**Memorandum**

**To:** Dr. Kwangyul Choi

**From:** Sarah Grego

**Date:** August 4, 2021

**Subject:** Connection of Bike Paths

## Summary

In today's environment, Geographic Information Systems (GIS) is used to develop a better understand of demographics. To understand GIS spatial analysis, the interpretations of spatial data and its attributes is crucial. As a result of utilizing this, the findings of this study include relationships between a city's districts and other demographics by applying a Hot Spot Analysis.

## Introduction

At a continually increasing rate, biking is becoming popular for commuting purposes. These bike paths being readily available for resident's use is necessary. Taking that into consideration, spatial analysis assists in discovering the connection of bike paths within commercial and residential zones and block groups. The geoprocess, analyzation, and interpretation of spatial datasets provided by reliable sources help create the results. Hot spot analysis investigates the overall question of how well the residents have access to bike paths.

## Methods

A hot spot analysis recognizes any clusters throughout dataset's density. The choice to analyze the datasets through hot spot analysis is appropriate because this identifies hot and cold spots through the featured datasets.

The unit of analysis is census block groups from 2019. This small scale captures the most accurate representation of bike path access points on the street level. The data is sourced through the City of San Angelo, TIGER/Line Shapefiles and the United States Census Bureau. The block group, commercial, and residential shapefiles are polygons while the bike path shapefile is a polyline. The City of San Angelo provided commercial and residential boundary along with the

bike paths. Population and income demographics are provided through the United States Census Bureau.

The creation of the block group shapefile happened by joining TIGER/Line Shapefiles to the download data from United States Census Bureau. This is possible after the geo id field in the downloaded data is set up correctly in excel to match the geo id in TIGER/Line. The population is found through the block group data that contains about 1,500 resident per polygon. A shapefile is created of the bike path access points, where a point is added over each access point in the bike path shapefile (Figure 1). 141 access points that are identified could potentially be a limitation because finding every access point might be unattainable. The Getis-Ord GI is calculated for these two feature datasets. Through the z-scores and p values calculations, the high and lows clusters are spatially place in ArcMap.

Two other hot spot analyses are created with the same access points but different inputs that use the commercial and residential shapefiles. These two analyses are used to compare between the zones and to compare with the block group hot spot analysis.

Utilizing the collection of geoprocesses inside the Arc Toolbox can be intimidating to a beginner user with ArcMap because there is an ample number of tools. A spatial analysis needed to be done to distinguish the areas bike paths go through with block groups, especially for the paths, since polylines can be difficult finding the starting point of lines. These limitations can hold one back if they do not know how to properly use these tools.

## Findings and Discussion

The Getis-Ord GI calculation in the hot spot analysis between block groups and bikes paths gave these featured datasets a z-score of 1.08 and a p-value of 0.28 with random pattern cluster (Figure 2). The results on the map displayed hot spots and no cold spots. The 99% confidence hot spots are located north and south of the city in residential areas. The 95% confidence hot spots are in the center and west of the city. This range covered the smallest area on the map. The 90% confidence range most fell west of the map. Even though the population and bike access are randomly clustered, when looking at the map the hot spots evenly distribute over the city covering all directions (Figure 3).

The High-low clustering report calculates block groups and bike path access points with a z-score of -1.7 and a p-value of 0.1 with low cluster pattern (Figure 4). Most of the low clusters covered more block groups south and central where north had large high-high hot spots. The findings from this map display the north residents have best access to the bike paths access points (Figure 5).

To take a closer look at the population, hot spot analysis maps between bike paths and residential and commercial zones occurred. Comparing the two zonal hot spot analyses together, resulted in similarities. They both only have hot spots and no cold spots. Commercial zones have hot spots that follow along busy streets and north of the city. Residential hot spots are clustered in the central area (Figure 6). When analyzing residential and commercial maps, residents have more access to bike paths in commercial zones because they are more spread out throughout the city. While residential zones, as stated above, are centralized (Figure 7). The zones perfectly complete each other when the confidence hot spots are on a map together. The statement means that bike paths in commercial and residential do connect into each other making it accessible for residents to travel within the zones.

When comparing the two zonal hot spot analyses to the block group hot spot analysis, no similarities were identified. But when comparing just the zone polygons with the block group hot spot analysis, found that the hots spots are located evenly throughout residential and commercial zones.

Based off reviewing income demographics from the census bureau, the lower income lives north, and middle income lives central of the city and the higher income residents live southwest of the city. The most significant findings from this analysis are that the bike paths are evenly distributed among all income demographic throughout the city in the Getis-Ord GI Hot Spot Analysis. But in the high low cluster map, all the high-high or high-low clusters are located north in the low-income area while the low high is located south in higher income. This means that the most access points of bike lanes are densely distributed north. These lower income residents will have best access to bike lanes.

By all counts, and with proven results, it is no wonder why biking is becoming more popular for traveling. The Getis-Ord GI analysis displays hot spot covering all over the city randomly. The cluster analysis showed high hot spots gives best access to low-income areas that utilize bike paths the most. The residential and commercial zones connect within each other all over the city. To conclude, bike access points are readily available to residents throughout the entire city.

## Appendix

Figure 1:

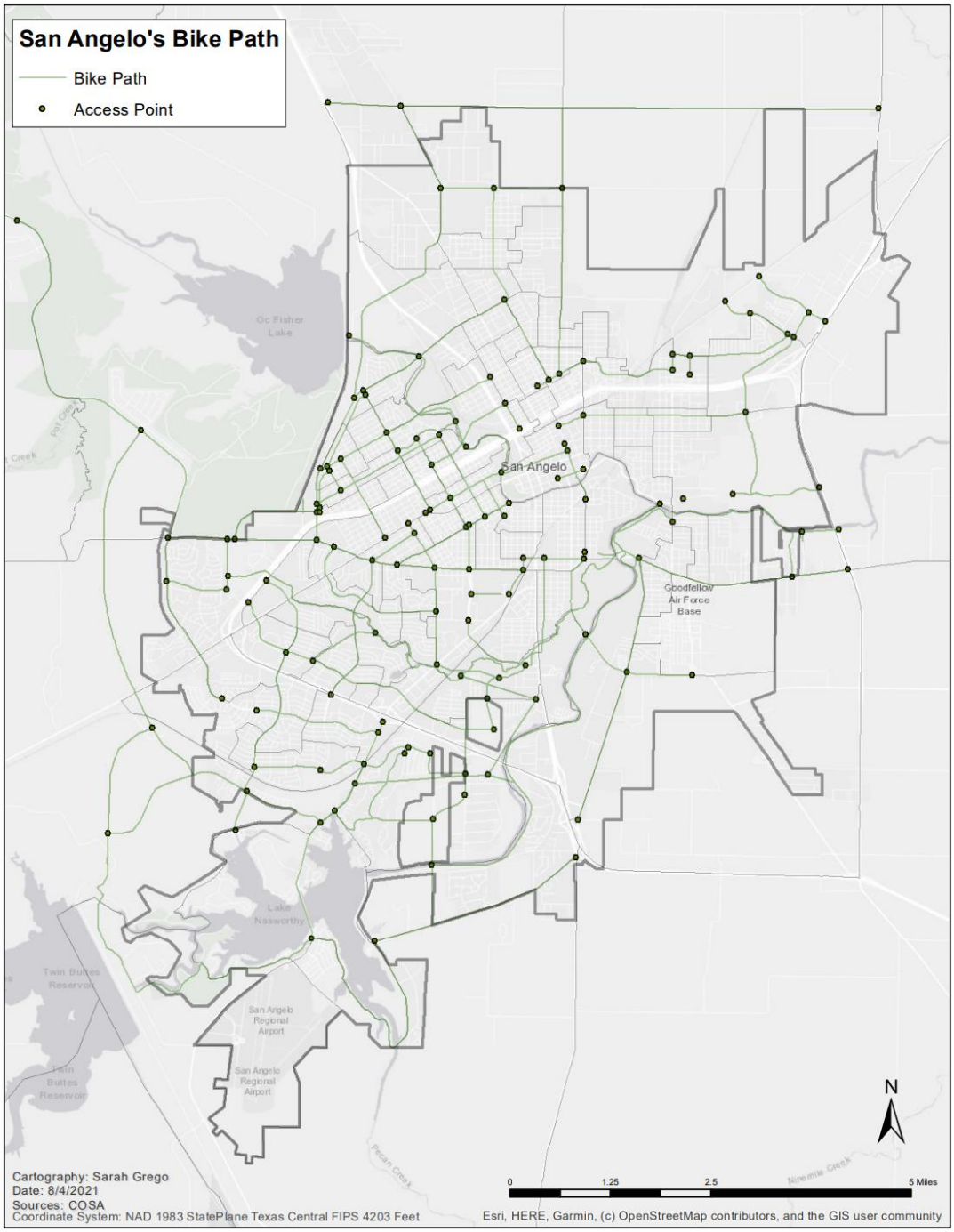
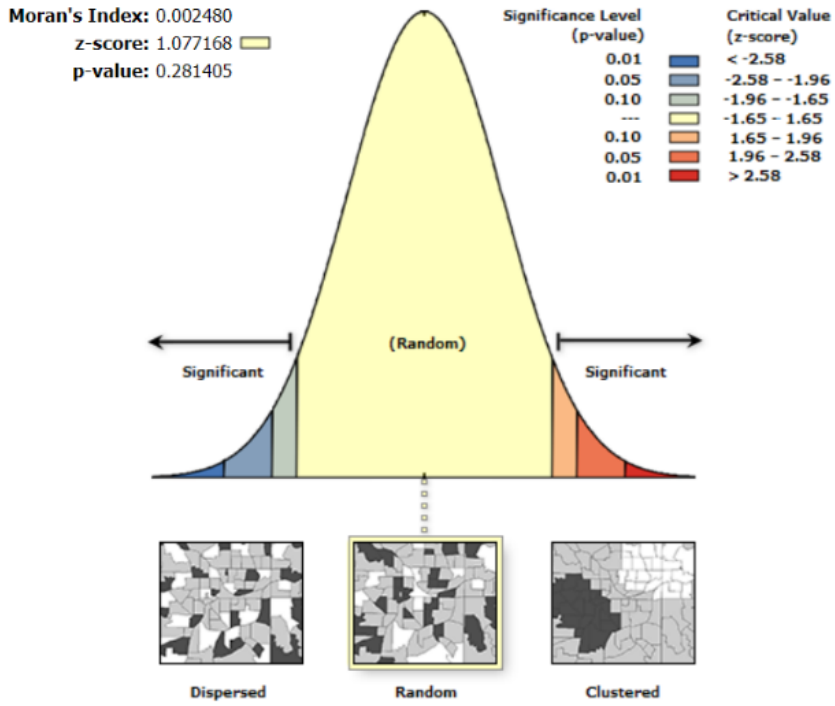


Figure 2:

## Spatial Autocorrelation Report




Given the z-score of 1.07716788793, the pattern does not appear to be significantly different than random.

## Global Moran's I Summary

| | |
|---|---|
| **Moran's Index:** | 0.002480 |
| **Expected Index:** | -0.010753 |
| **Variance:** | 0.000151 |
| **z-score:** | 1.077168 |
| **p-value:** | 0.281405 |

## Dataset Information

| | |
|---|---|
| **Input Feature Class:** | Join_Output |
| **Input Field:** | COUNT_ |
| **Conceptualization:** | INVERSE_DISTANCE |
| **Distance Method:** | EUCLIDEAN |
| **Row Standardization:** | False |
| **Distance Threshold:** | 35505.5947 Meters |
| **Weights Matrix File:** | None |
| **Selection Set:** | False |

Figure 3:

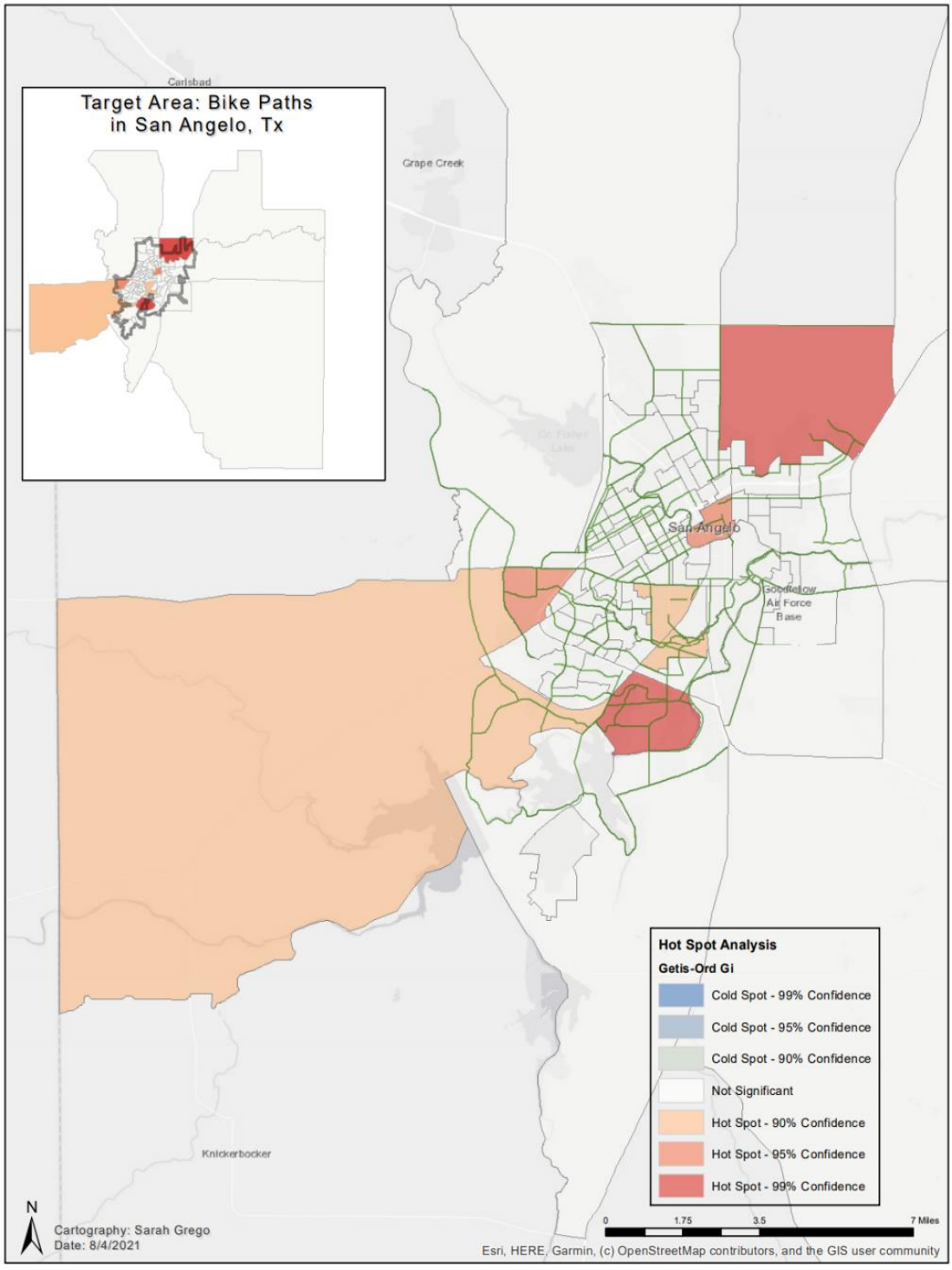
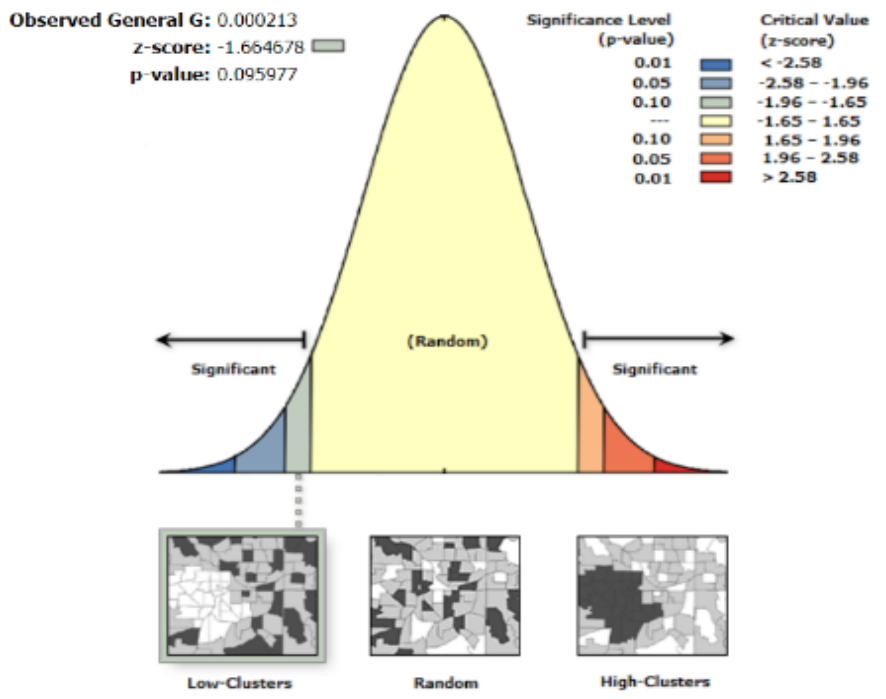

Target Area: Bike Paths in San Angelo, Tx
Carlsbad
Grape Creek
San Angelo
Goodfellow Air Force Base
Knickerbocker
Hot Spot Analysis
Getis-Ord Gi
Cold Spot - 99% Confidence
Cold Spot - 95% Confidence
Cold Spot - 90% Confidence
Not Significant
Hot Spot - 90% Confidence
Hot Spot - 95% Confidence
Hot Spot - 99% Confidence
0
1.75
3.5
7 Miles
N
Cartography: Sarah Grego
Date: 8/4/2021
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Figure 4:

## High-Low Clustering Report




Given the z-score of -1.66467759071, there is a less than 10% likelihood that this low-clustered pattern could be the result of random chance.

## General G Summary

| | |
|---|---|
| **Observed General G:** | 0.000213 |
| **Expected General G:** | 0.000250 |
| **Variance:** | 0.000000 |
| **z-score:** | -1.664678 |
| **p-value:** | 0.095977 |

## Dataset Information

| | |
|---|---|
| **Input Feature Class:** | Join_Output |
| **Input Field:** | COUNT_ |
| **Conceptualization:** | INVERSE_DISTANCE |
| **Distance Method:** | EUCLIDEAN |
| **Row Standardization:** | False |
| **Distance Threshold:** | 20096.5016 Meters |
| **Weights Matrix File:** | None |
| **Selection Set:** | False |

Figure 5:

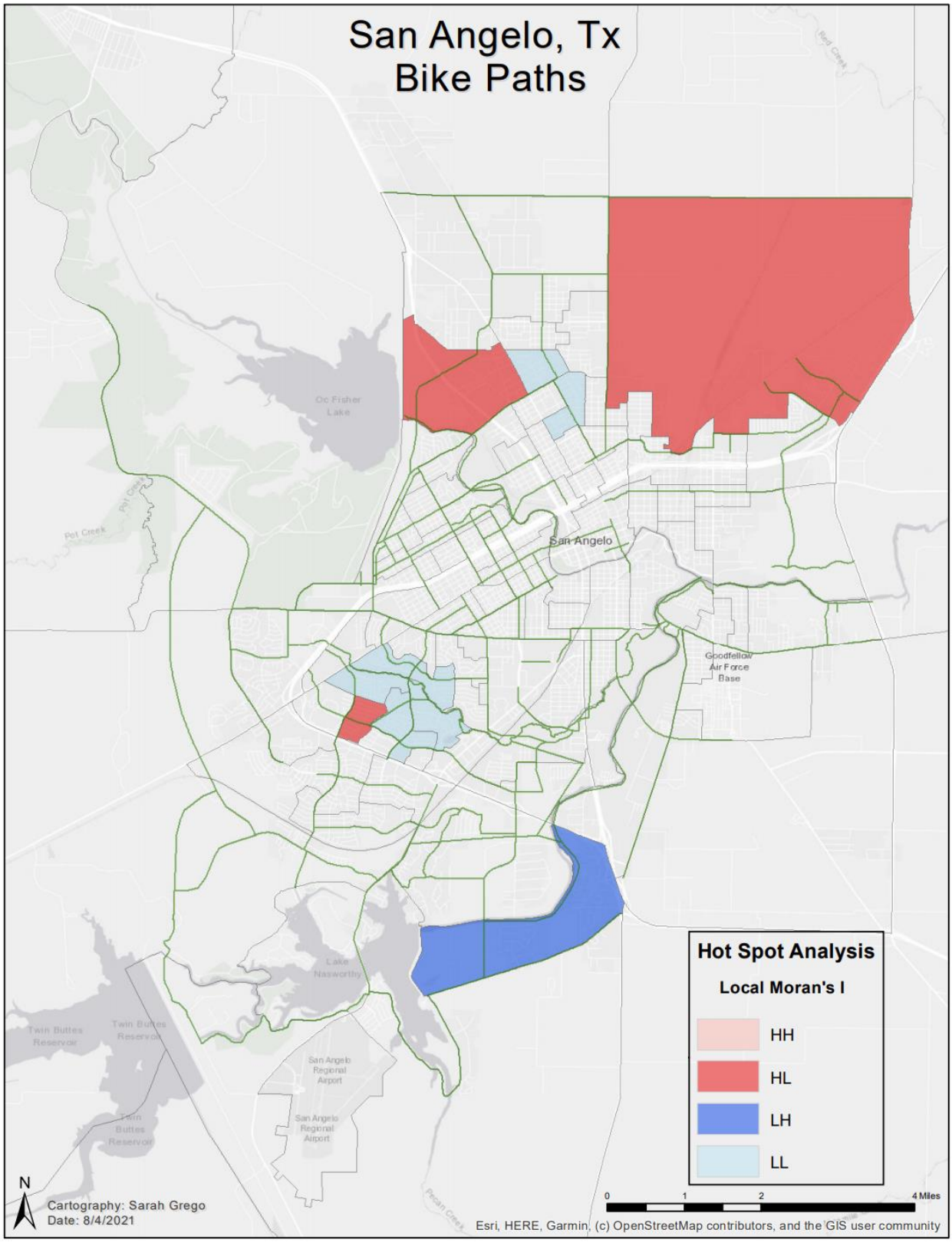

San Angelo, Tx
Bike Paths
Oc Fisher Lake
Pot Creek
San Angelo
Goodfellow Air Force Base
Lake Nasworthy
Twin Buttes Reservoir
San Angelo Regional Airport
Hot Spot Analysis
Local Moran's I
HH
HL
LH
LL
N
Cartography: Sarah Grego
Date: 8/4/2021
0
1
2
4 Miles
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Figure 6:

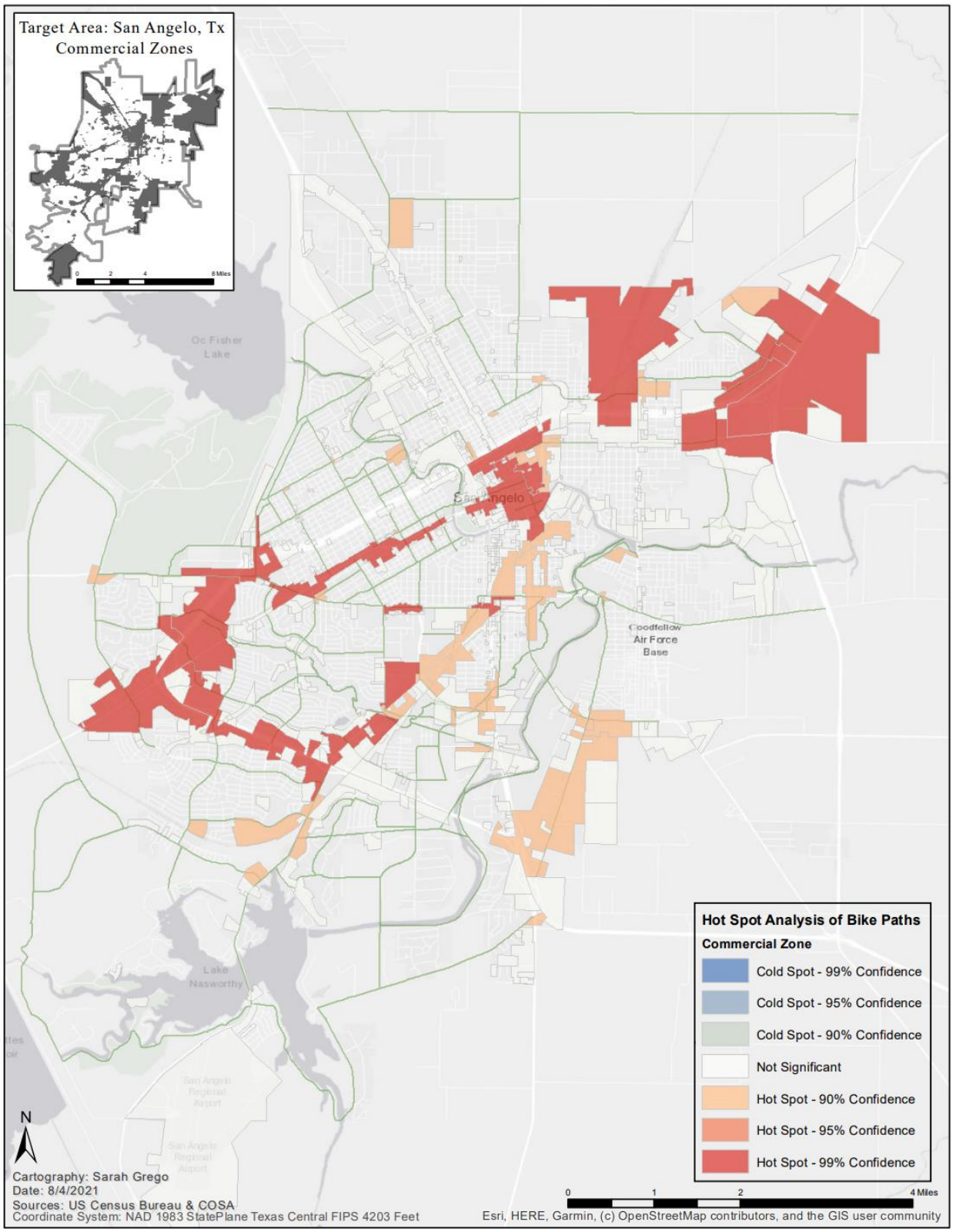
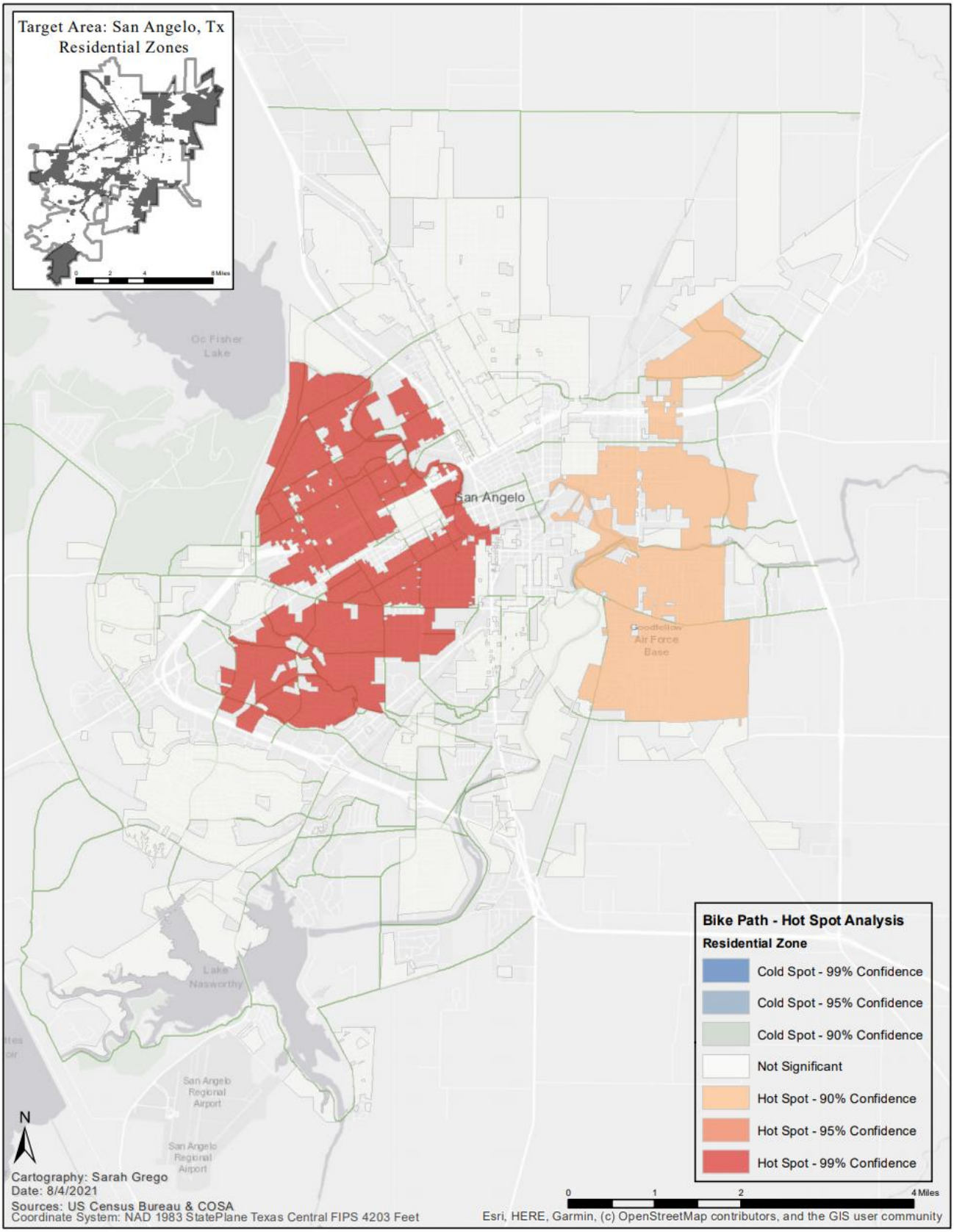

Target Area: San Angelo, Tx
Commercial Zones
0 2 4 8 Miles
Oc Fisher Lake
San Angelo
Goodfellow Air Force Base
Lake Nasworthy
San Angelo Regional Airport
Hot Spot Analysis of Bike Paths
Commercial Zone
Cold Spot - 99% Confidence
Cold Spot - 95% Confidence
Cold Spot - 90% Confidence
Not Significant
Hot Spot - 90% Confidence
Hot Spot - 95% Confidence
Hot Spot - 99% Confidence
N
Cartography: Sarah Grego
Date: 8/4/2021
Sources: US Census Bureau & COSA
Coordinate System: NAD 1983 StatePlane Texas Central FIPS 4203 Feet
0 1 2 4 Miles
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Figure 7:


Target Area: San Angelo, Tx
Residential Zones
0 2 4 8 Miles
Oc Fisher Lake
San Angelo
Goodfellow Air Force Base
Lake Nasworthy
San Angelo Regional Airport
San Angelo Regional Airport
N
Bike Path - Hot Spot Analysis
Residential Zone
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
0 1 2 4 Miles
Cartography: Sarah Grego
Date: 8/4/2021
Sources: US Census Bureau & COSA
Coordinate System: NAD 1983 StatePlane Texas Central FIPS 4203 Feet
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

## References


Bureau, US Census. “Data.” *Census.gov*, www.census.gov/data/.

Bureau, US Census. “Tiger/Line Shapefiles.” *The United States Census Bureau*, 14 Dec. 2020, www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html.

*Explore Census Data*, 2019, data.census.gov/cedsci/table?t=Income+%28Households%2C+Families%2C+Individuals%29&g=0400000US48_0500000US48451&y=2019&tid=ACSST1Y2019.S1901&hidePreview=true.

“Geographic Information SYSTEMS/ONLINE MAPPING.” *Geographic Information Systems/Online Mapping | City of San Angelo, TX*, www.cosatx.us/departments-services/geographic-information-systems-online-mapping.