Poverty in the Texas Triangle: A Megaregional View

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Author's Note

This report was completed as part of a semester-long project for a course in geospatial analysis at the University of Texas at Austin. The analysis area was inspired by my involvement in the Cooperative Mobility for Competitive Megaregions grant from the United States Department of Transportation. This time-constrained project left me with more questions than answers. My hope is that this body of work can contribute to the discourse of megaregional planning, as researchers and practitioners continue to evaluate the relationship between concentrated poverty and the built environment at varying scales.

EXECUTIVE SUMMARY

The existing body of research concerning geographic concentrations of people living below the poverty line proves that poverty does not adhere to jurisdictional boundaries. Researchers have proven that characteristics of poverty are far-reaching, from lasting effects of national economic downturns to lack of access to basic needs in the local community. Existing research includes evaluation of poverty characteristics from the national, state, and metropolitan scale. However, as metropolitan areas continue to grow, economic and physical interdependencies have provided the groundwork for areas known today as megaregions. This study examines the change of geographic concentrations of poverty from 1970-2010, and evaluates the possibility of the megaregion as a scale of analysis for enhanced coordination of service delivery to vulnerable populations. This report studies clusters of high percentage of populations living below the poverty line compared to the total population within a census tract in the Texas Triangle megaregion.

Using hotspot analysis, this study evaluates how clusters of poverty have changed geographically in Texas Triangle over the course of four decades (1970-2010) using U.S Census Data and American Community Survey data. The long-form questionnaire that previously collected poverty data was discontinued after 2000, and is now found in American Community Survey (ACS) data. A hotspot analysis was conducted for the dataset of each Decennial census from 1970-2000, and ACS 2006 – 2010 data for 2010. While many studies highlight the increase in poverty in suburban developments along the outer ring of metropolitan areas in recent years, this study confirms that areas experiencing the highest concentrations of poverty remain inside urban areas and surrounding rural areas.

By optimizing federal and state investments made in areas such as housing, transportation, local governments can plan complimentary investments in order to increase ease of access to basic needs. Additional study is recommended to compare other megaregions in the United States for more robust findings when assessing the megaregion as a scale of evaluation. Policy implications include elevating and integrating the topic of planning for populations living below the poverty line in ongoing megaregional research.

INTRODUCTION

In 1964, President Lyndon B. Johnson's declared a 'War on Poverty', which served as a catalyst for data collection and analysis concerning individuals living poverty in the United States. The first full U.S Census Bureau report on the subject of poverty was published in 1967, followed by the first decennial Census to collect information designating individuals above or below the poverty line[1]. Over the course of four decades, the way that the U.S measures poverty has evolved in tandem with available tools and technologies to combat a significant and widespread problem. Unfortunately, the widespread problem of poverty exists throughout the United States today.

Effects contributing to poverty are comprehensive, including but not limited to: access to transportation, access to healthcare, and access to daily needs and healthy food. The ability for a child to attend school on a regular basis, have food in their stomach, and work in an environment conducive to completing schoolwork is essential to the development of young generations; members of the generation who will ultimately evolve into our nation's future workforce. Basic needs remain absent from the lives of many families in the United States; due to a variety of factors contributing to this problem over time, there is a critical need to develop a multi-disciplinary approach to combat this phenomenon in a meaningful way.

Measuring Poverty

Since the initial poverty measure was defined, the long-form questionnaire of the U.S Census collected poverty information until 2000. The discontinuation of the long-form transitioned poverty data to be collected through the American Community Survey. Over time, there have been numerous attempts to augment data available about this vulnerable population. In November 2011, efforts by the Census Bureau and the Bureau of Labor Statistics culminated in a new estimate called the Supplemental Poverty Measure[2]. The new measure will be published annually by the Census Bureau with information on the effects of government programs that are not included in the official poverty measure. The United States Census determines if an individual is living in poverty if their total family income falls below the federally defined poverty level, which varies by family size and is adjusted each year for inflation[3]. The official poverty definition uses money income before taxes and does not include capital gains or noncash benefits (such as public housing, Medicaid, and food stamps)[4].

Why does this matter?

"The changing map of American poverty matters because place matters. It starts with the metropolitan areas, the regional economies that cut across city and suburban lines and drive the national economy. Place intersects with core policy issues central to the long-term health and stability of metropolitan areas and to the economic success of individuals and families…"[5]

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[1] Economics and Statistics Administration. "Measuring America. Poverty: The History of a Measure." United States Census Bureau; U.S Department of Commerce, June 23, 2016. https://www.census.gov/library/visualizations/2014/demo/poverty_measure-history.html.

[2] See supra note 1.

[3] "How the Census Bureau Measures Poverty." United States Census Bureau, August 11, 2017. https://www.census.gov/topics/income-poverty/poverty/guidance/poverty-measures.html.

[4] See supra note 3.

[5] Kneebone, Elizabeth. Confronting Suburban Poverty in America. Place of publication not identified: Brookings Institution Pr, 2014.

The amount of and location of people living in poverty should be a concern to planners nationwide, as they influence a built environment that influences choices available to members of all populations. In explaining the importance of the role that planners play in creating the built environment, Gary Hack wrote "The pattern of settlement has immediate human consequences, affecting the choices individuals make in organizing their lives."[6] He goes on to describe the potential for disparate impact through urban form, and how spatial relationships can affect members of society differently, particularly populations who have fewer resources to make choices regarding location. Individuals living in poverty are most likely to have resource accessibility issues, most often to basic needs. Evaluating this problem from a geo-spatial perspective allows planners and policy makers to consider programs that may yield disparate geographic consequences or benefits over time.

When thinking about poverty, a typical image that comes to mind is a blighted area or "slum", most frequently thought of as present in urban areas. However, the Brookings Institute produced a 2006 report analyzing spatial patterns of poverty, and observed that "…almost every major metropolitan area in the country has experienced rising poverty beyond its urban core."[7] This phenomenon has been concluded in many studies over several decades, increasing the understanding that poverty exists in all types of places, including suburbs and rural communities. In fact, in a 2013 report evaluating concentrations of poverty in metropolitan areas across the United States, Paul Jarowsky conducted a study that included geospatial analysis to compare changes in clusters of poverty populations in metropolitan areas. He found that the most dramatic increase occurred in smaller metropolitan areas, as opposed to large metropolitan areas where poverty is considered most prominent.[8]

Emerging Megaregions

"Regional planning, as a measure of regional coordination, is a factor that improves the economic welfare of the region. A region's success at competing on a global scale must be linked to its ability to coordinate and plan for economic functionality on a much larger scale than the city or metropolitan area. The increasing complexity and fragmentation are leading to an ever-widening spatial mismatch between a region's planning authority, its decision-making and economic functionality, and the related effects."[9]

As urban functions and spatial relationships continue to spread across jurisdictional boundaries into nonurban areas, so do ramifications of spatial investments and policy decisions regarding "interregional and intraregional transportation, land availability, economic competition, housing availability and

[6] Sanyal, Bishwapriya, Lawrence J. Vale, and Christina D. Rosan. Planning Ideas That Matter: Liveability, Territoriality, Governance, and Reflective Practice. Cambridge, MA: The MIT Press, 2012.

[7] Erickson, David, Carolina Reid, Lisa Nelson, Anne OShaughnessy, and Alan M. Berube. The enduring challenge of concentrated poverty in America: case studies from communities across the U.S. Richmond, VA.: Federal Reserve Bank of Richmond, 2008.

[8] Jargowsky, Paul A. "Concentration of Poverty In the New Millennium: Changes in Prevalence, Composition, and Location of High Poverty Neighborhoods." The Century Foundation and Rutgers Center for Urban Research and Education. Accessed November 28, 2017. https://tcf.org/assets/downloads/Concentration_of_Poverty_in_the_New_Millennium.pdf.

[9] Ross, Catherine, and Adjo A. Amekudzi. *Megaregions: Planning for Global Competitiveness*. Washington DC: Island Press, 2014.

affordability, natural resource management, and quality of life"[10] Spatial relationships that already exist begin to become increasingly complex as effects are seen farther reaching than ever before. Catherine L. Ross makes that case that as transportation planning adapts to change and demographic needs, the megaregion is the next evolution of planning to respond to requirements of sustainable development.[11]

While many programs that provide a safety net are funded and administered at state and local levels, a question remains to be investigated about the scale at which poverty is evaluated. Megaregions are becoming increasingly connected with advancement of technology and growing economies. These areas are linked by the advancement of commerce and increased wealth, and megaregional transportation planning seeks to provide more efficient movement of people and goods. Many studies have evaluated effects on poverty based on differing geo-spatial scales, primarily at the metropolitan, county, and neighborhood level. As megaregional planning evolves with a goal of global competitiveness and linking areas of commerce, a question remains: what is happening in smaller municipalities or rural areas in between anchor cities? Is the increase in production and growth of wealth spilling over into areas connecting the megaregion? In the Texas Triangle megaregion, any major improvement or advancement to connect anchor cities will have an impact on surrounding communities.

The California Department of Public Health conducted a hotspot analysis to identify areas for focused resource investment for Women, Infants and Children and Maternal, Child, and Adolescent Health programs. The California Department of Public Health epidemiologist explained the importance of understanding geospatial analysis and local of higher densities of people with unmet needs for decisions regarding resource allocation.[12] Similarly, service-provider agencies across the Texas Triangle can use hotspot analyses to identify areas to focus investments and optimize resources through collaboration to better meet the needs of people living in deep poverty.

Study Area: The Texas Triangle

The Texas Triangle is defined by anchor cities: Houston, Dallas, San Antonio, and Austin. Megaregions are typically anchored by specific metropolitan areas, and have generally defined boundaries. For the purposes of this study, surrounding counties have been included in the "megaregion" for the purposes of a comprehensive perspective when analyzing changes over time. Additionally, surrounding counties were added in order to augment results of the hot spot analysis for areas surrounding metropolitan places.

[10] See supra note 6.
[11] See supra note 6.
[12] Esri News. "Esri Helps Calirofnia Agencies Locate Regions with Unmet Needs." Hot-Spot Analysis Identifies Potential WIC Recipients (blog), August 11, 2011. https://www.esri.com/news/releases/11-3qtr/hotspot-analysis-identifies-potential-wic-recipients.html.

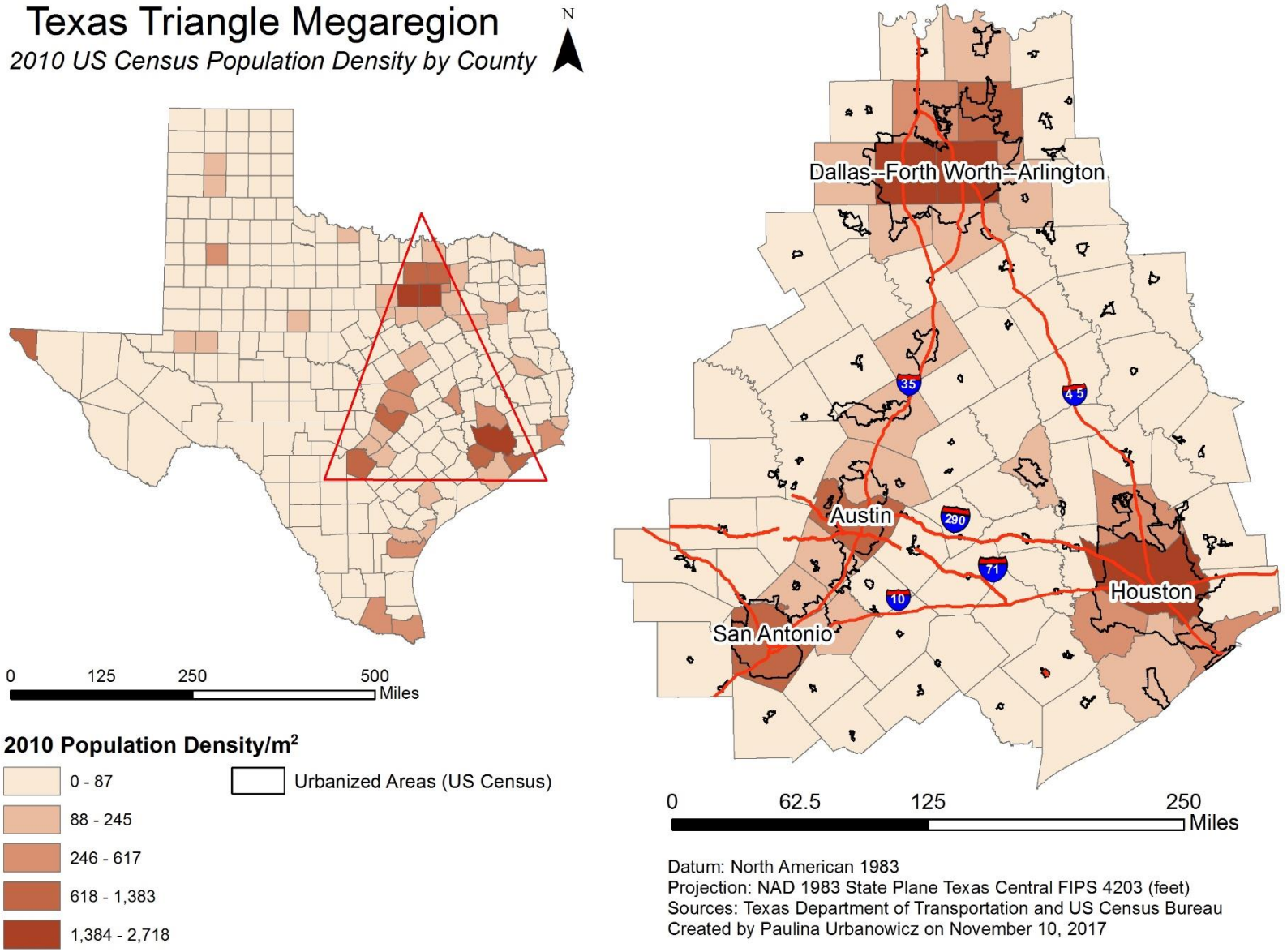


Figure 1: *(left to right) Population density per square mile by county of the state of Texas; Texas Triangle megaregion boundaries established as the study area for this report.*

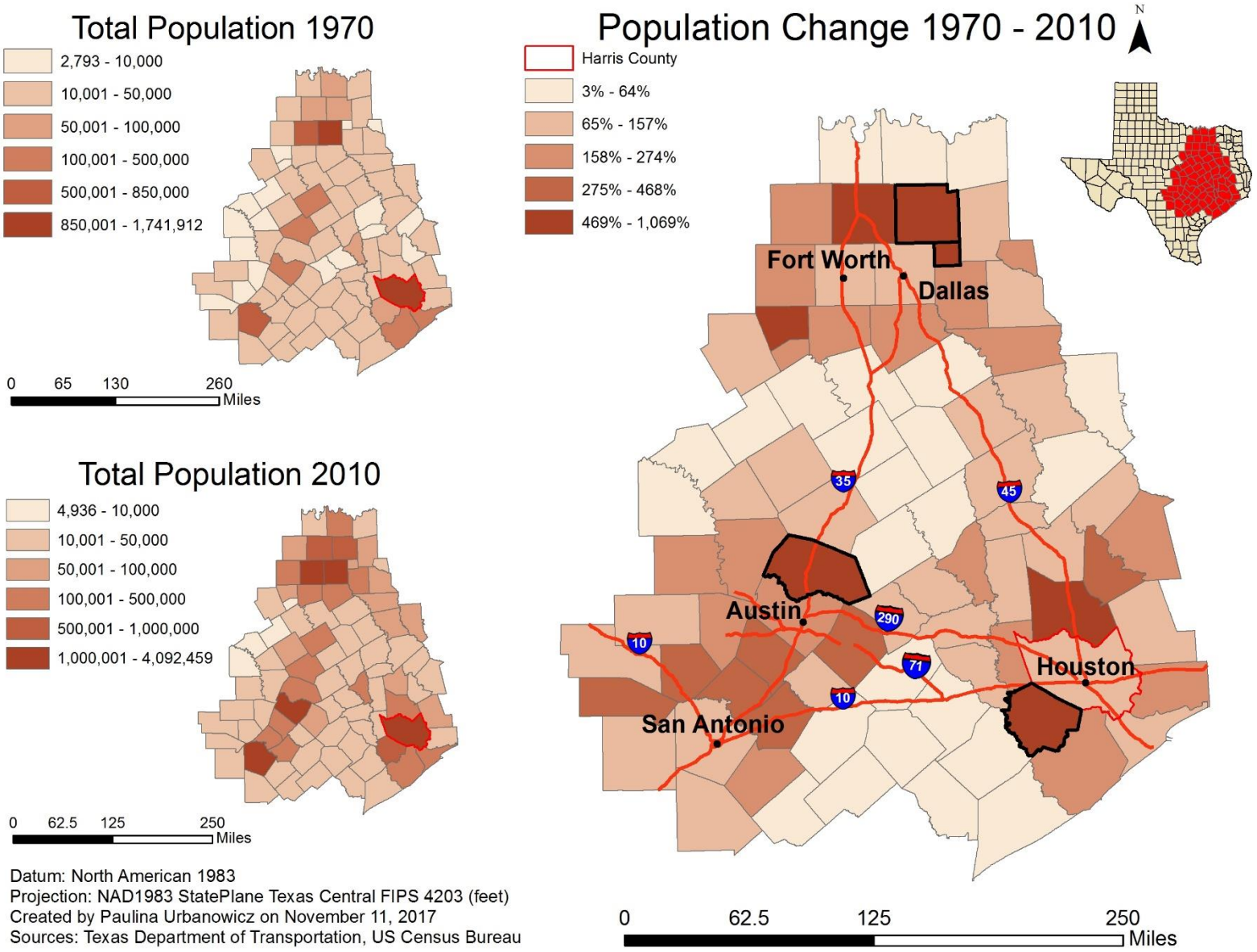


Figure 2: *This map displays the total population of the Texas Triangle megaregion by county in 1970 and 2010 for context of how Texas Triangle cities have evolved over time. The third map includes displays population change by county between 1970 and 2010. Harris County is depicted with a red outline, shown as the county with the highest population in both 1970 and 2010. Counties outlined in black experienced a population increase of over 1000% between 1970 and 2010: Rockwall, Collin, Williamson and Fort Bend.*

"Over the past 30 years, agriculture's share of jobs in rural and small-town America has dropped by half."[13] No stranger to changing economical tides, municipalities throughout the Texas Triangle are continuing to adjust to global changes in both location of manufacturing plants as well as the reliance in technology and its impact on the evolution of farming and manufacturing industries.

Table 1. Total Population of the State of Texas living in the Texas Triangle Megaregion.

U.S. Census	Total Population	Population living within the megaregion	Percent of Total Population living in the megaregion
1970	11,195,431	7,142,477	64%
1980	14,229,191	9,366,119	66%
1990	16,986,510	11,682,414	69%
2000	20,851,820	14,821,402	71%
2010	25,145,561	18,407,043	73%

Note: megaregion boundaries in this table are as defined by anchor cities and counties surrounding anchor cities for the purpose of geospatial analysis conducted in this study.

Table 2: Associated with Figure 3; county outline in red is reflected below.

County	Associated Urban Area	Total Population: 1970	Total Population: 2010
Harris County	Houston	1,741,912	4,092,459
Dallas County	Dallas	1,327,321	2,368,139
Bexar County	San Antonio	830,460	1,714,773
Tarrant County	Fort Worth	716,317	1,809,034
Travis County	Austin	295,516	1,024,266

Table 3: Counties with over 1000% of Population Change

County	Greater Urban Area	Total Population: 1970	Total Population: 2010
Rockwall	Dallas	7,064	78,337
Collin	Dallas	66,920	782,341
Williamson	Austin	37,305	422,679
Fort Bend	Houston	52,268	585,375

In his book studying concentrated poverty nationwide from 1970 – 1990, Paul Jargowsky identified poverty as an effect, as opposed to a cause, saying that increased poverty in many northern cities was "the changing opportunity structure faced by the minority community and, to a lesser degree, the changing spatial organization of the metropolis."[14] Just as metropolitan areas were and continue to evolve over time, the emergence of megaregional planning in the last decade has begun changing the landscape at a higher scale, and arguably, to a greater degree. In a 2013 study, Jarowsky used 2000 Census Data and ACS data to evaluate concentrations of poverty in U.S metropolitan areas. In a regional comparison, the South region took second place for the largest increase in concentrated poverty between

[13] See supra note 7.

[14] Jargowsky, Paul A. Poverty and place: ghettos, barrios, and the American city. New York: Russell Sage Foundation, 1998.

2000 and 2010.[15] Findings of this report include that high poverty neighborhoods tend to be decentralized and disconnected, and that the areas that experienced the most significant increases in concentrated poverty occurred in small to mid-sized metropolitan areas, as opposed to in cities.[16]

As poverty becomes a problem of increasing scope and reach, the question of alleviating effects of poverty on populations experiencing poverty called for new approaches to a question asked and studied for 57 years.[17] Decreasing the amount of people living in poverty in a megaregion is critical to the long-term success of a megaregion. This study seeks to investigate the question of concentrated clusters of high percentages of people living in poverty in order to consider policy changes related to megaregional planning.

[15] See supra note 8.
[16] See supra note 8.
[17] See supra note 7.

PROBLEM STATEMENT

This study evaluates concentrations of poverty in Texas from a megaregional scale, focusing on the Texas Triangle. In an effort to add to the body of research regarding patterns of poverty in metropolitan areas conducted from 1970-1990, and 2000-forward, this evaluation includes a continuous analysis of patterns of poverty from 1970 – 2010 using U.S Decennial Census and American Community Survey data. Research suggests that a spatial analysis will yield a rapid increase in suburban poverty[18], and that the most significant increase in concentrations of poverty will occur in smaller metropolitan areas, as opposed to large metropolitan areas.[19]

Catherine L. Ross, a megaregion expert, wrote that "The new and dynamically growing patterns of urban space and functionality at the metropolitan and regional levels demand more creative forms of service delivery. For example, development patterns in one jurisdiction may lead to traffic congestion in others and often adversely affect the quality of life and health. These issues are interrelated; yet the decision and planning processes continue to take place discretely."[20] This study applies a megaregional perspective for multiple reasons: to acknowledge that poverty is not confined to jurisdictional boundaries; to seek increased understanding of the spatial effects of interdependent forces between metropolitan areas and regions, and to introduce considering how investments might affect people living below the poverty line as an importance piece to be considered in megaregion research. As solutions are considered to various transportation and economic problems at the megaregional scale, the decision-making process should inherently include planning for people who are unable to participate or plan for themselves, by optimizing opportunities for connecting populations in poverty to increased transportation choices, or strategically focusing statewide resources for a combined greater effect at the local level. In an effort to contribute to informing this perspective, this study explores the following questions:

1. Does a visible spatial trend exist from the megaregional standpoint in the evolution of poverty since the United States began to measure it?
2. Could the megaregion be an appropriate scale to evaluate factors affecting poverty in a more comprehensive fashion than at a metropolitan or regional level to inform planning and policy decisions?

[18] See supra note 7.

[19] Jargowsky, Paul A. "Concentration of Poverty In the New Millennium: Changes in Prevalence, Composition, and Location of High Poverty Neighborhoods." The Century Foundation and Rutgers Center for Urban Research and Education. Accessed November 28, 2017. https://tcf.org/assets/downloads/Concentration_of_Poverty_in_the_New_Millennium.pdf.

[20] See supra note 9.

METHODS

After discovering that Census tracts have discrepancy over time, I decided to use Census tract information adjusted to 2010 geographies produced by Social Explorer. This information was available at the census tract level, which would allow the study to include and consider nuances of different places within the megaregion. Coming to the decision of what tables to use evolved from trial and error, and discovering what datasets existed, how datasets were compatible or incompatible for comparison across four decades. The most pertinent information to obtain would be a count of people living below the poverty line in a census tract. This necessitated spending time looking through data to account for and ensure any discrepancies or changes between Census periods, and evaluate how the alteration of questions could or would affect the overall analysis and report.

Hotspot analysis are conducted in order to identify statistically significant clusters of high values and statistically significant clusters of low values of a given dataset. Clustered high values are typically displayed in red, showing 'heat', and clusters of low values are typically displayed in blue, showing a 'cold' value in the given dataset. This study conducts a hotspot analysis on the percentage of people living in poverty of the total population in a census tract within the Texas Triangle megaregion.

Downloaded the following information:

- Shapefile for the state of Texas, U.S Census shapefile by County, 2010
- Interstate Highway network from Texas Department of Transportation website
- U.S Census data through Social Explorer to download total population and area for each county in Texas (1970 and 2010). Used dataset that is prepared for 2010 boundaries in order to achieve consistency where possible in analysis, and for ease of comparison.
- Poverty data from Decennial Census (1970-2000) and ACS 2006-2010, based on 2010 Geographies

All Census datasets used in this analysis were downloaded from Social Explorer:

- Table SET90: Poverty Status of Unrelated Individuals by Age, and SET80: Poverty Status for Families - 1970 Census based on 2010 Geography
- Table SET82 – 1980 Census based on 2010 Geography
- Table SET65.006: "Income in 1989 below poverty level" – 1990 Census based on 2010 Geography
- Table RC2000SF3: P87. Poverty Status in 1999 by Age – 2000 Census based on 2010 Geography
- Table B17001: Poverty Status in the past 12 months by sex and age - 2006-2010 ACS 5 year estimate

Steps to conduct analysis:

Descriptive maps (Figure 1-2)

- Projected the Texas county shapefile and major highways into: NAD 1983 State Plane Texas Central FIPS 4203 (feet).
- Created spreadsheet including population information for both 1970 and 2010 datasets in Excel
    - Calculated population density for 1970 and 2010

    - Calculated percent growth in population between 1970 and 2010.
- Joined Excel spreadsheet of 2010 Census data with the shapefile of counties.
- Used "select by attribute" tool to select counties to include in megaregion for analysis maps.
- Mapped and symbolized as needed.

Analysis Maps: (Figure 3–10)

- Projected the Texas census tract shapefile and major highways into: NAD 1983 State Plane Texas Central FIPS 4203 (feet).
- Prepared spreadsheet information to ensure successful 'join' with ARCGIS. Created new uniform field to join based on FIPS code.
- Joined spreadsheets for each decade to the shapefile with Texas Census Tracts.
- Data prep
    - Made excel spreadsheets with the following census tables for hot spot analysis
    - 1970
        - Joined it to 2010 boundary file
        - Created county of population living below the poverty line by combining the following tables: Count of unrelated individuals above 14 living below the poverty line and count of families living below poverty level. Based on limitations described below and available data, this was the most accurate reflection of poverty count available. This includes an assumption unrelated individuals 14 + up includes individuals that are 65 + up.
    - 1980, 1990, 2000 table information
        - Joined it to 2010 boundary file
    - 2010
        - Calculated population living below poverty using the dataset: Income in the last 12 months below poverty level.
        - Joined it to 2010 boundary file *Renamed category to BelPovLin – Incomein12, but it's income in the past twelve months that have been below poverty line.
- Created a model for each dataset in order to:
    - Initially, conduct hotspot analysis for entire state of Texas, in order to compare findings and evaluate the value of conducting analysis within the megaregion boundary.
    - Used the "clip" tool for each layer to the megaregion boundary created for descriptive maps, to produce a new version of all information for all four decades for only the megaregion.
    - Subsequently ran a hot-spot analysis to see where people living in poverty are most concentrated, and if that has changed over time within the megaregion boundary.
    - Symbolized data in order to communicate the confidence level of the statistically significant hot spot.
    - Analyzed findings and restructured or repeated aspects of the model as needed.

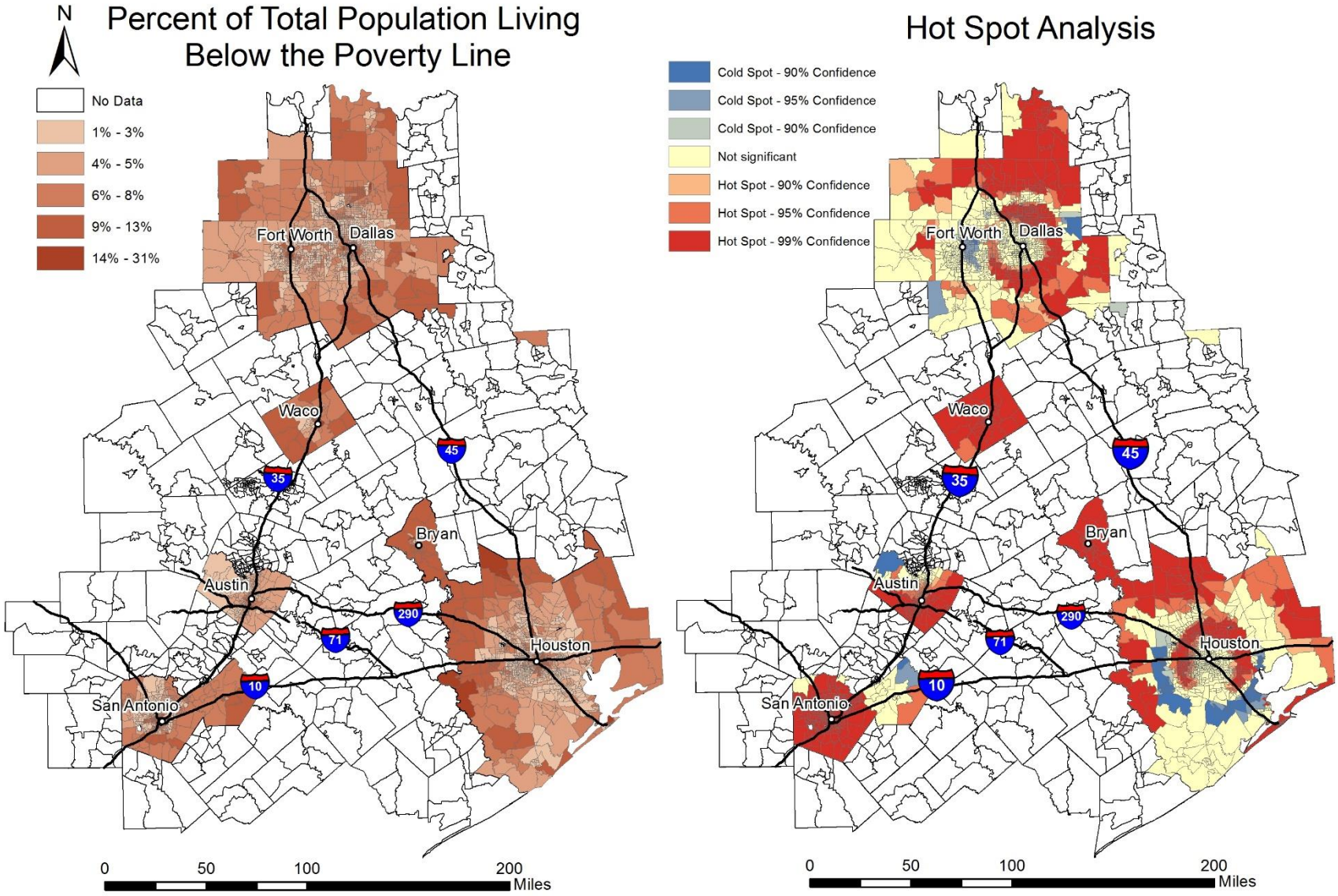
A hotspot analysis tool measures the intensity of high or low attribute values within a given polygon feature. The tool produces a Z-score and a p-value for each polygon, in this case, for each census tract.

Z-scores indicate whether census tracts with either high or low values are clustered spatially. In order to be a statistically significant hot spot, a census tract with a high value will be surrounded by other census tracts with high values. The statistically significant z-score is produced when the clustering is too significant to be the result of random chance. For statistically significant positive z-scores, a larger z-score indicates a more intense clustering of high values: a hot spot. Similarly, the lower that a negative z-score is indicates a more intense clustering of low values: a cold spot. Hot spots are identified by areas with high values clustered together, and cold spots are identified by areas with low values clustered together. The maps provided show both hot and cold spots in order to visually evaluate change over time and side-by-side comparison. Evaluating each map per decade and symbolizing areas based on statistically significant clustering allowed for a consistent unit of analysis to compare over time.

FINDINGS

See pages 14-21.

1970: Population Living Below the Poverty Line



Created by Paulina Urbanowicz on December 5, 2017 | North American Datum 1983 | Projection: StatePlane Texas Central FIPS 4203
Sources: U.S. Census via Social Explorer; U.S Census Bureau

Figure 3

1980: Population Living Below the Poverty Line

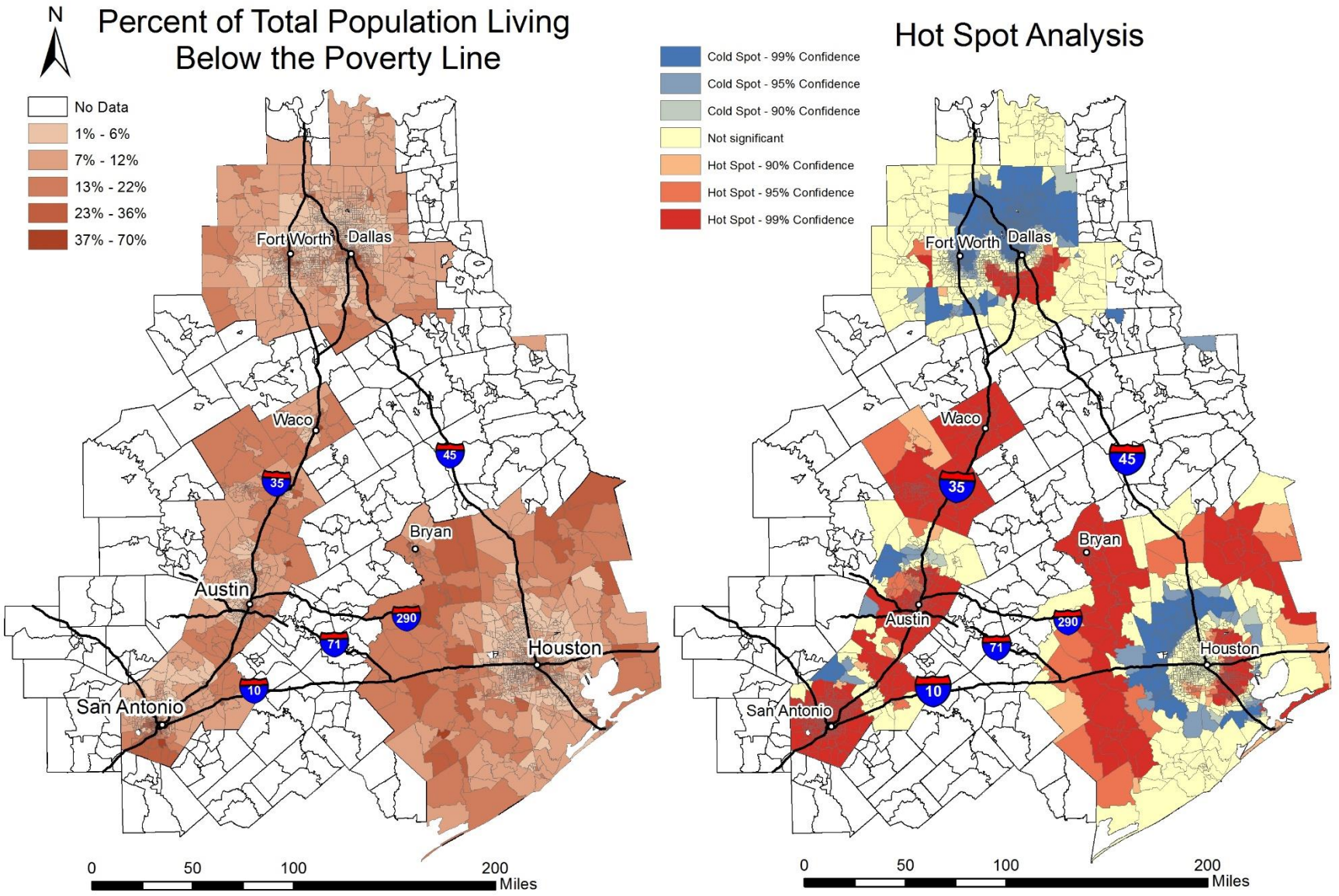


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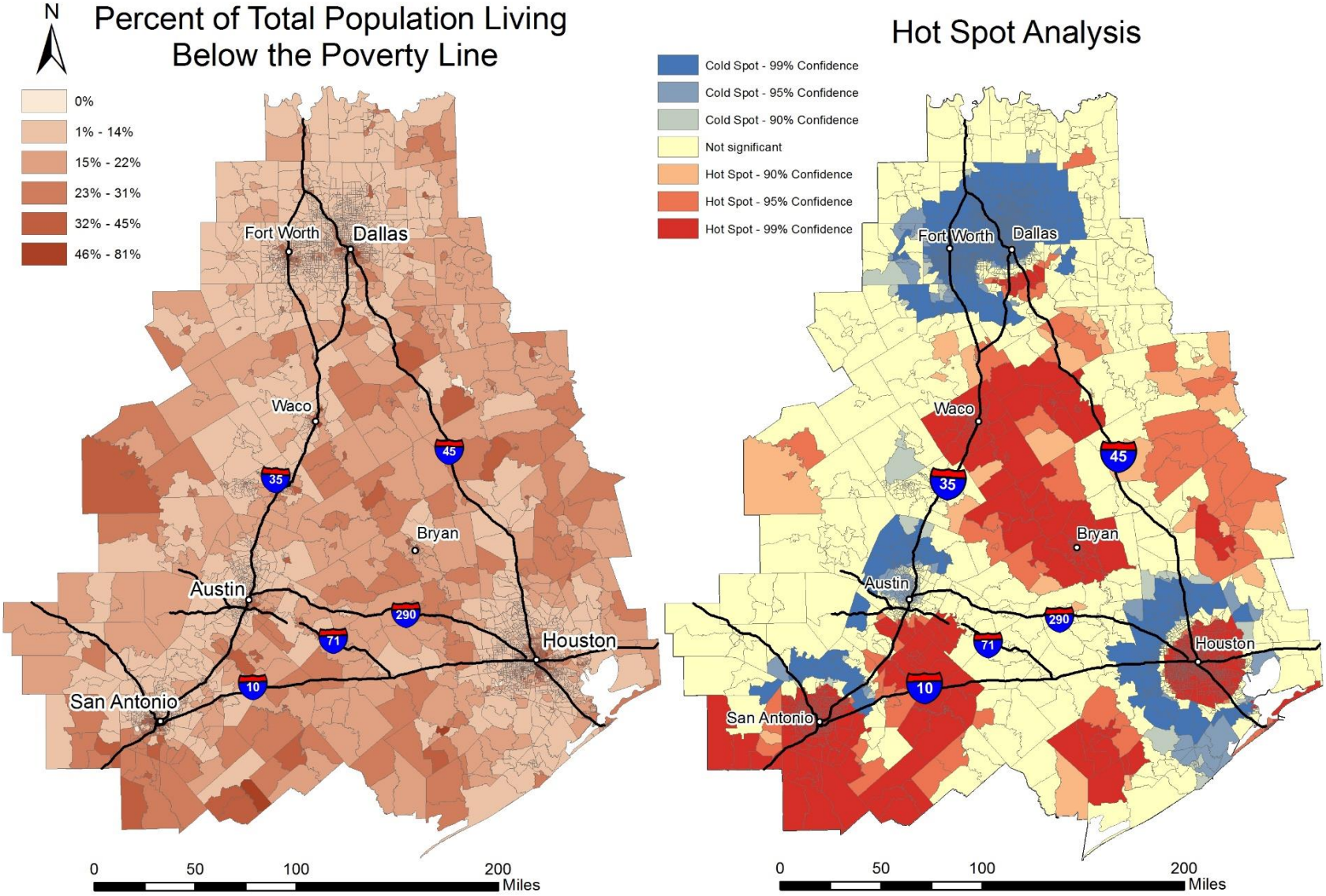
Figure 4

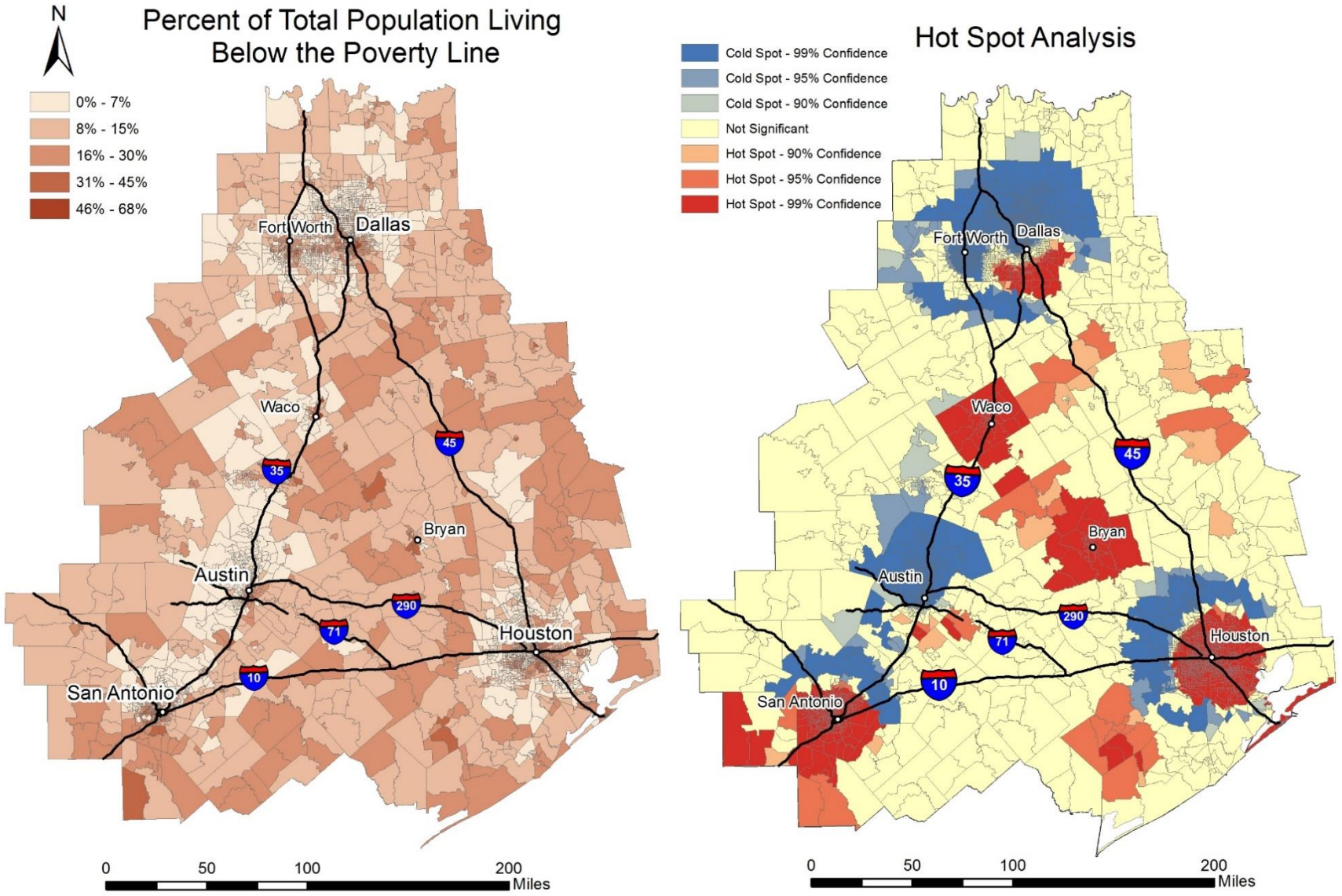
1990: Population Living Below the Poverty Line



Created by Paulina Urbanowicz on December 5, 2017 | North American Datum 1983 | Projection: StatePlane Texas Central FIPS 4203
Sources: U.S. Census via Social Explorer; U.S Census Bureau

Figure 5

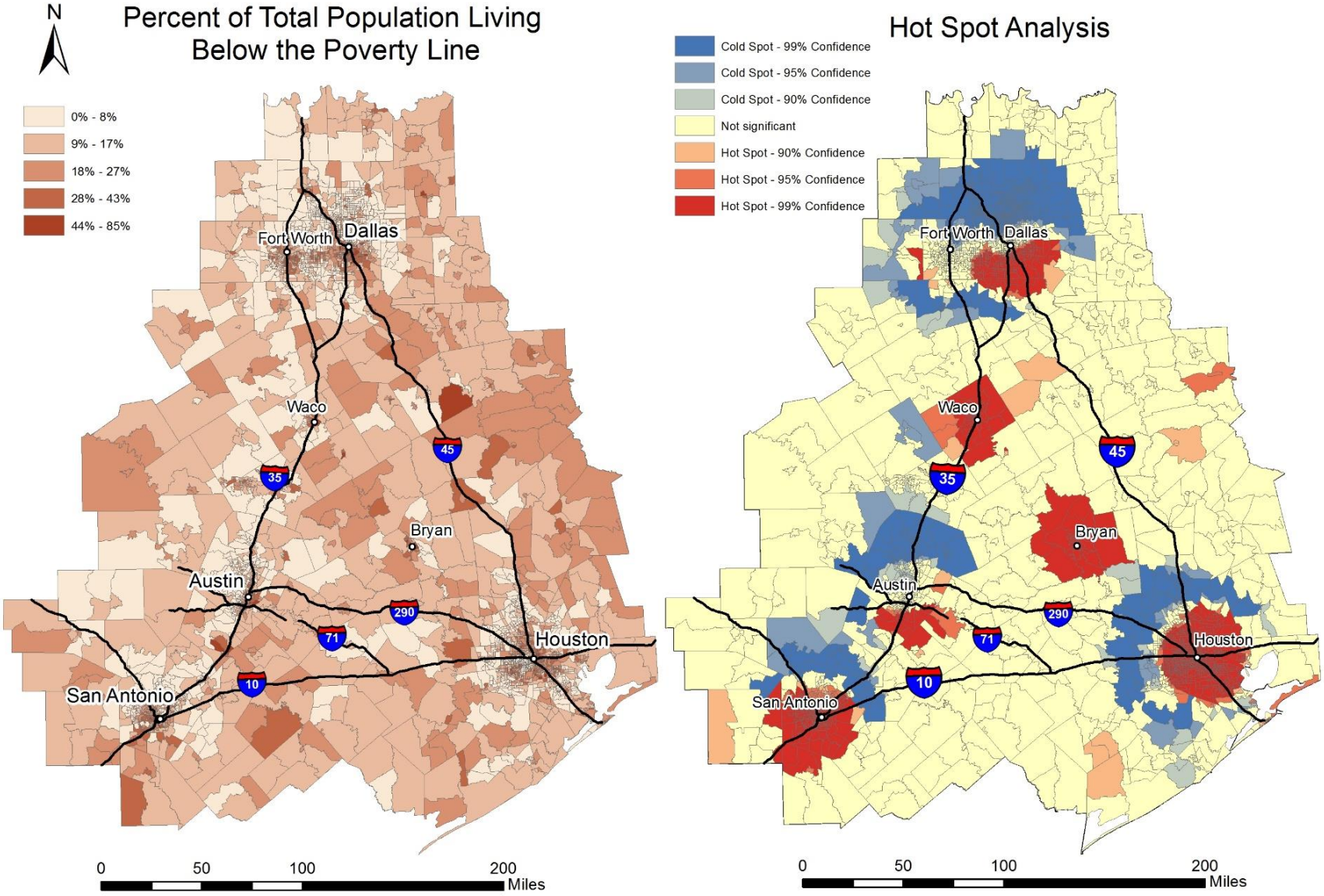
2000: Population Living Below the Poverty Line



Created by Paulina Urbanowicz on December 5, 2017 | North American Datum 1983 | Projection: StatePlane Texas Central FIPS 4203
Sources: U.S. Census via Social Explorer; U.S Census Bureau

Figure 6

2010: Population Living Below the Poverty Line



Created by Paulina Urbanowicz on December 5, 2017 | North American Datum 1983 | Projection: StatePlane Texas Central FIPS 4203
Sources: U.S. Census via Social Explorer; U.S Census Bureau

Figure 7

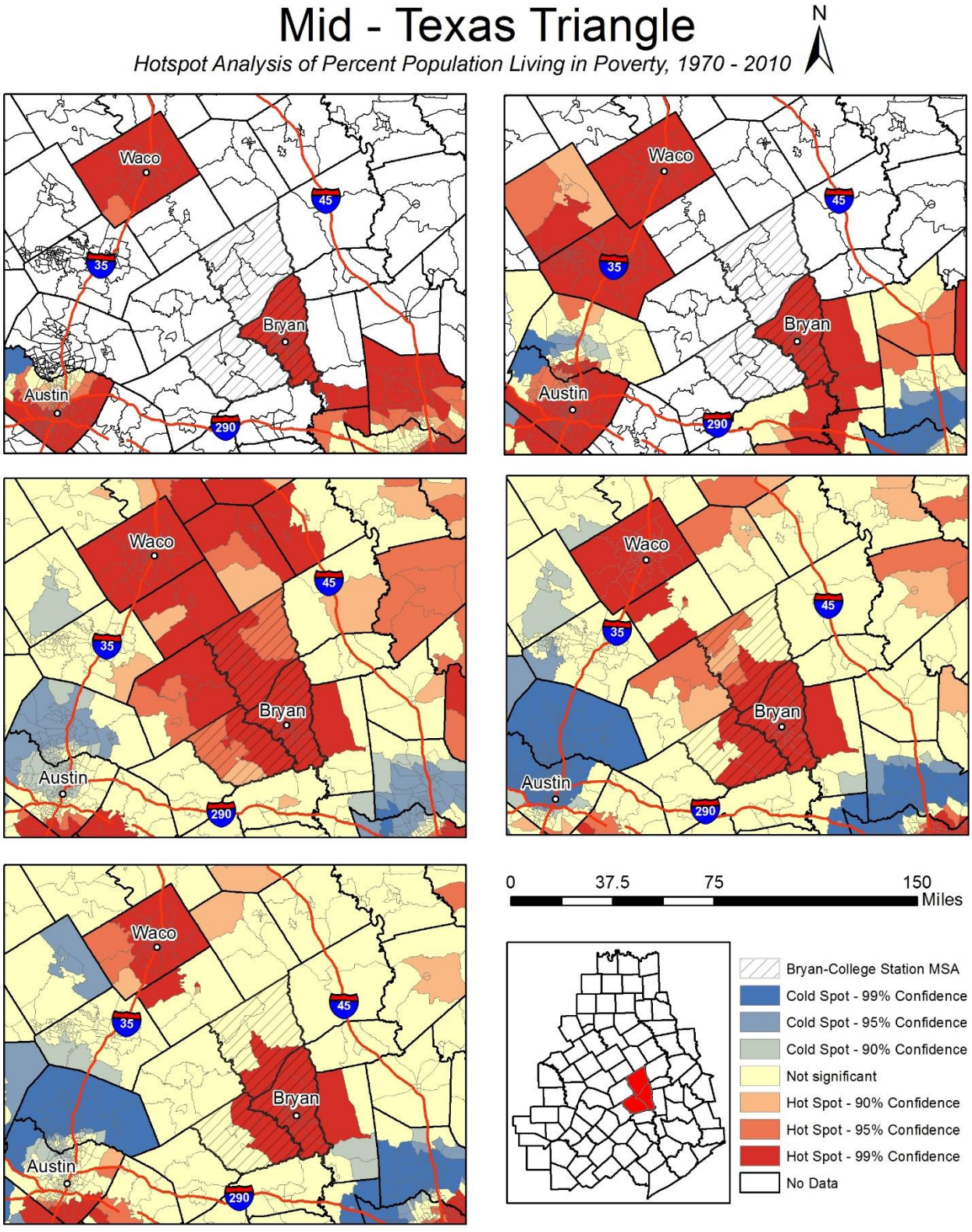


Figure 8: This map examines smaller metropolitan areas in the middle of the Texas Triangle to evaluate how concentrations of poverty have shifted over time.

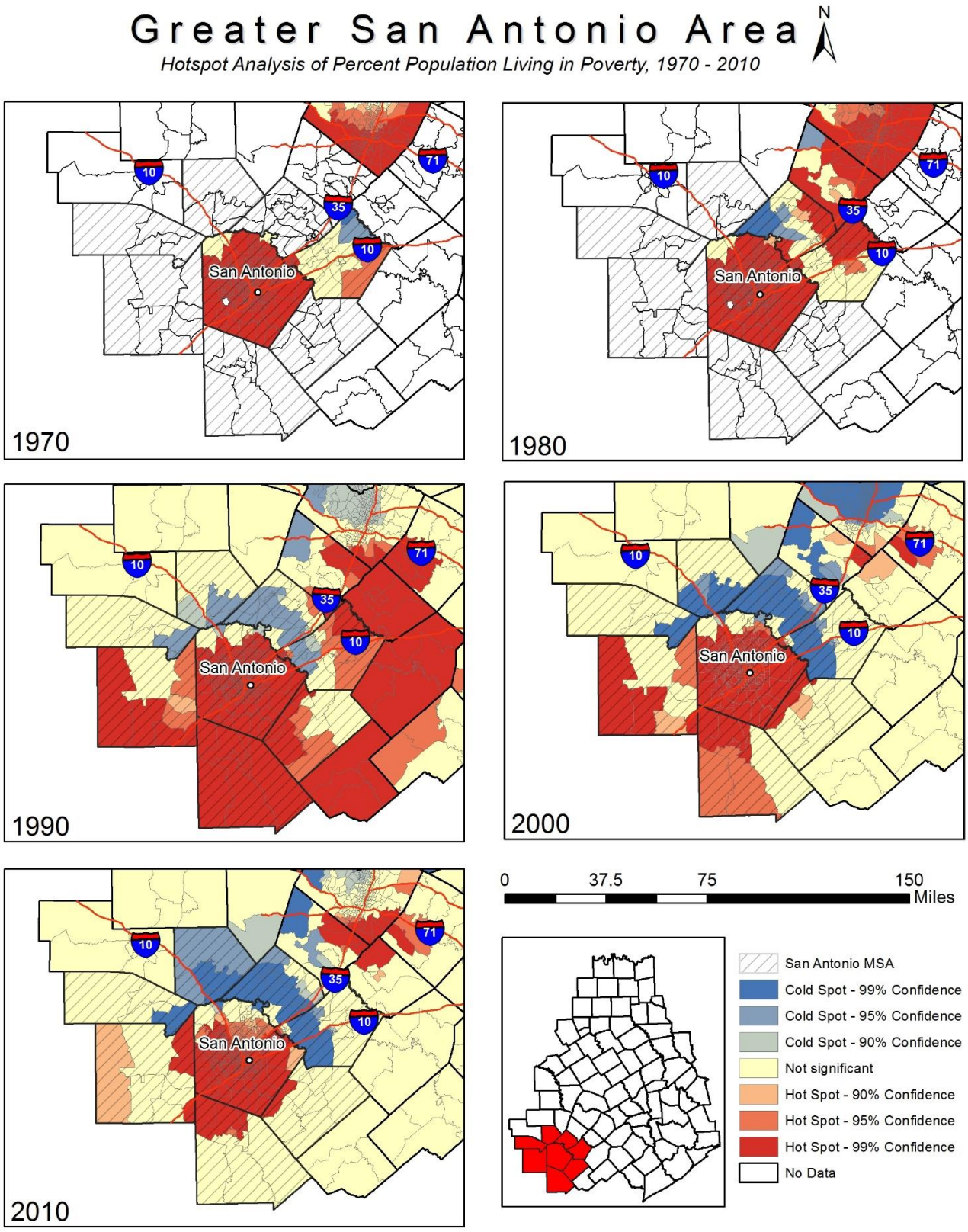

Greater San Antonio Area
N
Hotspot Analysis of Percent Population Living in Poverty, 1970 - 2010
1970
1980
1990
2000
2010
San Antonio
10
35
71
0
37.5
75
150
Miles
San Antonio MSA
Cold Spot - 99% Confidence
Cold Spot - 95% Confidence
Cold Spot - 90% Confidence
Not significant
Hot Spot - 90% Confidence
Hot Spot - 95% Confidence
Hot Spot - 99% Confidence
No Data
Created by Paulina Urbanowicz on December 8, 2017 | North American Datum 1983 |
Projection: StatePlane Texas Central FIPS 4203 | Sources: U.S. Census via Social Explorer; U.S Census Bureau

Figure 9

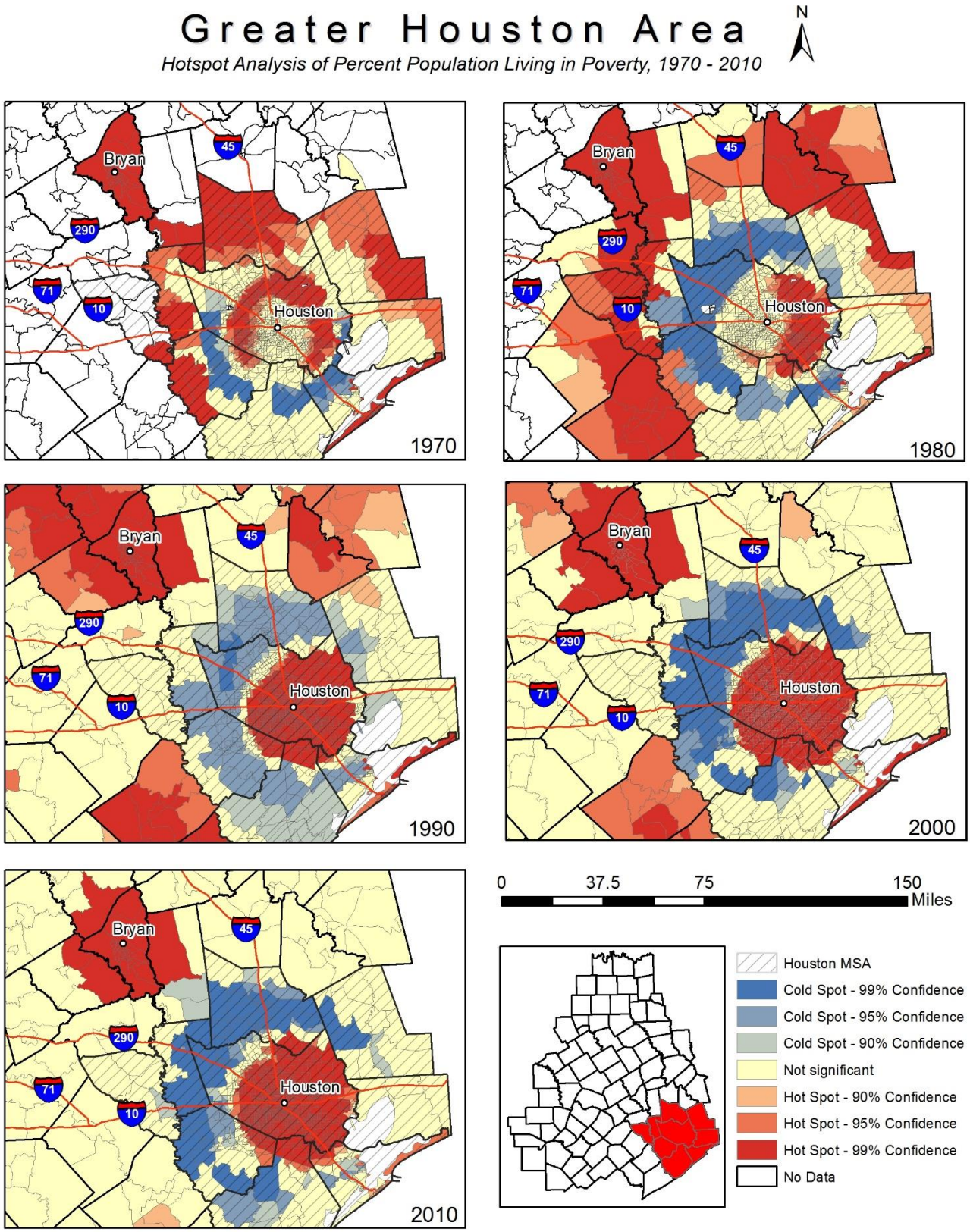

Greater Houston Area
Hotspot Analysis of Percent Population Living in Poverty, 1970 - 2010
N
Bryan
Houston
45
290
71
10
1970
1980
1990
2000
2010
0
37.5
75
150
Miles
Houston MSA
Cold Spot - 99% Confidence
Cold Spot - 95% Confidence
Cold Spot - 90% Confidence
Not significant
Hot Spot - 90% Confidence
Hot Spot - 95% Confidence
Hot Spot - 99% Confidence
No Data
Created by Paulina Urbanowicz on December 5, 2017 | North American Datum 1983 |
Projection: StatePlane Texas Central FIPS 4203 | Sources: U.S. Census via Social Explorer; U.S Census Bureau

Figure 10

DISCUSSION

Throughout each decade, a strong trend of concentrated poverty remains visible in major metropolitan areas as well as along an outer ring surrounding metropolitan areas. Due to redrawing of census tract boundaries, maps created for 1970 and 1980 show many census tracts with no data. The jump in data collection and creation of new census tracts is seen in 1990, where boundaries are redrawn because of population increase. Blue rings of "cold spots" appear well-defined outside of the Houston and Dallas metropolitan areas, showing concentrations of low percentage levels of poverty in terms of total population. The change in the Dallas area between 1970 and 1980 where a hot spot changes into a cold spot begs the question of if the change is a result of dramatic population increase, ultimately lowering the percent of poverty population, and/or if people living in poverty moved outside of those census tracts toward Oklahoma.

Similarly, the Houston area (Figure 10) shifts after 1970 to show a significant cold spot in surrounding suburbs including what are known today as the Woodlands, Sugarland, and Katy areas. These areas remain consistently statistically significant spots of clustered low values of percent of people living in poverty compared to total population.

The same question emerges for San Antonio (Figure 9). As increased data is available in 1990, large concentrations of poverty are visible in the southern ring of census tracts and counties surrounding San Antonio. The transition between 1990 and 2010 may be a combined result from dramatic population increase, and from poverty populations moving southward, away from and outside of the megaregion.

Perhaps most interesting, the progression of data in the middle of the Texas Triangle supports earlier research determining that poverty is increasing the fastest in small municipalities. This is first seen in the jump between 1970-1990 along the corridor of Interstate Highway 35, which becomes diluted over time as population and employment centers continues to increase between Austin and Dallas. In 1990 (Figure 8), as data is available for census tracts between Bryan and Waco, a big jump is seen in concentrated poverty in the middle of the Texas Triangle. While this seems to taper off in 2000 and 2010, this seems to be a result of population increase when compared to **Figure 2**. Counties depicted in **Figure 2** as experiencing the greatest population increase between 1970 and 2010 do not show a distinct pattern. While this study does not shed light on the increase in poverty in suburban areas, it does confirm that urban and rural areas maintain the highest amount of clustering of poverty, and have maintained this over the course of four decades.

As stated by Norman and Susan Fainstein, "policies to ameliorate spatial inequalities require people-and place-based approaches." In order to make substantial change in the trends seen today, a multi-pronged approach must be implemented. This is not to suggest an extra level of governmental or quasi-governmental formation at the megaregional level. Majority of existing people-based redistributive programs are funded by the federal government (Medicare, Medicaid, Social Security, SNAP, Temporary Aid to Needy families and Earned Income Tax Credit).[21] Fainstein and Fainstein suggest approaches for place-based programs to emerge from states to promote equity through economic development programs, and regulatory reforms to encourage increased equality in spatial regulations, and alleviate spatial inequality.

[21] See supra note 8.

Limitations:

- There is an inherent limitation in comparing Decennial Census Data to American Community Survey Data because ACS data samples significantly less people than the U.S. Census, and therefore has a higher margin of error. However, after the discontinuation of the long-form of the U.S Census, poverty data collection was transferred to ACS collection methods. In more recent years, the Supplemental Poverty Measure provides additional robust data to complement ACS data. The data used for 2010 is taken from a 5 years ACS estimate from 2006-2010.
- The 1970 Census asked slightly different question in collection of poverty data. One limitation is that the data showing people living below the poverty line in 1970 in this analysis was created from adding the number of unrelated individuals above 14 living below the poverty line, and the number of families living below the poverty line. This limitation will present a smaller number in overall population living in poverty. Changes in how the Census Bureau collected poverty data from 1970 – 1990 were evaluated to have a slight impact on the number of people recorded.[22]
- In analysis maps provided, white census tracts designated "no data" represent census tracts in 2010 that did not exist in 1970 and 1980. However, using 2010 geography allows for comparison across decades that would otherwise have different census collection boundaries. Census tracts in yellow on all maps represent a lack of statistically significant clusters of high percentage of poverty population, or low percentage of poverty populations. Social Explorer relocated original U.S. Decennial Census boundaries using interpolation weights found in the Longitudinal Tract Data Base to preserve uniformity and comparability of original U.S Census Data. [23]
- This study evaluates only populations determined to be living below the federal poverty line; populations of individuals living slightly above the poverty line and/or with low levels of incomes are also vulnerable to poverty concerns, and should be evaluated for additional context in future studies.
- Poverty status cannot be determined for people in institutional group quarters such as prisons, mental hospitals or nursing homes, college dormitories, Military barracks, living situations without convention housing, and unrelated individuals under 15; therefore, these people are not included in the overall count of individuals living below the poverty line.[24]

In an evaluation of characteristics of places of poverty in his book *Poverty and Place: Ghettos, Barrios, and the American City*, among issues such as dilapidated and abandoned housing, differences in educational attainment, and variations in employment and labor force participation, Jarowsky cites multiple other obstacles to employment.[25] These obstacles include disability, a lack of choices in transportation options, and travel time.[26] While the multifaceted set of problems affecting poverty

[22] U.S Census Bureau. "Data Dictionary: Census 2000 on 2010 Geographies." Social Explorer. https://www.socialexplorer.com/data/RC2000/metadata/?ds=RC2000SF3&table=RC2000SF3_008_P087

[23] Social Explorer, and U.S Census Bureau. "U.S Decennial Censuses on 2010 Geographies." Accessed November 15, 2017. https://www.socialexplorer.com/data/RC1980/documentation/9e257041-e92b-4101-bbe0-b3f3fdf92d02.

[24] "How the Census Bureau Measures Poverty." United States Census Bureau, August 11, 2017. https://www.census.gov/topics/income-poverty/poverty/guidance/poverty-measures.html.

[25] See supra note 13.

[26] See supra note 13.

populations have spatial components, the spatial organizations or places and the transportation system within them influence an individual's ability to access daily needs. This includes employment as well as educational institutions for children. Varying transportation means provide an additional variable to consider in cost effects to a family or individual trying to emerge from below the poverty line. While historically emphasized as a concern for metropolitan areas, providing sustainable access to services and employment centers is integral in smaller metropolitan areas and rural communities. This presents an opportunity to optimize investments being made within the megaregion that affect areas along a "corridor", or interstate highway between megaregions. It is crucial to consider the effects of these investments, and moreover, how to partner with smaller communities for them to realize cost-savings and budget efficiently to best serve residents.

CONCLUSIONS

Research Question 1: *Does a visible spatial trend exist from the megaregional standpoint in the evolution of poverty since the United States began to measure it?*

While concentrations of poverty may have dramatically increased in suburban areas in raw numbers, the hotspot analysis yields that the highest concentrations of percentage of people living poverty in poverty per total population remain inside metropolitan areas and in surrounding rural areas. After 1990, a high concentration of poverty is visible in between anchor cities of the Texas Triangle, primarily in rural communities and areas such as Bryan, Texas. The findings of this study are consistent with Jargowsky's observation when comparing concentrated poverty populations between 2000 and 2010, the most dramatic change is found in increased populations in small metropolitan areas than in large metropolitan centers.[27] This is most visible in the evolution and change seen in the mid-Texas Triangle area (Figure 8), made up of primarily rural communities, affected by and increasingly economically connected to major metropolitan areas in its surrounding.

Research Question 2: *Could the megaregion be an appropriate scale to evaluate factors affecting poverty in a more comprehensive fashion than at a metropolitan or regional level to inform planning and policy decisions?*

The findings of this study are consistent with Fainsetin's predication that inequality manifests geographically over time within a national socioeconomic structure of worsening inequality[28]. Conducting a hot spot analysis from a megaregional perspective yields a pattern related to economic interdependencies between anchor cities of the Texas Triangle megaregion. While the data included in this study examines only concentrations of people living below the poverty line, recommendations for further research should include varying socioeconomic levels.

In addition, poverty research should be included in megaregional transportation planning research. As megaregion experts explore the future of transportation planning and seek to move people and good more efficiently, opportunities exists for municipalities in between larger metropolitan areas to maximize investments made by federal or state agencies in transportation infrastructure. Collaboration in this sense could yield better connectivity and economic opportunity stemming from nearby major megaregion cities. Thoughtful coordination between rural areas and small metropolitan cities with state and federal agencies could allow municipalities to optimize and augment larger investments, potentially making funds available for increased investment in improving access to basic services and daily needs.

Alleviating poverty is in the best interest of all government entities involved. Local government budgets can see a future of restructure if allowed the opportunity to stop treating the symptom instead of the problem: in 2006, local governments were found to be hindered from making strategic investments in physical infrastructure and continued workforce development, due to the amount spent on welfare case-loads, public health clinics, and patients in poverty in hospitals.[29] Implementing and emphasizing a

[27] See supra note 8.
[28] See supra note 8.
[29] See supra note 7.

collaborative approach to any investments made at the megaregional level will allow local municipalities to optimize investments and improve the ability to provide other public services.

While many factors have contributed to the development of concentrated poverty over time such as economic change, widespread changes in development patterns, housing and immigration policies, and opportunities and constraints to economic mobility, one thing is clear: a new and multi-faceted approach is needed to begin chipping away at solving the problem.

Additional research in this field could include evaluating concentrated populations in socioeconomic levels vulnerable to poverty, paired with an evaluation of proposed transportation projects at municipal, state, and federal levels. Further analysis to understand effects of poverty related to geographic area can yield to firm recommendations for policy direction as well as specific collaboration opportunities. As increased data becomes available, an analysis of the Supplemental Poverty Measure will augment existing poverty data with this more substantial dataset. Combining historical analysis with current data will allow policy makers to address long-term issues directly. Additionally, planners at all levels of government can implement context-based analysis using poverty concentration information in evaluating how to best optimize delivery of services affecting poverty populations.

SOURCES FOR SPATIAL ANALYSIS

Census 1970 on 2010 Geographies Count 4(ORG), Census 1970 on 2010 Geographies, U.S. Census Bureau & Social Explorer. https://www.socialexplorer.com/tables/RC1970/R11535647 [October 17, 2017].

"RC2000SF3" prefixed tables: Census 2000 on 2010 Geographies Summary File 3 (Sample Data)(RC2000SF3), Census 2000 on 2010 Geographies, U.S. Census Bureau & Social Explorer. https://www.socialexplorer.com/tables/RC2000/R11536618. [October 17, 2017].

Social Explorer Dataset(SE), Census 1990 on 2010 Geographies, Social Explorer; U.S. Census Bureau. https://www.socialexplorer.com/tables/RC1990/R11536609. [October 15, 2017].

Social Explorer; U.S. Census Bureau; Census of Population and Housing, 1980: Summary Tape File 3 [machine-readable data file] / conducted By the U.S. Bureau of the Census. Washington: Bureau of the Census [producer and distributor], 1982. https://www.socialexplorer.com/tables/RC1990/R11536543. [October 15, 2017].

"SE" prefixed tables: Social Explorer Tables: ACS 2010 (5-Year Estimates)(SE), ACS 2010 (5-Year Estimates), Social Explorer; U.S. Census Bureau. https://www.socialexplorer.com/tables/ACS2010_5yr/R11536845. [October 15, 2017].

Cedar Lake Ventures. "Statistical Atlas Webpage." Accessed December 1, 2017. https://statisticalatlas.com/state/Texas/Overview.

Texas Department of Transportation [Open Data GIS Portal]. (2016). Austin, Texas: Texas Department of Transportation: http://gis-txdot.opendata.arcgis.com/datasets/8b2f979d4ef24388a6a893019322e71c_0. [October 1, 2017].

U.S Census Bureau [TIGER Portal]. Washington D.C: U.S Census Bureau. https://www.census.gov/geo/maps-data/data/tiger.html [October 1, 2017].