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New York City Air Quality and Tree Cover: Green Urban Interventions

I. Project Summary

This project investigates the relationship between average annual AQI , and the presence of street trees in New York City Community districts over the years 2009-2015.

II. Statement of Purpose

The purpose of my research project was to observe the relationship between street tree cover in New York City community districts and their respective Air Quality Index (AQI) for 2009-2014. I was curious to investigate whether the presence of street trees (designated as alive and growing as of 2015) in NYC has an effect on the recorded Air Quality Index (AQI) reported by the New York City Department of Health and Mental Hygiene. Green intervention' in urban areas has become quite a hot topic as of recently. Supporters of urban forestry laud the environmental benefits of increased vegetation, specifically fixating on its ability to improve air quality. The results of this research project may offer insight into the ecosystem services provided by street trees in New York City, and which areas to target for more street-tree and green interventions.

III. Background

Contemporary urban design oftentimes incorporates green interventions into plans due the various ecological benefits provided by the vegetation. Urban forestry in particular has become more and more popular as means to improve aesthetic and environmental value of an urban area. Particularly, urban forestry has been lauded for the vast ecosystem services it provides, particularly in improving air quality.

I currently work as a research intern under Brian Mailloux in the Environmental Science department, researching street trees in New York City. Our project aims to improve and update currently-available data regarding street trees, and in the future, to hopefully identify and quantify their ecosystem services. I began my GIS project in hopes of furthering our possible future research in the Fall, where we will begin to investigate various sequestration rates of these trees. Thus, I undertook performing a primary investigation using NYC open data to observe the relationship between street tree canopy and air quality in New York City. between 2009 and 2015.

IV. Literature Review

Urban forestry has come to forefront of many urban design and architectural interventions. Specifically, urban greenery has been heralded for providing a vast amount of ecological, environmental and cultural ecosystem services (Kondo et. al, 2018; Wang et al., 2015; Chan et al., 2012). Moreover, there is substantial literature arguing that urban forestry plays a substantial role in mitigating the effects of air pollution (Yang et. al, 2005; Wolch et.al, 2014). Also, literature has shown that the

addition of urban forests can help improve microclimate and absorb harmful dust and gases (Bolund & Hunhammar, 1999; Kondo, et al., 2018; Wang et al., 2015).

More specifically, contemporary studies illustrate urban trees' ability to sequester various pollutants, including O_3, PM10, NO_2, SO_2, and CO, as well as improve microclimate (Nowak, Crane, & Stevens, 2006). Though there does exist some push-back on this theory, as some studies show evidence of urban trees exacerbating poor air quality by binding with volatile organic chemicals (VOC's) and producing O_3; however, the general phasing out of atmospheric VOCs in the United States makes this issue negligible (Calfapietra et al., 2013). As of last month, a new spatial study found spatial disparities between air quality, asthma rates, and tree pollen in New York City, ultimately recommending the planting of trees in populations prone to respiratory illness (Lai & Kontokosta, 2019). Internationally speaking, the Evidently, there is mounting scholarly evidence supporting the theory of urban forestry as mitigators of urban air quality.

V. Data

- NYC Community Districts Boundaries Shp. File (NYC Open Data, 2019) https://data.cityofnewyork.us/City-Government/Community-Districts/yfnk-k7r4
    - Used as base layer to identify NYC community districts and join AQI and street tree data to

- NYC Tree Census (NYC Parks and Rec. 2015)
  https://data.cityofnewyork.us/Environment/2015-Street-Tree-Census-Tree-Data/pi5s-9p35
  - Data type: Tree Census 2015 shapefile
  - Provided information regarding presence and location of NYC trees as of 2015
- Annual Air Quality Summary Data (NYC Dept. of Health and Mental Hygiene 2009 - 2015)
  https://data.cityofnewyork.us/Environment/Air-Quality/c3uy-2p5r
  - Data type: Annual Air Quality Data - By CBSA excel file
  - This data was used to find and extract air quality index averages for years 2009 to 2015 for community districts in NYC.

VI. Methodology

All of my data needed is available online for public use. However, there is some necessary changes that need to be made to the data in order to serve my purposes. I searched and selected DOHMH AQI data from 2009 to 2014 only concerning the five counties in NYC, and saved that as a separate excel file. I then joined this data to the map of NYC community districts in order to display AQI data.

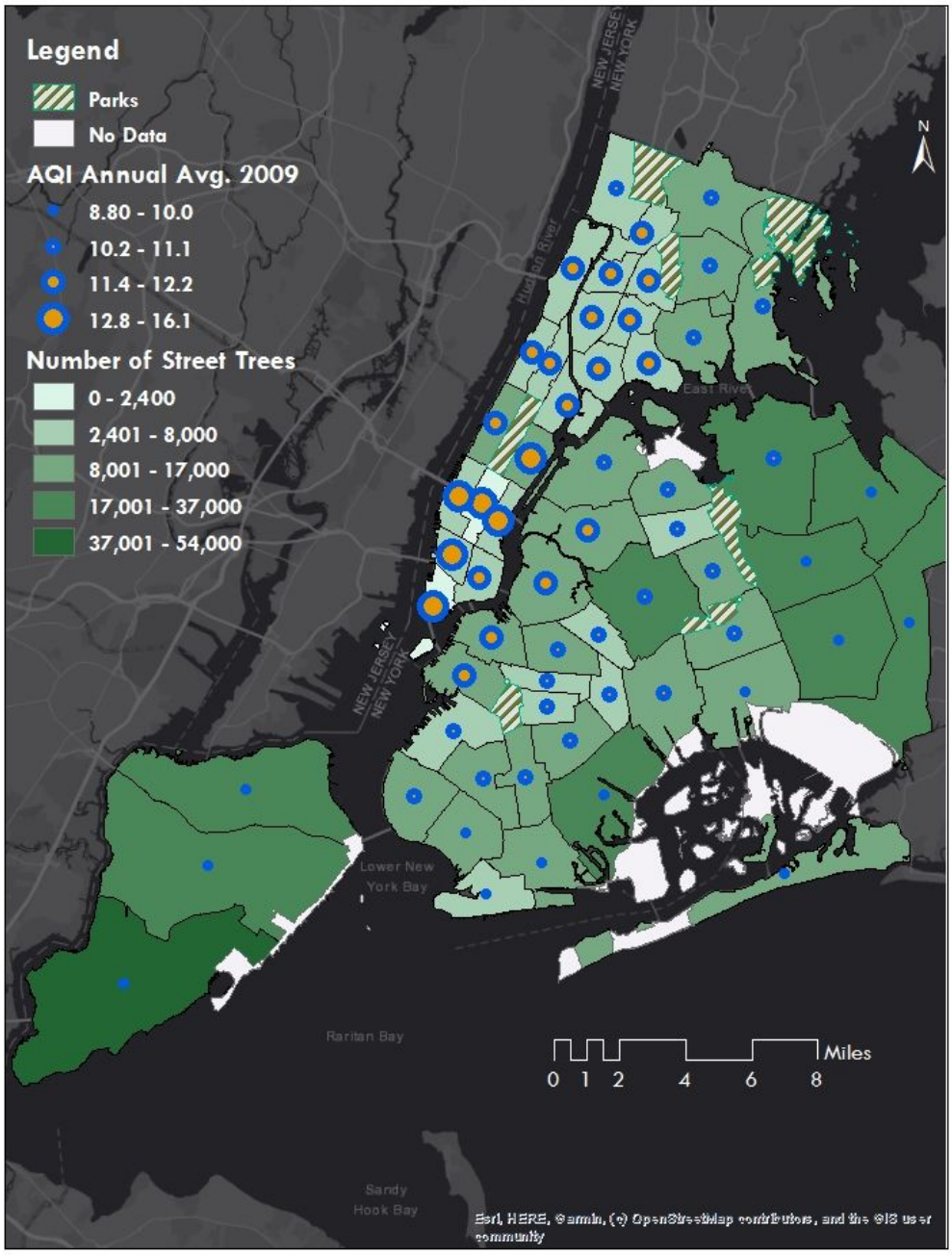
The 2015 Tree Census Data was sourced already in appropriate form (SHP file). This file was then spatially joined to a separate shapefile containing NYC community districts in order to get a count of trees per district. I displayed the first map containing

tree-data as a base choropleth, and the second one as graduated points representing air quality index (AQI) from 2009 to 2015. My first four maps represent stree tree cover and AQI annual average for years 2009, 2011, 2013, and 2015, respectively. The final map depicts street tree cover as well as % change in AQI annual averages from 2009-2015.

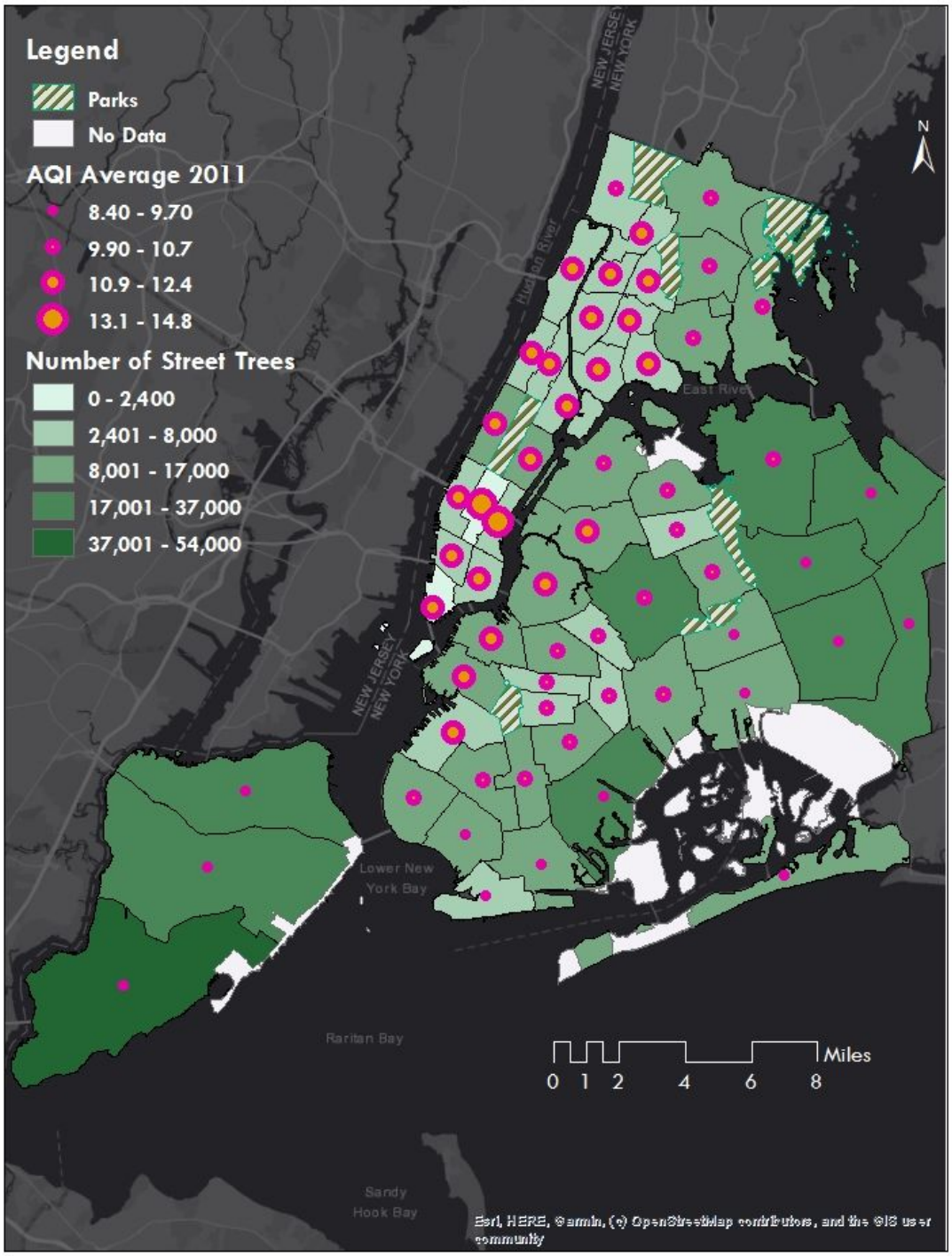
VII. Findings

The first three maps represent NYC street tree cover and AQI average for 2009, 2011, 2013, and 2015 by community district. These maps showed little change in each district over time as Manhattan and parts of the Bronx typically displayed highest AQI out of the five boroughs particularly in Midtown. These areas had relatively low concentration of street trees, and generally high AQIs in comparison to the rest of the city. The last map represents percent change in AQI from 2009 to 2015. Here, Uptown Manhattan and the Bronx show relatively significant decreases in their AQI from 2009-2015 in comparison to the rest of the island, as well as the city. Midtown, on the other hand, showed some of the lowest percent changes in the city, perhaps due to its highly commercial/industrial character .

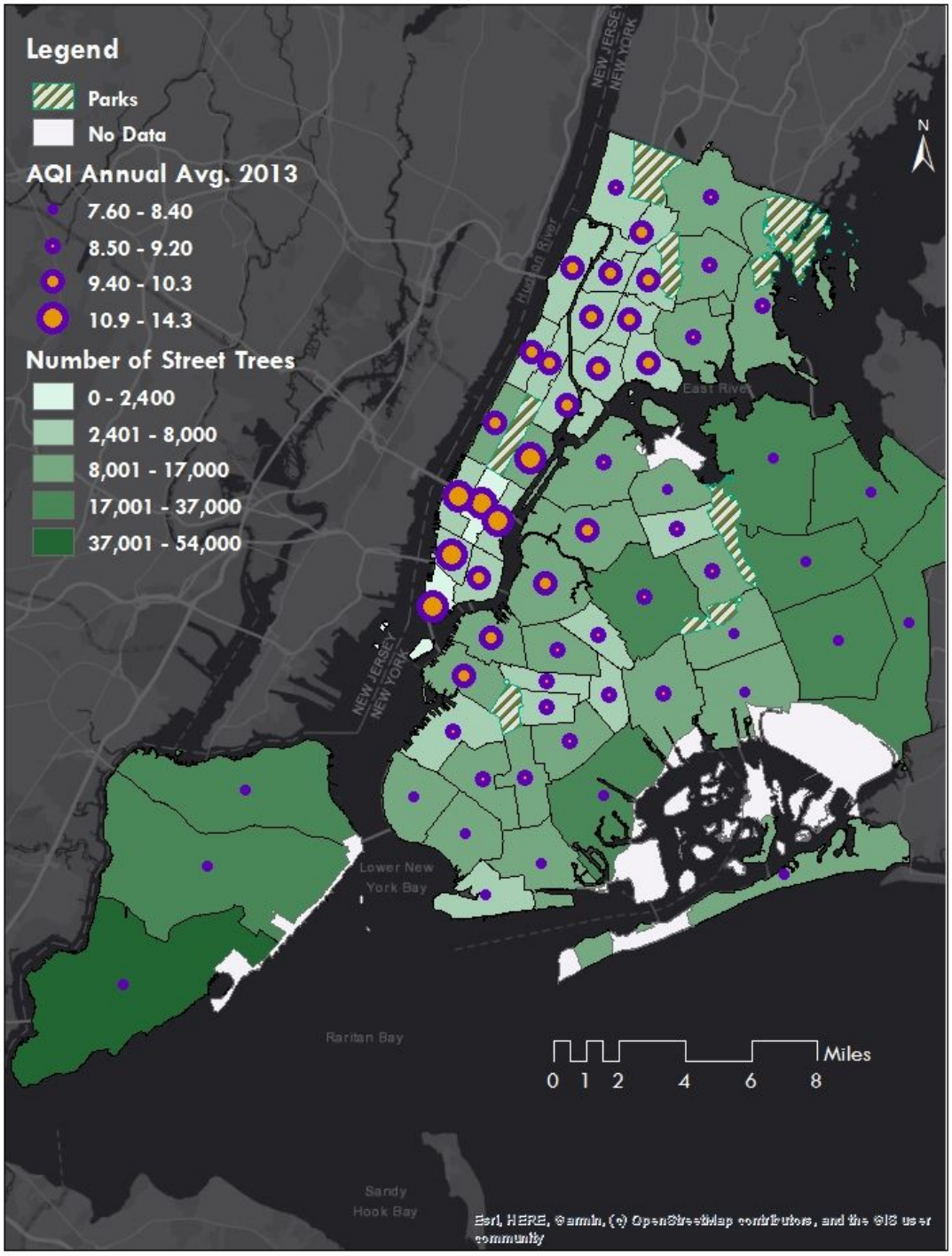
NYC Street Tree Cover and AQI Annual Average 2009



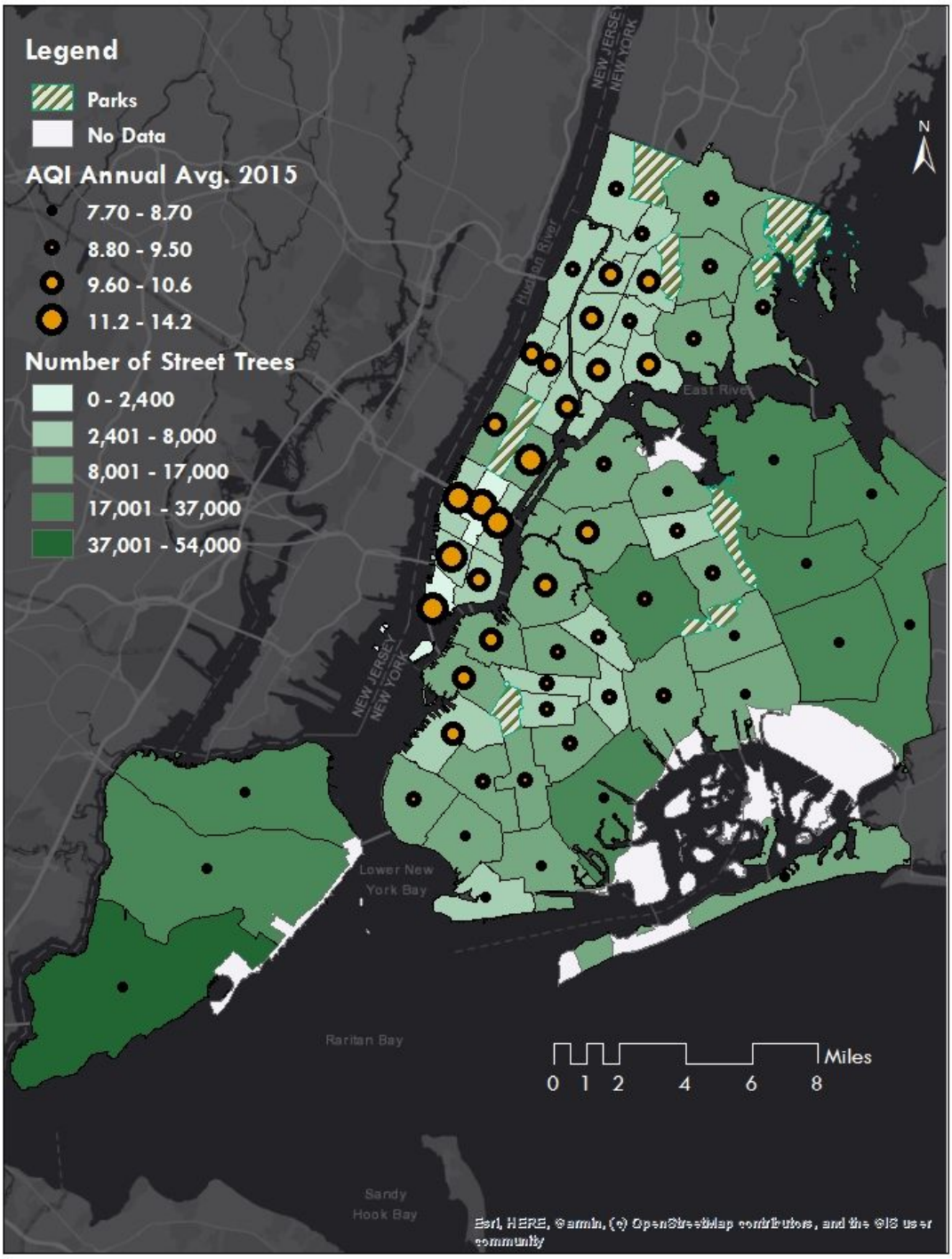
NYC Street Tree Cover and AQI Annual Average 2011



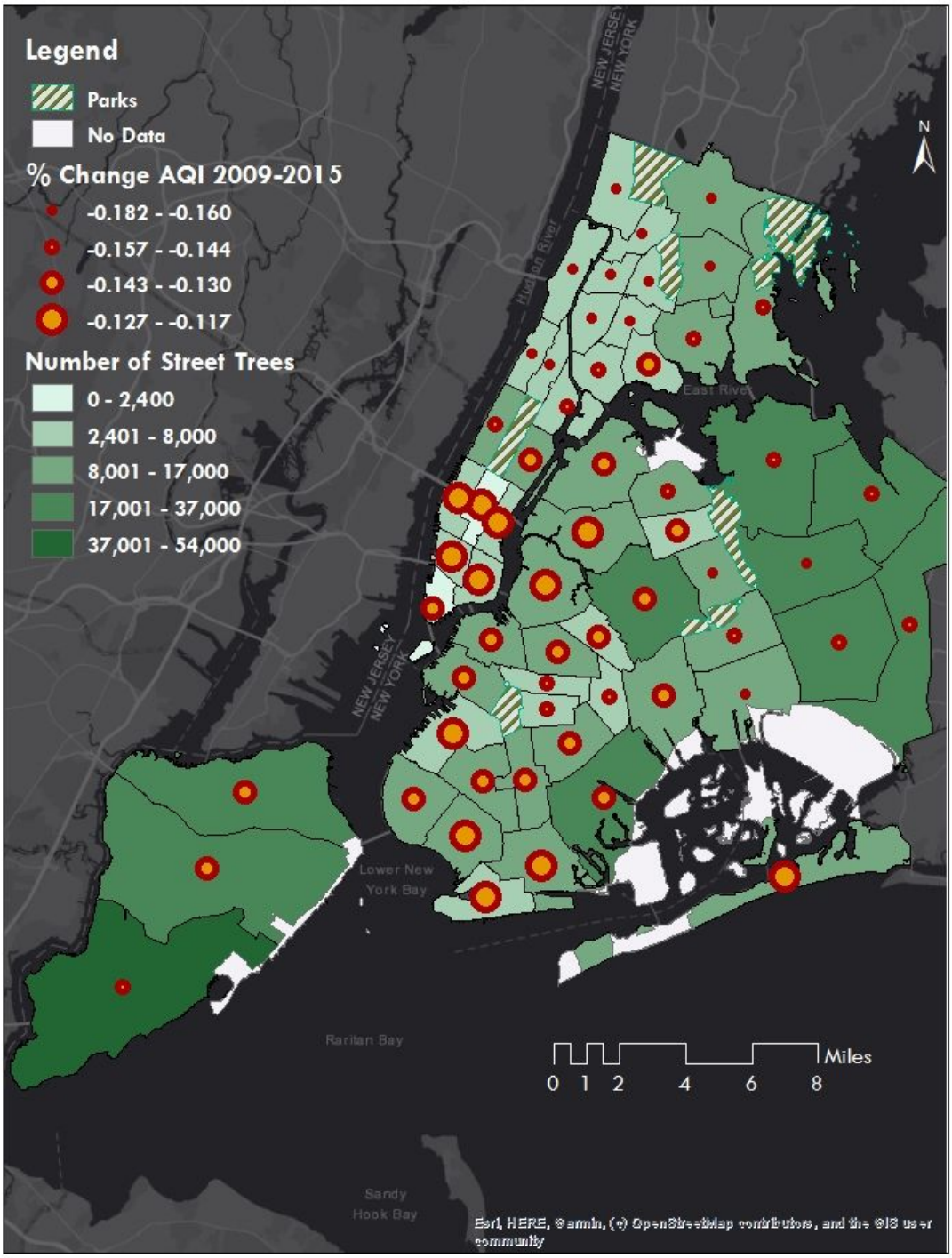
NYC Street Tree Cover and AQI Annual Average 2013



NYC Street Tree Cover and AQI Annual Average 2015



NYC Street Tree Cover and % Change in AQI Annual Average 2009-2015



VIII. Limitations

My primary limitations to my project were borne mostly of insufficient data. The NYC Street Tree Census is conducted by NYCDPR and their cohort of nonprofits and volunteers who record this data. Often, trees are mismeasured and or mislocated due to human error and/or lack of training. As for the air quality data, the figures represent averages taken by DOHMH from site-specific monitoring systems over 1 year periods. Because these are averages, its difficult to parse out any trends that may occur within a year (such as seasonal/monthly fluctuations). Additionally, I would have preferred to work with a more 'concrete' metric, such as [SO_2] or [NO_2]) in order to give a more quantitatively-significant depiction of data.

IX. Recommendations/Conclusion

My project highlights a semblance of relationship between street tree cover and annual average AQI. Less-densely vegetated areas, such as in midtown Manhattan, the Bronx and parts of Brooklyn, had generally less decrease in average AQI from 2009-2015. However, parts of Upper Manhattan and the South Bronx showed relatively significant levels in AQI reduction, possibly due to the prevalence of parks and more-open spaces in these areas. Additionally, there have been efforts in the South Bronx within the last decade to improve air quality risks caused by heavy industry. Clearly, there are many exogenous factors which affect the outcomes presented above.

My reccomendations for future studies are as follows; perhaps these investigations could focus in on a particular neighborhood in Manhattan, and use more current and accurate tree data. Furthermore, the $[SO_2]$ or $[NO_2]$ could be measured as well, in order to observe the unique relationship between street tree cover and sequestration of certain pollutants.

X. Bibliography

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