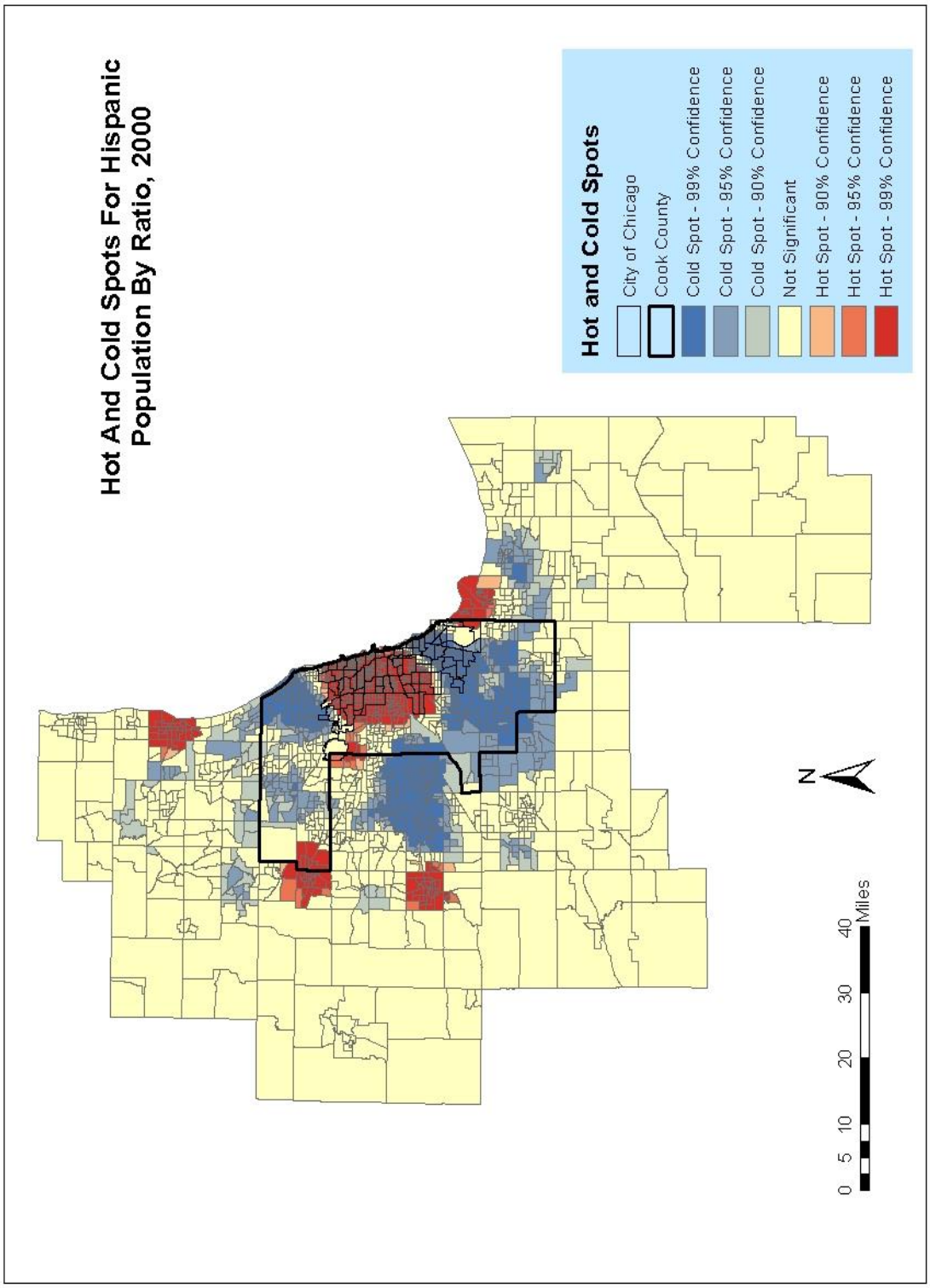

Figure 4.8 Hot and cold spots of Hispanic populations in 2000

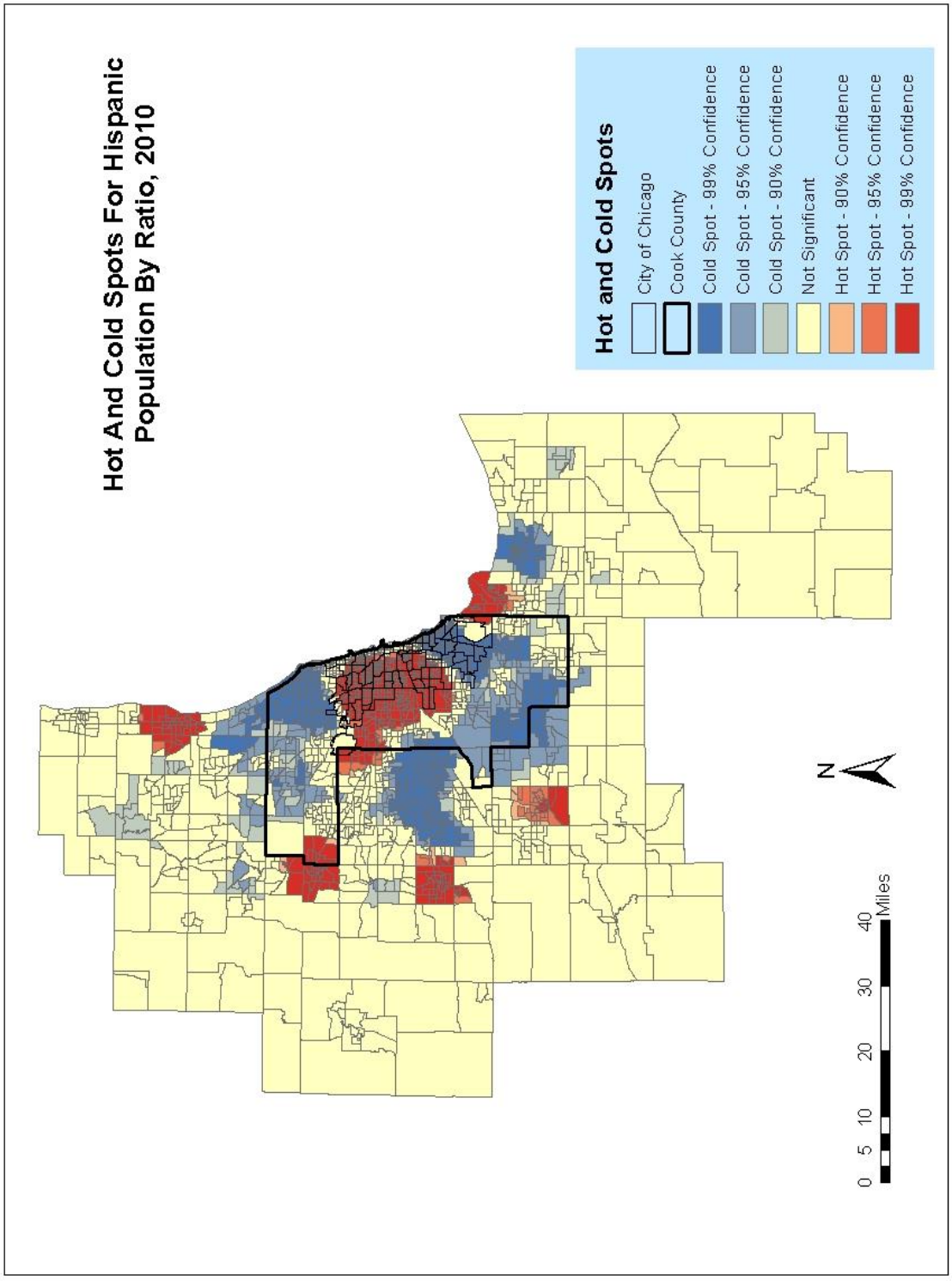

Figure 4.9 Hot and cold spots of Hispanic populations in 2010

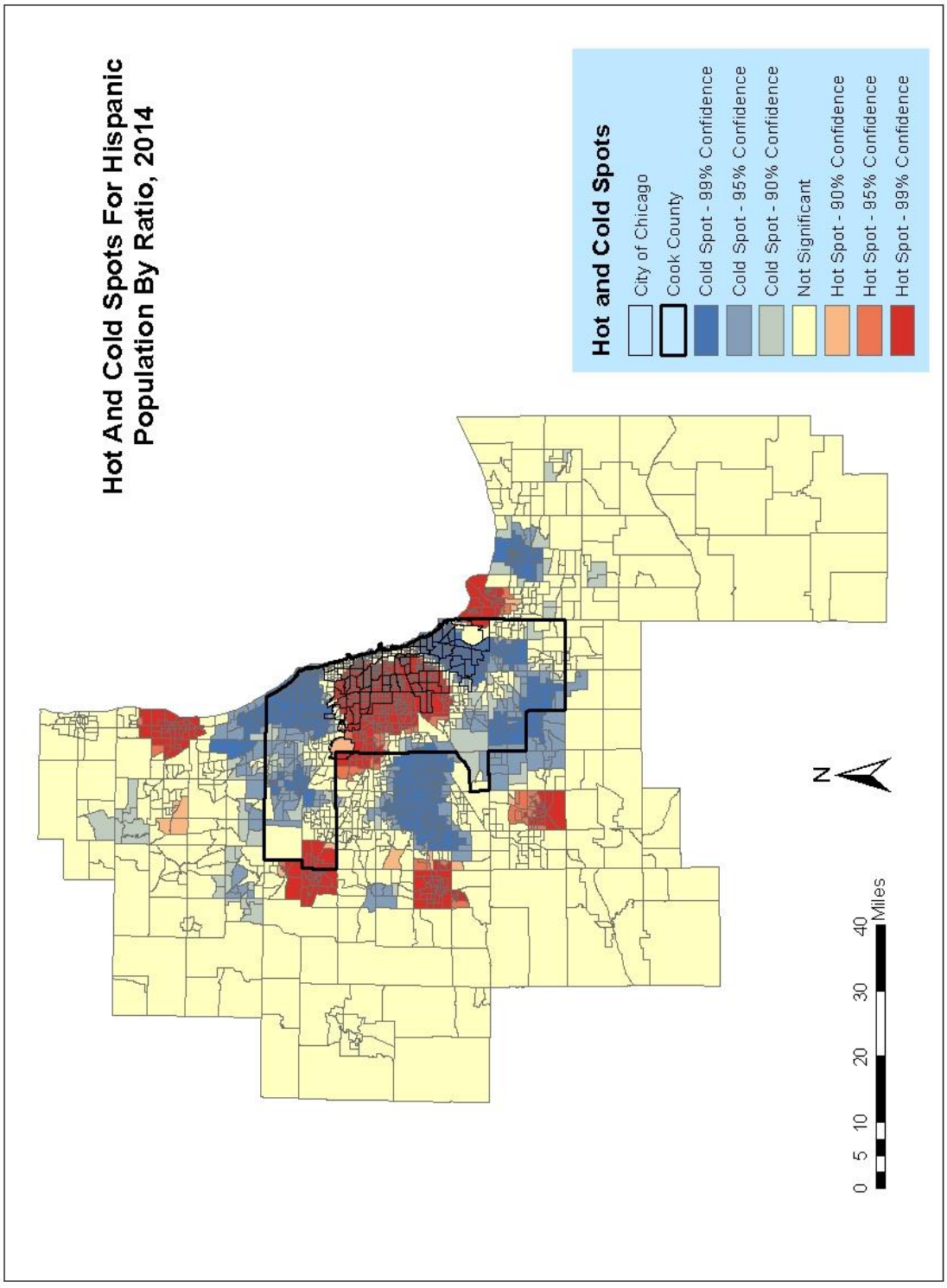

Figure 4.10 Hot and cold spots for Hispanic populations in 2010-2014, five-year estimate

The significant high and low proportion clusters of Hispanic populations are shown above. Figure 4.8 shows the hot and cold spots of Hispanic populations in 2000. Unlike other ethnic groups, the high clustered of Hispanic populations reside dispersive. According to the map in figure 4.8, a large clustered area with high proportion of Hispanics are in downtown Chicago with several small clustered areas distributed in all directions in the suburban zones. As figure 4.6 and figure 4.7 present for the 2010 and 2014 patterns, downtown and northern Chicago remain clustered and the hotspots have expanded west of the city limit of Cook County. However, the Hispanic population has a significantly lower population proportion along all other areas of Cook County. Overall, high Hispanic population proportion areas have increased during the past 14 years and the distribution of hot spots are dispersed.

The high population proportion of Asians has slightly expanded from 2000 to 2014. Compared to other ethnic groups, spatial pattern changes for Asians are small but continuous. These changes are presented below in figures 4.11, 4.12 and 4.13.

It is noteworthy that a high proportion of Asians in 2000 tended to cluster in northern Cook County and the western suburbs outside of Cook County. Meanwhile, there is also a high clustered area in downtown Chicago along Lake Michigan. In 2010 and 2014, northern Cook County and the western suburbs retain the same pattern, but high proportions of Asians in the downtown area have expanded remarkably compared to 2000. In contrast, there are significantly lower proportions of Asians clustered in western Chicago, southeast Cook County, and northwest Indiana. The clustered patterns of low Asian proportions from 2000 to 2014 have practically no change. In general, the spatial

patterns of Asians remain fairly stable, and both high and low Asian proportions tend to appear within or close to Cook County.

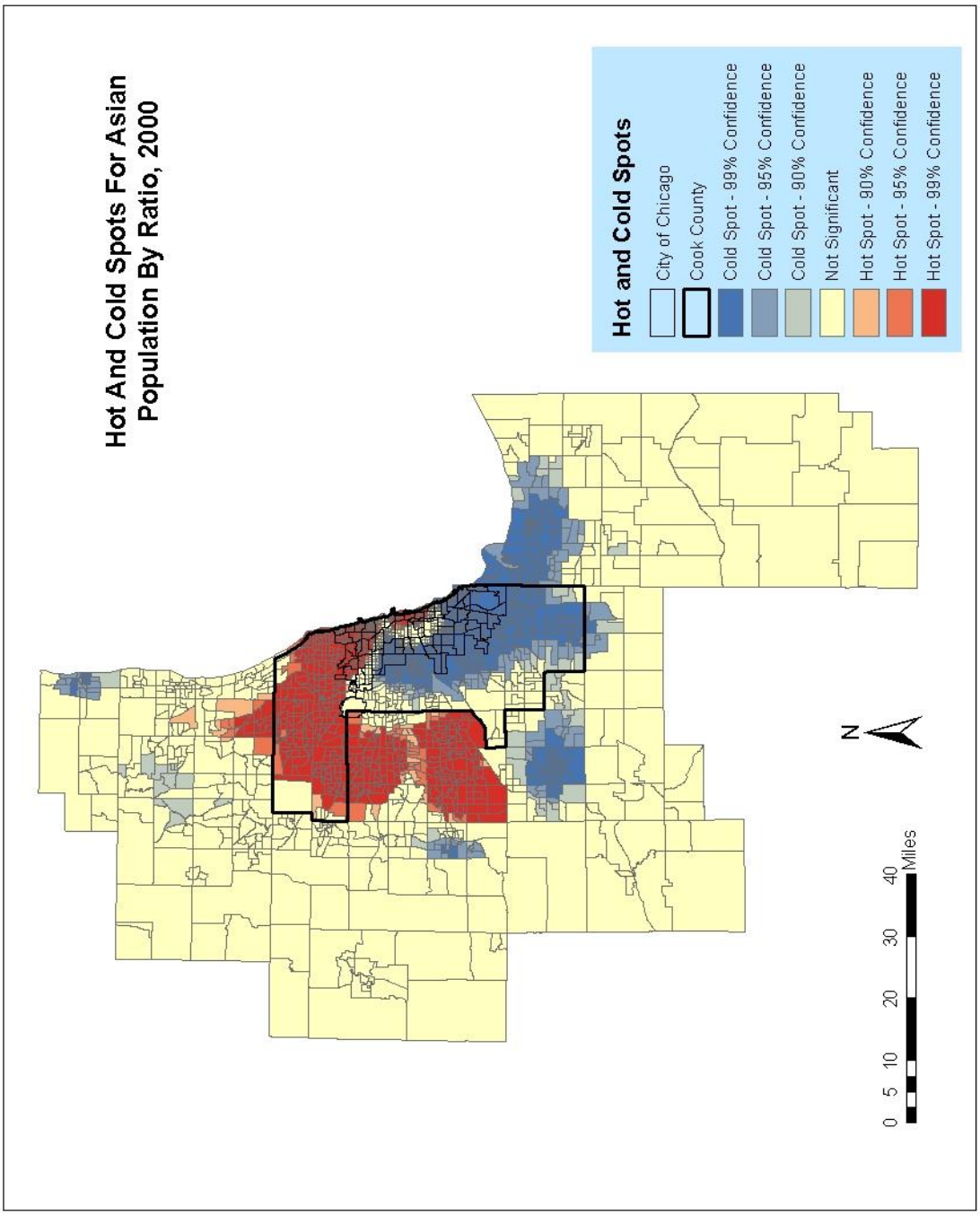

Figure 4.11 Hot and cold spots of Asian populations in 2000

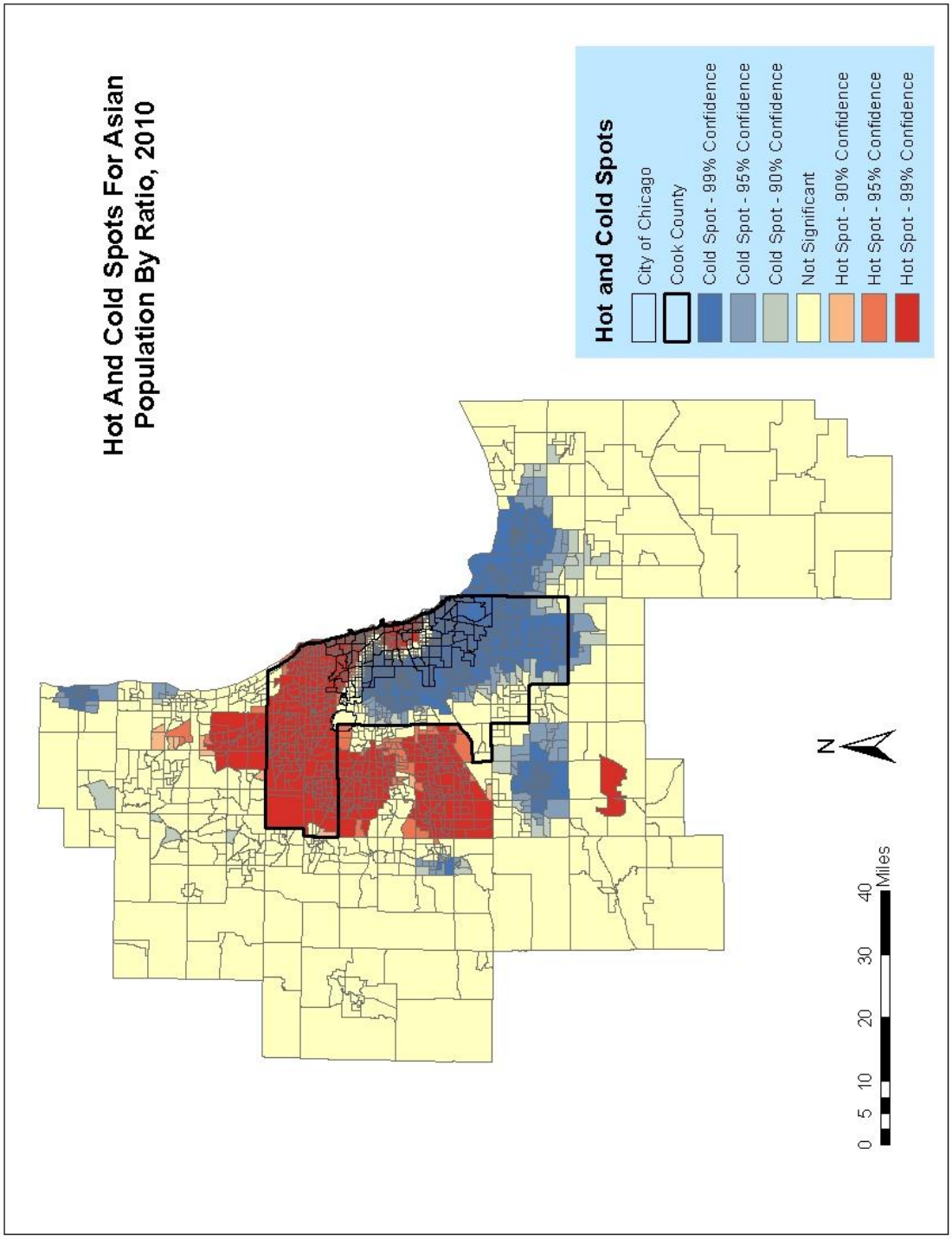

Figure 4.12 Hot and cold spots of Asian populations in 2010

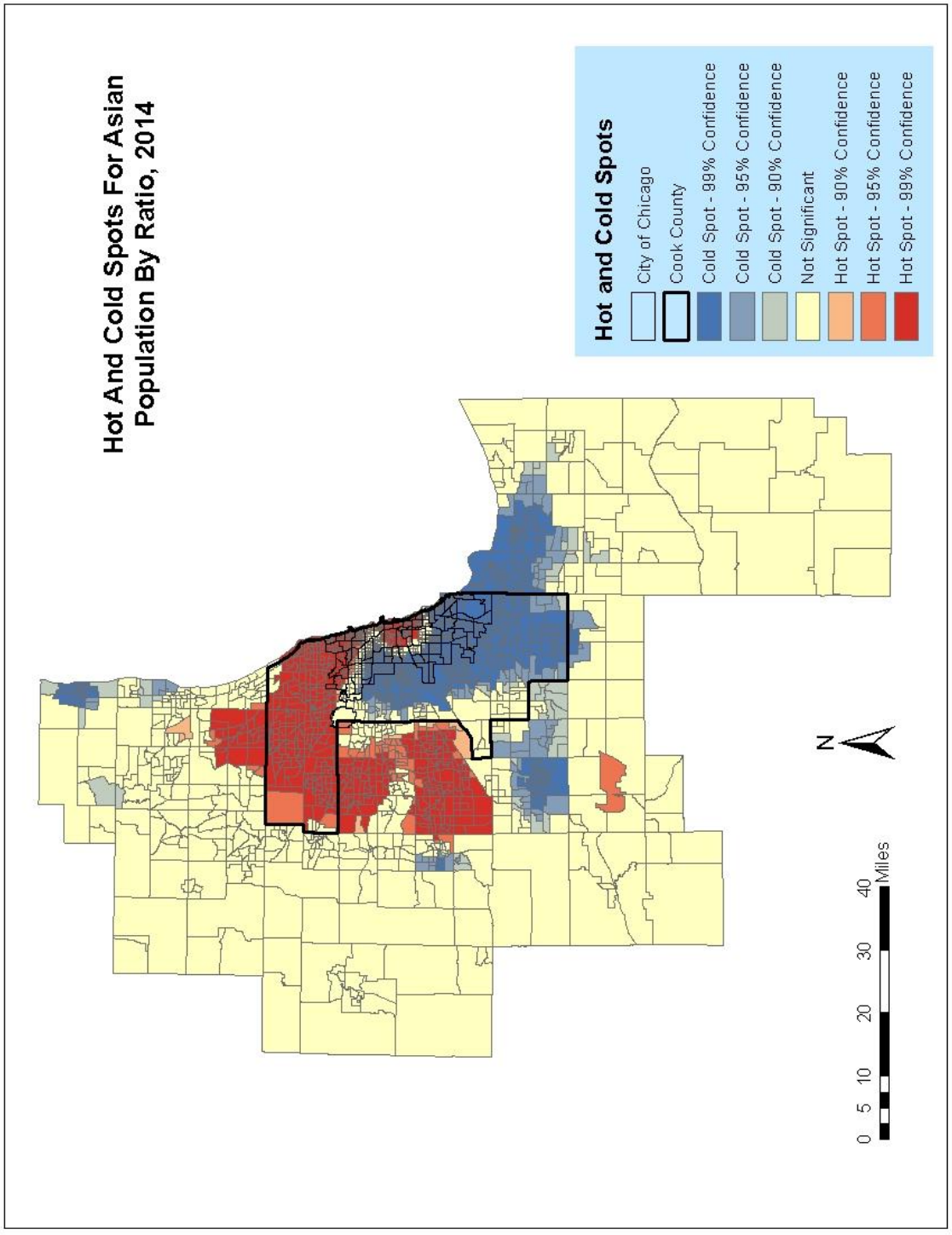

Figure 4.13 Hot and cold spots of Asian populations 2010-2014, five-year estimate

4.3 Discussion of Results

Results from the dissimilarity index revealed that in general African Americans are the most segregated racial group in Chicago. The largest segregation happens between African Americans and whites, and African Americans and Asians. The least segregated groups are whites and Asians and whites and Hispanics. The white and Hispanic segregation diminished in recent years and the white and Asian segregation level stayed low and stable.

The resulting clustering maps represent that most clusters tend to happen within Cook County, specifically the city of Chicago. However, white populations as the majority are an exception. White populations tend to have high values away from the Chicago city limit, high clusters of low values (cold spots) in the city of Chicago, and more clusters of high proportion at the edge of Cook County and other counties within the Chicago metropolitan area. White populations remain highly clustered at the northwest and western suburbs, but the northern coastal areas of Chicago became highly clustered starting in 2010 and continuing into 2014.

Meanwhile, African Americans and Hispanics tend to have clustering patterns of high proportion populations within the city of Chicago. Hispanics and African Americans both have high proportion populations clustered in downtown Chicago. However, Hispanics show the trend of hot spot expansion west of the Cook County city limits, and African Americans' hotspot locations remain stable. At this point, South Chicago and southern Cook County are where high proportions of African American clusters contained low proportion population, which are also the cold spots for whites and Asians.

The overall trend indicates that African American populations decreased from 2000 to 2014, but the hot spots and cold spots have expanded.

The high proportion clustering areas of Asians overlapped with white populations. The northern Chicago area and northern and western Cook County include high proportions of both Asians and whites. The clustering pattern of Asians correspond with the dissimilarity index presented above, showing that whites and Asians have the relatively smallest segregation ratio.

One significant finding from the hot spot maps is that from 2000 to 2014, a mixed ethnic zone with the cluster of high population proportion of all four ethnics has gradually formed. The 2010-2014 ACS five- year estimate hot spot maps show a high clustered population proportion of mixed ethnic zone. The mixed ethnic hot spot zone locates at the downtown Chicago and extended towards the northern Chicago city limit along the coast. The mixed ethnic zone in 2000 and 2010 hot spot maps was not as significant as the 2010-2014 hot spot maps. The mixed ethnic pattern shows the tendency that Northern Chicago is becoming less racially segregated.

4.4 Chapter Summary

This chapter provided an assessment of racial segregation both numerically and geographically. The dissimilarity index revealed that racial segregation in Chicago is experiencing a tendency toward evenness. Hot spot analysis over time revealed that all racial groups except for African Americans have expanded their clustering areas, where African American clustered areas have geographically decreased. Also, the overall result revealed that a low dissimilarity index ratio between two racial groups tends to have more

geographically overlapped hot spot areas. In comparison, a high dissimilarity ratio between two racial groups tends to have hot spots geographically apart from each other. The overall changes from the two methods of this research present that the index of dissimilarity corresponded to the hot and cold spots in general. Additional suggestions for future research and a summary of this thesis will be introduced in chapter 5.

Chapter 5: Results, Conclusion and Future Studies

5.1 Overview

Racial segregation is constantly the great concern to the city of Chicago and its region. The dissimilarity index and hot spot analysis have shown a slight decline in racial segregation as more African Americans opt to move to the suburbs and more whites, Hispanics and Asians move toward historically black communities. However, Chicago remains highly segregated between whites and African Americans and Asians and African Americans. It is still difficult to predict the future patterns of racial segregation in Chicago, but this research seeks to expand the understanding and identify the most recent changes in the pattern of racial segregation in Chicago by using GIS and statistical tools to examine recent data.

This last chapter concludes a discussion of improvements needed for the future study of racial segregation. Section 5.2 discusses the methodological limitations together with resource restrictions. Section 5.3 presents future studies on racial segregation of Chicago, with various perspectives and methods needed for long-term segregation pattern analyzation. This paper ultimately concludes with section 5.4, which summarizes the trends in racial segregation in Chicago from 2000 to 2014. The conclusions also offer a final thought regarding the current segregation patterns and future expectations for the region of Chicago.

5.2 Limitations

Although Chicago racial segregation issues have been studied previously by many scholars, this research presents the most recent update of the Chicago metropolitan area. Unfortunately, the 2015 census data was not released during the data collection period. However, data collected between 2000 and 2014 can still be used for future study to track the segregation pattern. Moreover, like many other studies, the index of dissimilarity in this research was only measured at the census tract level, which limited the accuracy of the measure. Due to the amount of numbers and the boundary change, block group level data were not available for this research. Additional calculations and hot spot analysis focusing on the dissimilarity index at the block group level may provide a more accurate result to help explain the inequity level of Chicago between races. More importantly, the distance threshold of 15,000 meters also influenced the accuracy of the Gi * statistical results for the hot spot analysis. The neighborhood distance that used for this research only ensured all census tracts to meet the minimum of one neighbor requirement. However, some census tracts have relatively smaller area but very dense population, where some census tracts have relatively larger area but rarely contain any resident. Using the 15,000-meter distance threshold resulted small census tract features to receive much more neighbor features than large census tract features which decreased the accuracy of the Gi* statistical results.

5.3 Future Research Possibilities

This research is an on-going project that keeps attention on racial segregation patterns. Future study should focus on how the patterns change as census data gets

updated. It is necessary to use aggregated block group level data and improve the accuracy of the results. In addition, there are more methodologies that can be used to measure the racial segregation level from different perspectives such as education and median household income. Adding education factor and median household income factor into calculation in future studies will help to explain the correlation between racial segregation and different variables. The method of regression analysis was not introduced in this thesis, utilizing regression analysis may be applicable for future research aimed at investigating how education and median household income might influence racial segregation.

It is also important to discuss more about the fast-growing ethnic group of Asian population in the future. This study mentioned Asian population as a general ethnic group. In fact, Asian population is made up by Chinese, Japanese, Korean, Vietnamese and many other nationalities. Future study should also discuss more detail into specific Asian nationalities to analyze the education and income level. Thus, a more detailed hot and cold spot maps of education and income for each ethnic group would reveal more distribution pattern.

5.4 Final Thoughts

Racial segregation in Chicago reflected relationships and interactions between each racial group. Although there are economic, cultural, and educational factors that can influence segregation levels, the index of dissimilarity results from this research revealed that the African American group has been significantly separated from the white and Asian groups. More importantly, the hot spot analysis geographically presented the

location where the clusters of high population proportions are located for each ethnic and racial group.

Despite the fact that the topic of racial segregation has been studied and measured in many different methods, the involving of hot spot analysis for this study was the first time it was used to study segregation in Chicago. Using hot spot analysis measured the cluster pattern of population proportions within the Chicago metropolitan area, and increased the accuracy of racial segregation measurement. Identifying racial segregation using a geospatial statistical method is an experimental breakthrough.

Research on racial segregation should not be limited only to Chicago, but should expand to include the entire United States. Therefore, the purpose of this research is to improve the understanding and knowledge of racial segregation in Chicago to the public. Also, measuring racial segregation with hot spot analysis seems fitting to provide an alternative perspective of the segregation issue.

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