Are Trees Biased? Investigating Environmental Justice Issues Related to Tree Canopy Distribution in Long Island

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Abstract

This study examines the distributional equity of urban tree canopy (UTC) cover in Long Island, New York using aerial Google Imaging and census data. UTC provides ecosystem, economic, and health benefits to a community; yet, it is being threatened by the development of commercial and residential areas, invasive insect damage, natural aging of trees, and an increased occurrence of extreme storms. The percent change in UTC from 2007 to 2017 was recorded in potential environmental justice communities and Tree City USA towns to determine if regulatory measures are effective in curbing tree canopy loss. Environmental justice involves an equitable distribution of environmental burdens and amenities. The potential environmental justice towns researched have a higher percentage of minority populations and a higher population impoverished than neighboring towns. The potential environmental justice towns were compared with Tree City USA communities, which is a governmentally funded program that regulates and encourages UTC. To determine UTC, an observer used aerial Google Earth imaging to record tree canopy, land cover type, and land usage type that a random sampling of points occupied in 2007 and 2017. A Chi-Squared analysis test was taken to determine significance. It was found that potential environmental justice areas saw a greater loss of tree canopy from 2007 to 2017 than Tree City USA communities; however, this was not statistically significant, which indicates that regulatory measures did not influence the tree canopy loss over time. These findings suggest that current UTC conservation efforts are insufficient in maintaining and growing tree canopy.

Introduction

The term "environmental racism" was first used in 1987 by Dr. Benjamin Chavis to better describe the alarming results of his study entitled, "Toxic Wastes and Race": that hazardous waste sites are disproportionately placed near communities of color. This research was prompted after several minority communities protested for a cleaner environment. Prior to Chavis' publication in 1982, African American residents assembled a coalition to halt production of a hazardous landfill facility in their poor, rural town of Warren County, North Carolina. This was just one of many examples that called attention to the inequitable allocation of environmental burdens, such as pollution and Superfund sites, that was predominantly located in and harming minority and poor communities (1).

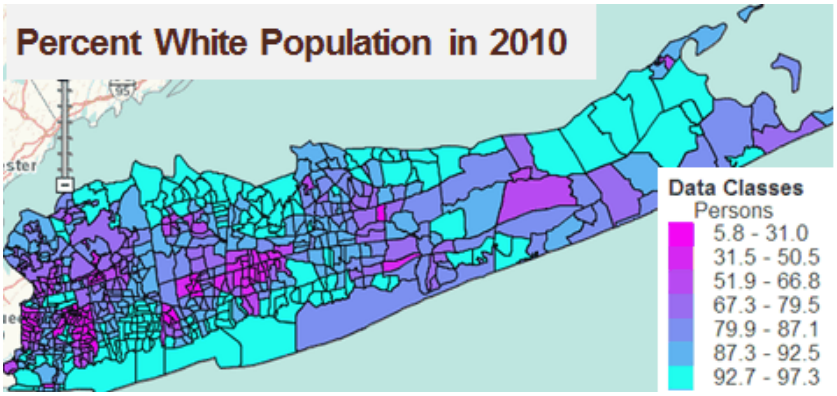


Figure 1- *Percent White Population on Long Island, New York (2).*

The environmental justice movement began and gained political traction in its fight to provide a healthy environment for all regardless of one's racial, ethnic, or economic background. Environmental justice aimed to correct injustices faced by minority, lower-income communities through remedial action, introduce nondiscriminatory governmental policies, and protect citizens from a depletion of environmental resources. Environmental justice grants are mainly allocated to improve water and air quality (4).

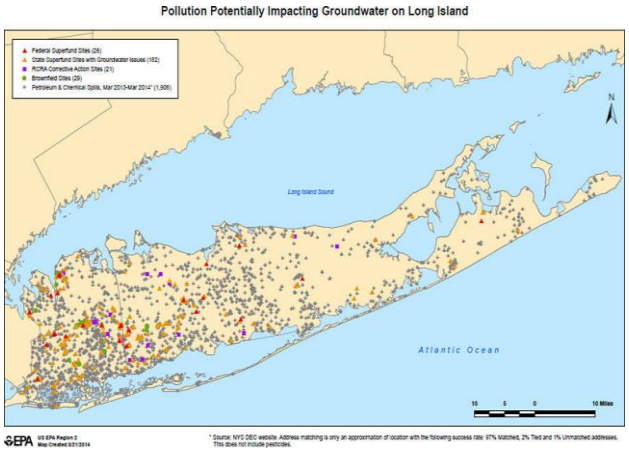


Figure 2- *Contamination sites in Nassau and Suffolk counties, Long Island. Superfund sites are represented by red triangles (3).*

Figure 1 and Figure 2 show the distribution of white populations compared with Superfund sites on Long Island, New York. Often, Superfund sites and other environmental burdens are located in communities of color.

Environmental justice also addresses a disproportionate distribution of environmental amenities in addition to environmental burdens (5). According to Figure 3, African Americans populations have, on average, less park acreage per capita than predominantly white communities. Parks have been found to moderate urban areas with disproportionately hotter temperatures than its surrounding area, filter water pollutants, absorb precipitation, reduce stormwater runoff buildup from flooding, reduce air pollution, and inhabit wildlife (6).

Acres of accessible parks per thousand population, categorized by income class and race

Income class ($)	Accessible acres	Population	Acres/1,000 population	Mean % white	Mean % black	*SD* of income
0–11,739	815	28,500	28.60	5.95	90.33	<–2
11,740–36,704	6,208	429,047	14.47	26.11	70.05	–2 to –1
36,705–61,669	9,242	513,242	18.01	63.25	31.80	–1 to 1
61,670–86,633	20,056	258,634	77.55	80.70	13.39	1 to 2
86,634–200,000	13,281	119,562	111.08	85.76	6.26	>2

Figure 3- *Park acreage sites accessible to white populations and black populations for different wealth classes in Baltimore, Maryland. Black populations had, on average, less access to park sites than their white counterparts (6).*

Tree canopy is often underappreciated, providing various environmental, social, economic, and human health benefits. Some of which include reduced runoff water to help regulate the sewage system; energy savings; reduced atmospheric carbon dioxide (CO_2) levels; and reduced air pollutants of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone (O_3), and particulate matter. In addition, areas with a greater percent of tree canopy have been found to have higher property values (7); reduced rates of obesity, type 2 diabetes, high blood pressure, and asthma (8); and a reduced risk of having a low birth weight baby (9). Urban tree canopy has also been linked with reduced stress levels (10) and better recorded social unity (7).
While benefits of forestry in urban areas prove to be immeasurably vital, several factors have been threatening tree canopy. Throughout the United States, there has been an average net loss of 36 million trees annually (11). Some of this can be attributed to dendrophobia, which is the fear of damage to residential and commercial areas caused by falling trees that causes property owners to prematurely remove healthy trees (12), invasive insect damage, the loss of trees due to the development of commercial and residential areas, natural aging of trees, and increasing occurrence of extreme storms (13).

This research is intended to see if there is greater tree canopy loss in environmental justice areas compared with Tree City USA communities, which are federal government-funded programs, driven by the Arbor Day Foundation, to implement environmental benefits by regulating tree canopy. These towns typically have a higher socio-economic conditions and lower percentages of minority populations. To qualify as a Tree City USA community, a town must maintain a tree board or department that delegates tree care decisions on town-owned property; have a community tree ordinance that provides guidance for planting, maintaining, and removing trees from streets, parks, and other public-owned spaces; spend at least two dollars per capita on urban tree canopy annually; and celebrate Arbor Day. Lynbrook and Floral Park are two of over 3,400 Tree City USA participants. Since Lynbrook and Floral Park have 19,427 and 15,863 residents respectively, Lynbrook must spend $38,854 and Floral Park must spend $31,726 to maintain tree canopy each year. Preference is sometimes given to Tree City USA communities over other communities when allocations of grant money are made for trees or forestry programs (14).

In the Town of Hempstead, which encompasses Lynbrook, Floral Park, Uniondale, and Hempstead, there exists certain regulatory measures regarding tree canopy. Removing a tree in the town right-of-way, which is the area from the curb to the property line of one's residence, requires a permit. Requests for removing a healthy or growing tree are not granted. The Town of Hempstead will also plant a tree along the right-of-way in front of one's property if requested (15).

Two Tree City USA towns and two environmental justice areas on Long Island, New York will be studied. It is predicated that lower income areas mostly comprised of minorities would see greater tree canopy loss due to less implementation of environmental policies. This research intends to see if governmental regulations will influence the tree canopy over time in a community. In addition, this research hopes to determine if tree canopy can be used as a remedial tool to bring about environmental benefits to environmental justice communities.

Methods

Four towns located in Long Island, New York were selected based on their similarity in biophysical characteristics. The towns consisting of Lynbrook, Floral Park, Southern Uniondale, and Hempstead, were chosen due to similarities in population, impervious surface cover provided by the National Land Cover Database (NLCD), NLCD tree canopy, and population density. The NLCD tree canopy cover is used as a rough estimate for tree canopy in a community because the method in which its data is determined is flawed. This procedure cannot differentiate between tree canopy and other greenery such as lawn or bushes, leading to incorrect estimates. The data collected describes the characteristics of each town and was provided by the US Census website, from the 2010 Census. Other factors considered, such as impervious surface percentage and tree canopy percentage, were derived from the NLCD.

Both Hempstead and the southern part of Uniondale were deemed potential environmental justice towns by the New York State Department of Environmental Conservation from the 2010 US Census Burau. Each town has a higher percentage of black and Hispanic residents compared with other neighboring towns. In addition, the median house value and median income were lower while the percentage of people in poverty were higher than neighboring towns.

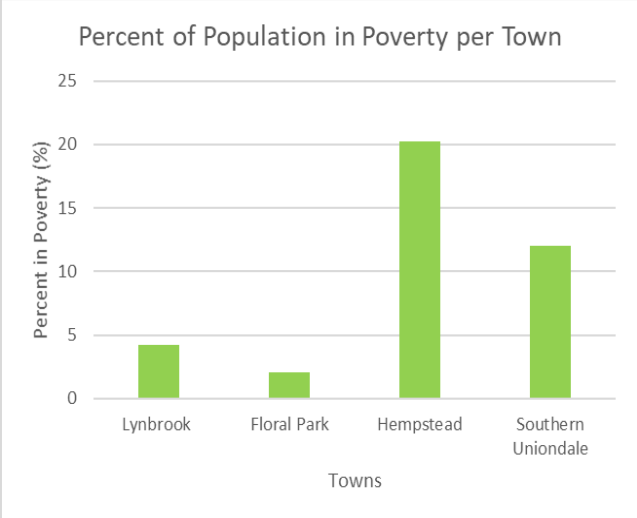
Lynbrook and Floral Park act to counteract Southern Uniondale and Hempstead due to their high percentage of white residents and wealth. Thus, each town has active tree planting programs, as a Tree City USA community, and it is hypothesized that since no extra regulatory measures exist in Hempstead and Uniondale, environmental justice areas would see less tree canopy and a greater tree canopy loss over the years 2007 and 2017.

Figure 4 shows the demographics of Lynbrook, Floral Park, Hempstead, and Southern Uniondale that were considered when determining the towns to compare. Hempstead and Southern Uniondale have a higher percent of their populations in poverty and have lower median housing values and median incomes than Lynbrook and Floral Park. Meanwhile, Lynbrook and Floral Park have higher percent white population then Hempstead and Southern Uniondale. Figure 5 and Figure 6 shows the distribution of potential environmental justice and Tree City USA respectively.

A.

Parameter	Town			
	Lynbrook	Floral Park	Hempstead	Southern Uniondale
Population	19,427	15,863	53,891	24,759
Percent White (%)	82.9	85.2	13.8	34.1
Percent Black (%)	5.4	1.0	46.6	38.2
Percent Hispanic (%)	19.5	10.5	46.6	35.4
Percent Asian (%)	3.3	7.6	1.7	3.2
Median Housing Value ($)	426,800	546,600	308,800	337,900
Median Income ($)	89,020	107,917	58,476	71,839
Percent in Poverty (%)	4.2	2.1	20.2	12.0

B.



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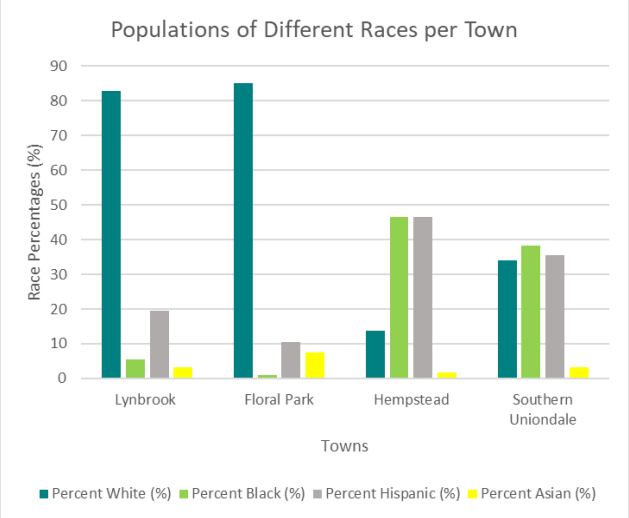

Figure 4-

A. *Parameters for determining which towns to compare. Lynbrook and Floral park are Tree City USA villages and Hempstead and Southern Uniondale are environmental justice areas.*

B. *Bar graph depicting the percent of population in poverty in Lynbrook, Floral Park, Hempstead, and Southern Uniondale.*

C. *Percent white, black, Hispanic, and Asian populations in Lynbrook, Floral Park, Hempstead, and Southern Uniondale.*

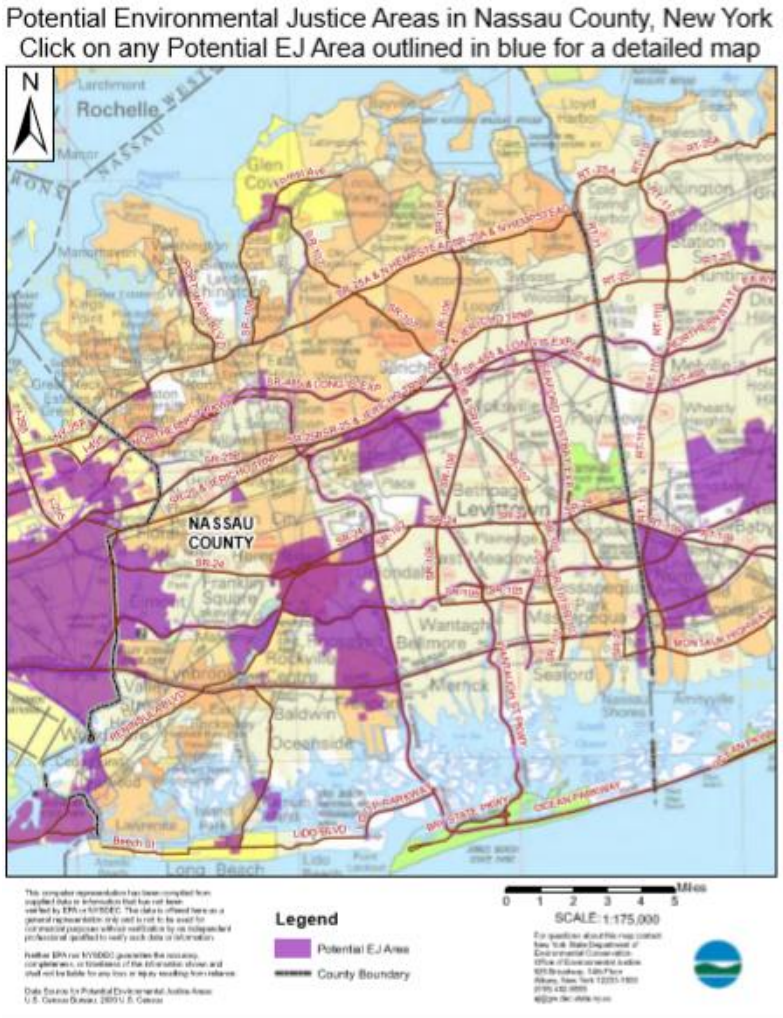

Figure 5- *Map of Long Island depicting the potential environmental justice areas. Potential environmental justice areas are indicated in purple. Hempstead and the southern part of Uniondale are deemed potential environmental justice by the New York State Department of Environmental Conservation from the 2010 Census (16).*

Figure 6- *Map of Long Island depicting the Tree City USA areas. Both Lynbrook and Floral Park and Tree City USA villages.*

To determine the tree canopy change throughout Long Island, Google Earth imaging was used to document the change of tree canopy in a specific area from the years 2007 and 2017. These years were chosen due to their clear images throughout all four towns. To do this, a random sampling of points was generated throughout the towns through arcGIS. An observer recorded the presence of tree canopy, land use, and land cover the points occupied in both 2007 and 2017. The land cover and land use options were determined by several defining features for the environment. The land cover options consist of impervious surface, lawn/shrub/garden, forest/patch of trees, rock/bare soil, water, natural area without trees, and agriculture. The land usage options consist of industry/commercial, residential, park/preserve/natural area/golf, transportation, right of way residential, right of way industrial/composition, right of way transportation, water, landfills/quarries/junkyards/extraction areas, and agriculture. A minimum of 1500 points was selected for each area of study. Each point was documented by two observers to ensure validity and sites where there was discrepancy were revisited by a different observer. Figure 7 depicts an example of three specific points and the land cover and land usage it occupies.

Figure 7- *A time series of aerial Google Earth images demonstrating a change from forest, to bare earth, to residential land use.*

For analysis, a Chi-Squared test was performed to compare the percent decrease in tree canopy for environmental justice and Tree City USA towns for significance. It was found that there is no statistical significance of the decrease in tree canopy between Hempstead and Uniondale with Lynbrook and Floral Park.

Results

Towns	Percent Tree Canopy 2007 (%)	Percent Tree Canopy 2017 (%)	Percent Change (%)
Lynbrook	29.75	25.97	3.78
Floral Park	32.3	27.86	4.34
Hempstead	30.33	29.93	7.40
Southern Uniondale	32.21	26.28	5.93

Figure 8- *The percent tree canopy in 2007 and 2017 was recorded for Lynbrook, Floral Park, Hempstead, and Southern Uniondale.*

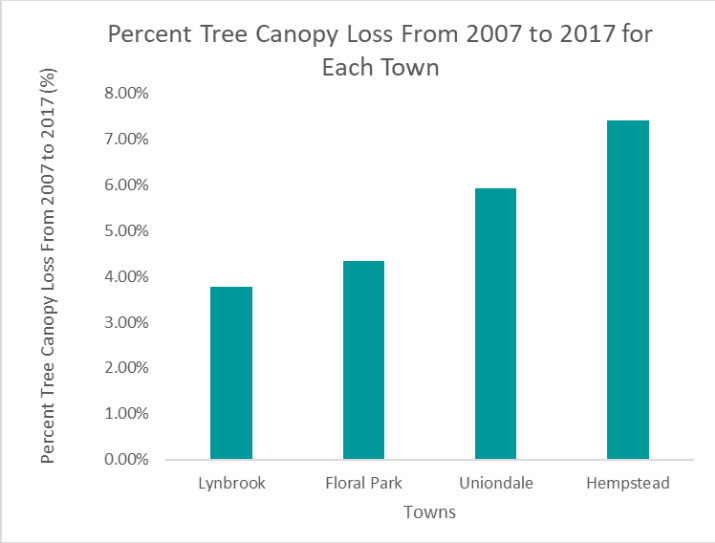

Figure 9- *The percent change in tree loss was documented from 2007 to 2017 for Lynbrook, Floral Park, Hempstead, and Southern Uniondale.*

Towns	Percent Tree Canopy 2007	Percent Tree Canopy 2017	Total
Southern Uniondale	32	26	58
Hempstead	30	23	53
Lynbrook	30	26	56
Floral Park	32	28	60
Total	124	103	227

Figure 10- *A Chi-Squared test was preformed to determine significance. P= 0.98*

P values <0.05 are significant.

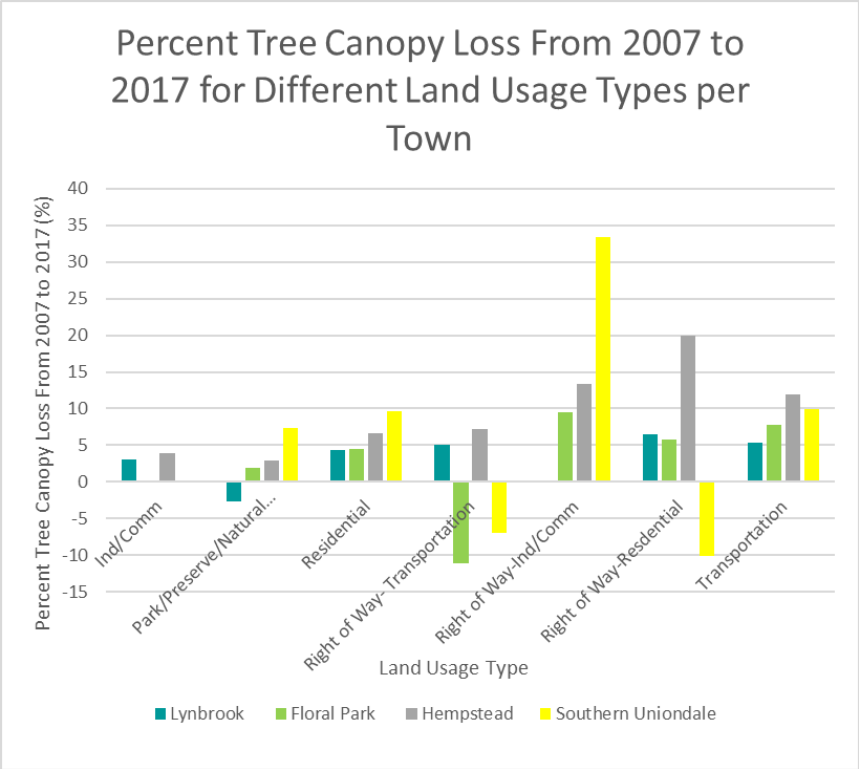

Figure 11- *The type of land use on each point was recorded for both environmental justice towns, Southern Uniondale and Hempstead, and Tree City USA towns, Lynbrook and Floral Park. This graph shows the percent decrease in tree canopy for each land use type from 2007 to 2017. Not enough points were recorded to represent water, landfills/quarries/junkyards/ extraction areas, or agriculture sites to determine a percent change.*

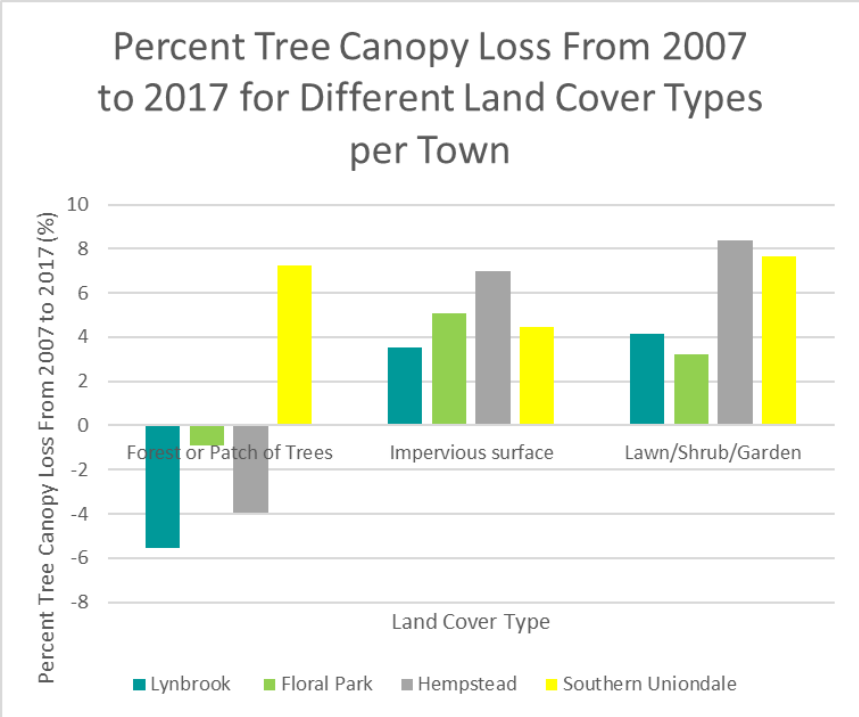

Figure 12- *The type of land cover on each point was recorded for both environmental justice towns, Southern Uniondale and Hempstead, and Tree City USA towns, Lynbrook and Floral Park. This graph shows the percent decrease in tree canopy for each land cover type from 2007 to 2017. Not enough points were recorded to represent rock/bare soil, water, natural area without trees, and agriculture sites to determine a percent change.*

Discussion

Overall, it was found that each town researched experienced a loss in tree canopy from the years 2007 to 2017 (Figure 8 and Figure 9). Most notably, the two potential environmental justice locations researched, Southern Uniondale and Hempstead, experienced a greater tree canopy loss over time. However, after a Chi-Squared analysis was undergone, a p value of 0.98 was found. Since p values less than .05 are considered significant, there is not a statistically significant change in tree canopy loss between environmental justice and Tree City USA towns (Figure 10).

In addition, the change in tree canopy for each land usage type was recorded for each point. Tree canopy loss was predominantly recorded for each land usage type in each town. Lynbrook gained tree canopy in areas of park/natural areas/preserve and saw no loss in tree canopy for right-of-way industry/commercial areas. However, in order of least to greatest net loss, Lynbrook lost tree canopy in industry/commercial, residential, right-of-way transportation, transportation, and right-of-way residential areas. Meanwhile, Floral Park saw no net change in tree canopy in industry/commercial and gained tree canopy in right-of-way transportation areas. Still, in order of least to greatest net loss, Floral Park lost tree canopy in park/natural areas/preserve, residential, right-of-way residential, transportation, and right-of-way industry/commercial areas. Hempstead had its lowest loss in park/natural areas/preserve, industry/commercial, residential, right-of-way transportation, transportation, right-of-way industry/commercial, and right-of-way residential areas respectively. Unlike the other three towns researched, Hempstead saw no net gain in tree canopy in any land usage type. Southern Uniondale saw tree canopy gain in right-of-way residential and right-of-way transportation, while seeing no tree canopy change in industry/commercial areas. Southern Uniondale saw a low loss in tree canopy in park/natural areas/preserve, residential, and transportation areas, while right-of-way industry/commercial saw the highest loss in tree canopy among all parameters for each town. Overall, the environmental justice towns saw a greater decrease in tree canopy over Tree City USA communities in transportation, residential, right-of-way industry/commercial, and park/natural areas/preserve (Figure 11).

For the change in tree canopy for each land cover type, impervious surface and lawn/shrub/garden saw a net loss of tree canopy in every town. However, forest/patch of trees saw an increase in tree canopy in Lynbrook, Floral Park, and Hempstead. Lynbrook saw the

greatest net tree canopy gain in forest/patch of trees areas of the four towns. In both impervious surface and lawn/shrub/garden land cover types, Hempstead saw the greatest net tree canopy loss, followed by Floral Park in impervious surface and Southern Uniondale in lawn/shrub/garden areas. Overall, the percentage of tree canopy loss and gain was relatively low in different land cover types, with the highest percent change being an 8.39% decrease of tree canopy in lawn/shrub/garden land cover in Hempstead (Figure 12).

There were opportunities for limitations in this project. Since this was an observational study, a person's observation of tree canopy on a specific point can lead to incorrect data. However, two observers viewed each point, and points were viewed by a third party if there was a discrepancy in answers, which ensures the validity of the observation on a given point. In addition, due to time constraints, there was a small sample size of towns, so the results of this experiment may not be repeated in similar studies in different regions.

Conclusion

With a growing concern over climate change, trees are being valued now more than ever as a tool to sequester CO_2. Significantly decreasing greenhouse gas emissions while increasing tree canopy cover may be a solution to curb the climate crisis. In addition, tree canopy provides various ecosystem and human health benefits including reduced air pollutants, reduced rates of obesity, and reduced stress levels for a community. However, regardless of tree regulation attempts, tree canopy was lost from 2007 to 2017 in each town researched. This coincides with a national trend of tree canopy loss since tree canopy is threatened by the development of commercial and residential areas, extreme storm weather, dendrophobia, and the natural aging of trees. The findings of this study further cement the need for an increase in tree planting projects.

Ultimately, it was found that potential environmental justice areas saw a greater loss of tree canopy from 2007 to 2017 than Tree City USA communities. However, this occurrence was not statistically significant which indicates that regulatory measures in certain areas did not influence the tree canopy loss over time. Despite efforts to regulate tree canopy in Lynbrook and Floral Park by participating in the Tree City USA initiative, both towns saw a decrease in tree canopy over time. These findings suggest that current urban forest conservation efforts are not enough to maintain and grow tree canopy. Additionally, while it is important to introduce tree canopy to a community, it is also necessary to make sure tree canopy is being maintained to

maximize the potential ecosystem benefits that a tree can provide. Perhaps the Tree City USA foundation is mismanaging its resources, or not strict enough to provide tree canopy growth.

Since the Town of Hempstead provides tree regulation only for right-of-way residential areas, these measures are not enough to combat tree canopy loss. Only Southern Uniondale saw an increase in tree canopy in right-of-way residential areas, while Lynbrook, Floral Park, and Hempstead lost tree canopy, indicating that the regulations put in place by the Town of Hempstead are not strong enough to prevent tree canopy loss. As transportation, residential, right-of-way residential, and right-of-way industry/commercial sections saw a great loss of tree canopy over time, perhaps these are appropriate places to introduce tree canopy in environmental justice areas. Since tree regulatory measures cannot be as strictly enforced in residential areas, initiatives should be taken to encourage planting initiatives in private properties. Since each town saw a decrease in tree canopy in areas of impervious surface and lawn/shrub/garden, the development of commercial areas is likely responsible for some of the tree canopy loss in the towns.

Aiming to introduce equitable allocations of environmental benefits is important to ensure a safe environment for marginalized and poor communities; however, since both potential environmental justice and Tree City USA communities saw tree canopy loss, increasing tree canopy among all communities is necessary. The findings of this study further cement the need to tree planting projects in communities. In addition, grants may have to be allocated to lower-income communities that cannot afford to pay for tree planting programs to ensure that tree planting goals are met among all communities, regardless of race and wealth.

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