2009
-
2019

Urban Tree Canopy Assessment and Change Analysis

Results | 2009 – 2019

Prepared for the City of Decatur, Georgia

City of Decatur®

Prepared By

Tony Giarrusso
Senior Research Scientist
Associate Director for the Center for Spatial Planning Analytics and Visualization at Georgia Institute of Technology

Mike Edelson
Project Manager
Director of Operations & Director of Geographic Information Systems at InterDev

Acknowledgement

Decatur Environmental Sustainability Board
Michael Black, Chair

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EXECUTIVE SUMMARY

The City of Decatur, Georgia, commissioned a study of the urban tree canopy to provide citizens and decision-makers a quantitative method for monitoring its tree canopy over time. Repeating this study over several years allows the City to understand and monitor significant tree canopy trends.

An increase in development over the past ten years has caused citizens to have legitimate concerns about the City's valuable tree canopy. By commissioning this study, the City of Decatur continues to develop an authoritative method to monitor a changing tree canopy.

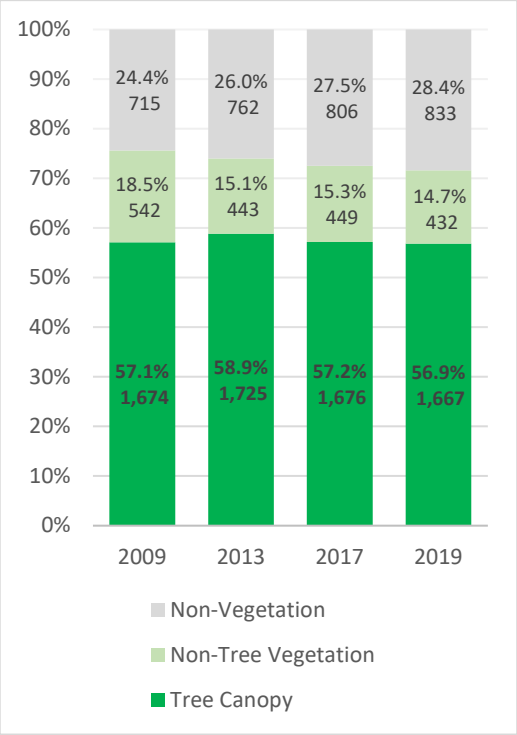
This analysis provides the City with a measurement of tree canopy for each square meter of the City and the overall percentage of the city's land area covered by tree canopy. Whether changes are natural or human-made, understanding the evolution of the City of Decatur's tree canopy will be crucial to understanding the trends in canopy change.

This study hopes to facilitate informed and educated conversations and decisions around preserving Decatur's valuable tree canopy.

BETWEEN 2009 AND 2019, DECATUR'S URBAN TREE CANOPY REMAINED CONSISTENT AT 57%± CITY-WIDE COVERAGE

What is a Canopy Study?

- The USDA Forest Service definition: tree leaves, branches, and stems covering the ground when viewed from above.
- Canopy studies provide a powerful "bird's eye view" of the urban forest.
- Canopy studies reveal patterns of change. Ground-truthing (onsite inspections) helps interpret patterns of change.
- Canopy studies measure quantity, not quality.
- When running a tree canopy study, growth and loss is to be expected.



Using the Results

- Inform decision-making, policy, and sustainability efforts related to climate, water, air quality, tree preservation, and watershed protection.
- Refine policies and set canopy goals to ensure that each area of the City receives the benefits of a healthy canopy and that the overall tree canopy is maintained, with no net loss.
- Educate the public about the tree canopy in Decatur.
- Canopy coverage is a critical indicator when assessing local urban heat island effects.

FINDINGS

- The total canopy remained consistent at 57%± between 2009 and 2019.
- Per the current ordinance, the City has achieved and maintained its 50% canopy coverage goal.
- Land use drives canopy distribution
    - Properties zoned low-density residential make up 70% of the City's tree canopy change
    - Downtown Decatur and the CSX rail corridor have the least amount of tree canopy.
- The City's eastern residential neighborhoods have the most tree canopy.
- The southwestern residential neighborhoods have the least amount of tree canopy.
- Characteristics of areas with tree canopy gain include:
    - New plantings and street trees
    - The continued growth of established trees
- Characteristics of areas of tree canopy loss include:
    - Single-family residential redevelopment
    - New townhomes and commercial developments
    - Expansion of existing institutional properties (schools, city facilities, utility corridors)Discretionary tree removal or loss due to storms

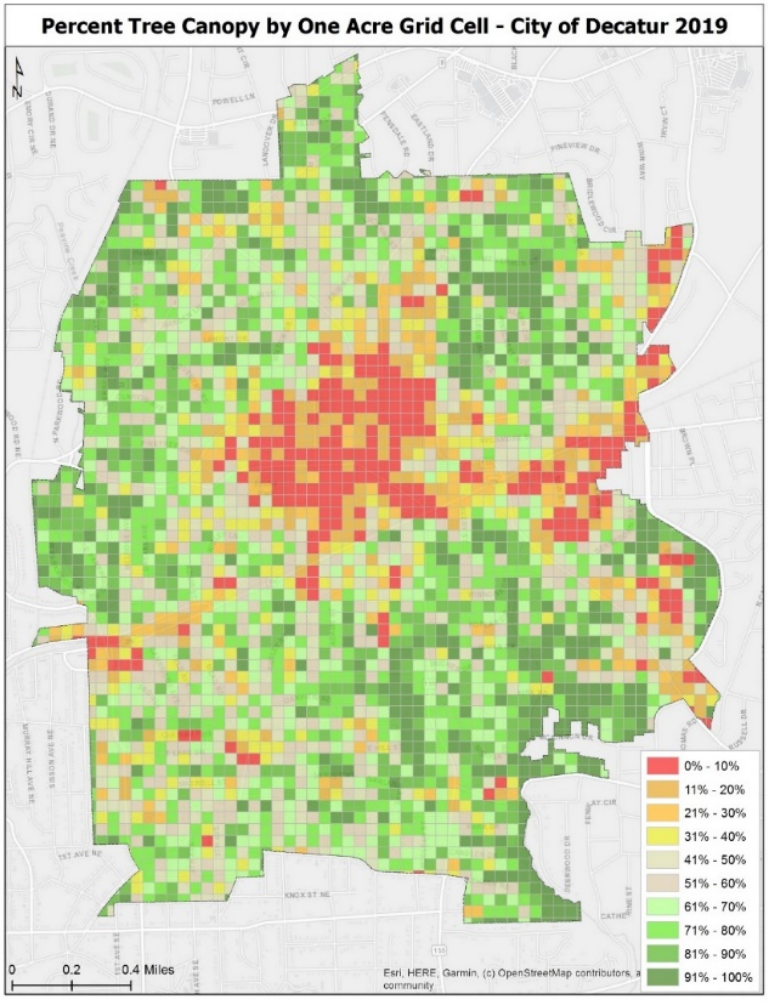
TREE CANOPY COVERAGE AND CHANGE ANALYSIS

To perform this assessment, the City was divided into one-acre grid cells, then analyzed on an acre-by-acre basis to understand at this very localized level if the City experienced gain or loss in the canopy. Dividing the City in this way allows us to compare consistent and localized areas year over year. This consistency helps to confidently identify trends in the canopy.

Studying the canopy using one-acre grid cells helps to focus our attention on the information the imagery provides. Any attempt to provide more exact canopy percentages may lead to a false interpretation of accuracy. To analyze the tree canopy using this one-acre method allows for minor fluctuations in the tree canopy. Many factors, such as pixel size, shadows, time of day, and wind conditions, can introduce errors as you attempt to analyze areas in more detail.

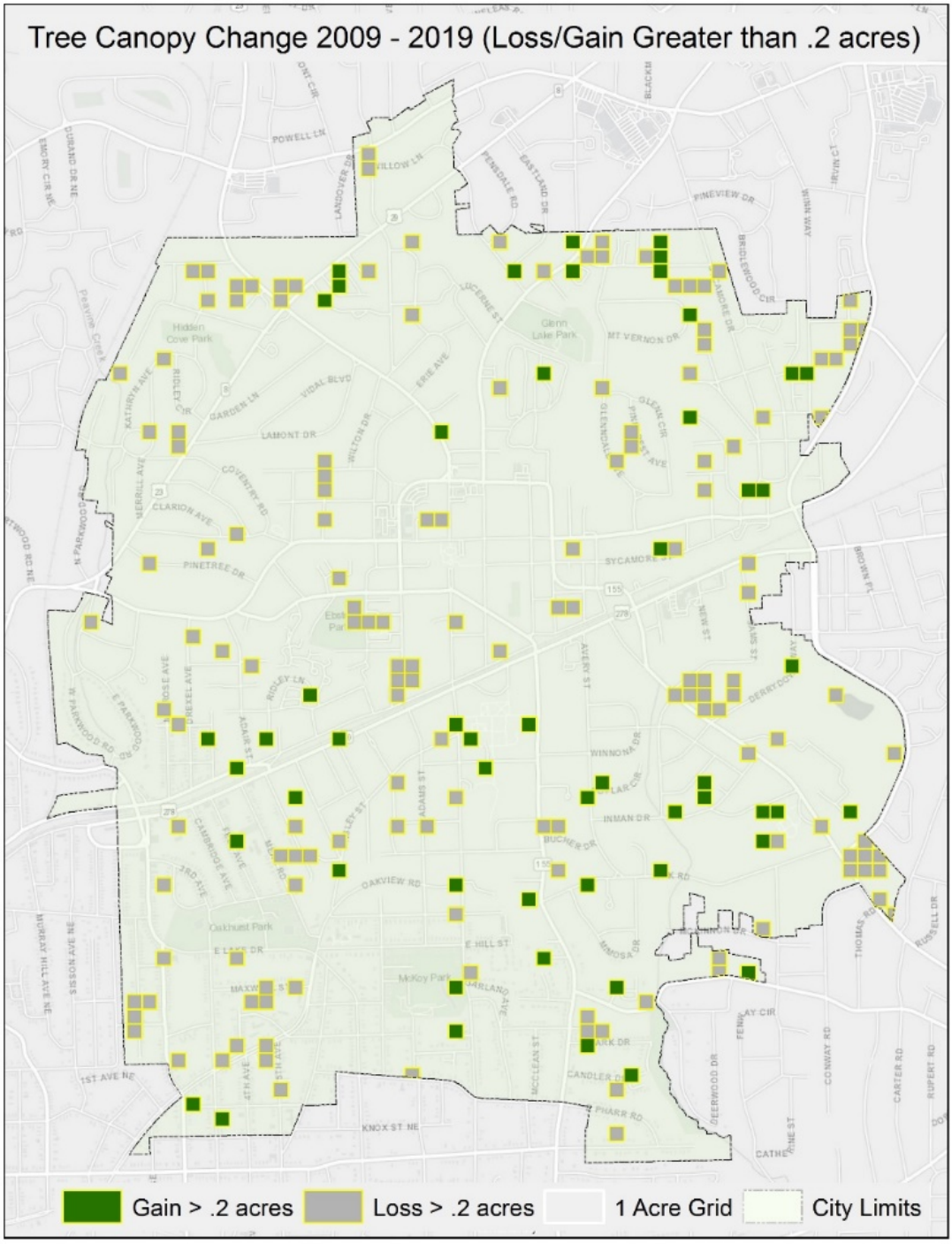
The map on the right shows the percent tree canopy for each one-acre cell in the City. Like many urban cities with a vibrant downtown, Decatur had an expected tree canopy distribution in September 2019: less canopy downtown and a thicker canopy in the periphery.

This study created similar data using the same grid pattern for 2009, 2013, 2017, and 2019 and compared each cell's coverage. These results were used to generate the map on the next page showing the one-acre grid cells identifying gain or loss in the canopy.



September 2019 Tree Canopy Coverage

The map below depicts one-acre grid cells of significant tree canopy loss or gain between 2009 and 2019. The grey grid cells show locations of loss of 0.2 acres or greater. The dark green grid cells show areas of gain of 0.2 acres or greater.



METHODOLOGY

A land cover classification study was conducted using available aerial imagery collected in 2009, 2013, 2017, and 2019.

Aerial Imagery (Leaf-on)

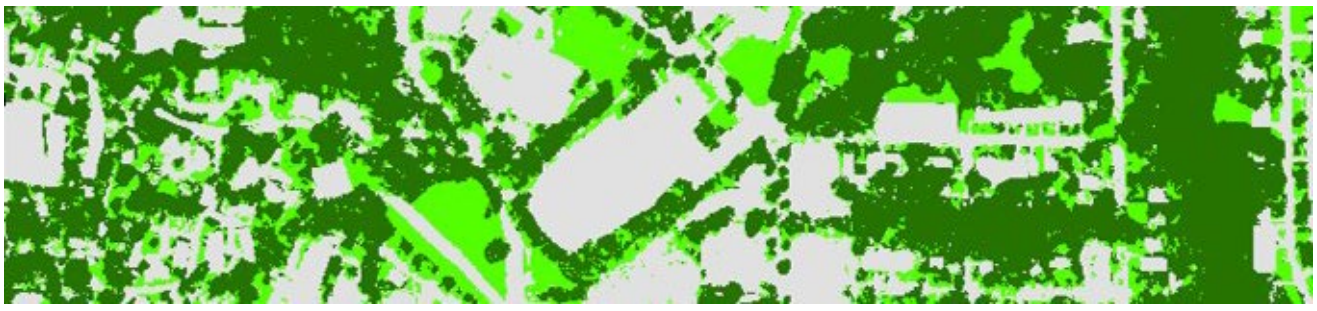
The aerial imagery was obtained through the U.S. Department of Agriculture National Agricultural Imagery Program (USDA NAIP). The NAIP imagery program provides 1-meter resolution aerial imagery collected during the "leaf-on" season on a 2-3-year cycle. This imagery is the standard for urban tree canopy studies.

A critical factor in determining tree canopy coverage over time is the ability to compare two aerial imagery data sets taken years apart that are as close to identical as possible. Conditions include the time of day, time of year, pixel size, camera angle, cloud cover, and other variables.

Side-by-side aerial imagery showing West Ponce de Leon Ave eight years apart. Notice the shadows of the trees (see red arrow). The shadows are similar in length and angle, indicating that these two aerial photos were taken at a similar time of year and within a few hours of each other.

Classification Analysis

The processing technique used in this study is called *Iso Cluster Unsupervised Classification*. This process analyzes each pixel in the image to find natural clusters of values (or colors.) The method uses techniques to programmatically combine millions of pixel values based on similar characteristics down to three categories: *Tree Canopy*, *Non-Tree Vegetation*, or *Non-Vegetation.*



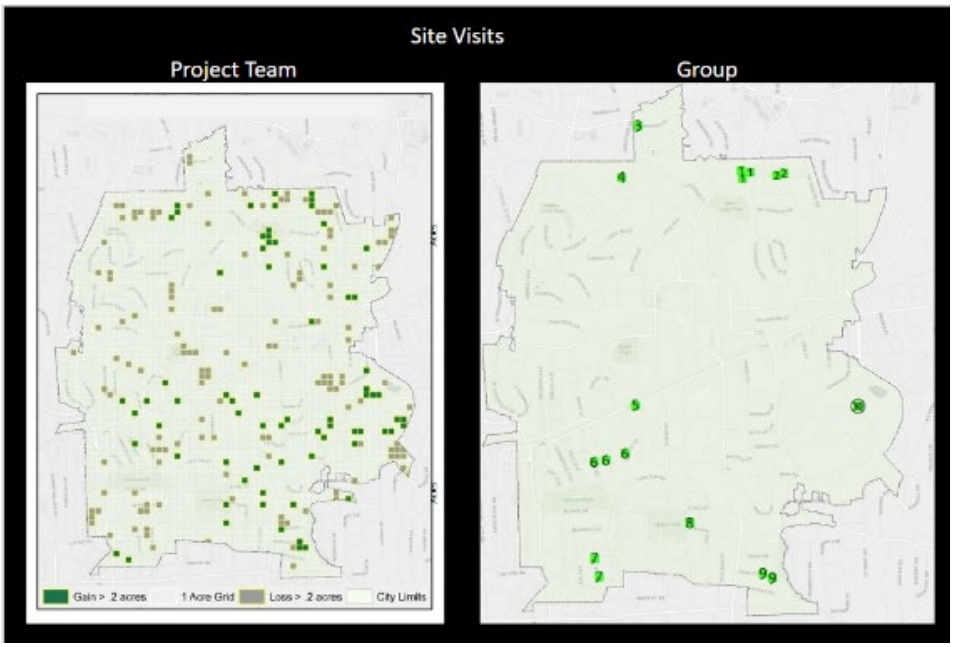
Dark green areas are tree canopy. Light green areas are categorized as Non-Tree Vegetation, and the gray regions are categorized as Non-Vegetation.

SITE VISITS, GROUND-TRUTHING, AND QUALIFYING TREE CANOPY

SITE VISITS AND GROUND-TRUTHING

In January 2021, the Decatur Environmental Sustainability Board (ESB) project team members, city staff, and citizens conducted site visits throughout the City to confirm or refute the study's findings. The project team worked with David Nifong (LEAD for America Fellow in the City's Public Works Department) to organize and conduct a ground-truthing exercise.

Site visit locations were chosen by identifying areas in the City with the most significant canopy loss or gain (below left.) Other sites were selected to identify potentially problematic areas for canopy cover classification, such as areas covered by kudzu and English Ivy .



(Left) Map identifying areas with the most significant canopy loss or gain.
(Right) Ten sites were chosen, divided equally between areas of gain and loss.

While at the site, each participant was encouraged to take notes on observed loss and gain in the canopy.

1. If it was a *Loss* site - Observe any new canopy, if present. Note the types of trees replanted, if possible.
2. If it was a *Gain* site - Confirm canopy gain and note the types of trees observed. If the area identified as indicating growth is not actually canopy, the participant stated the vegetation type.

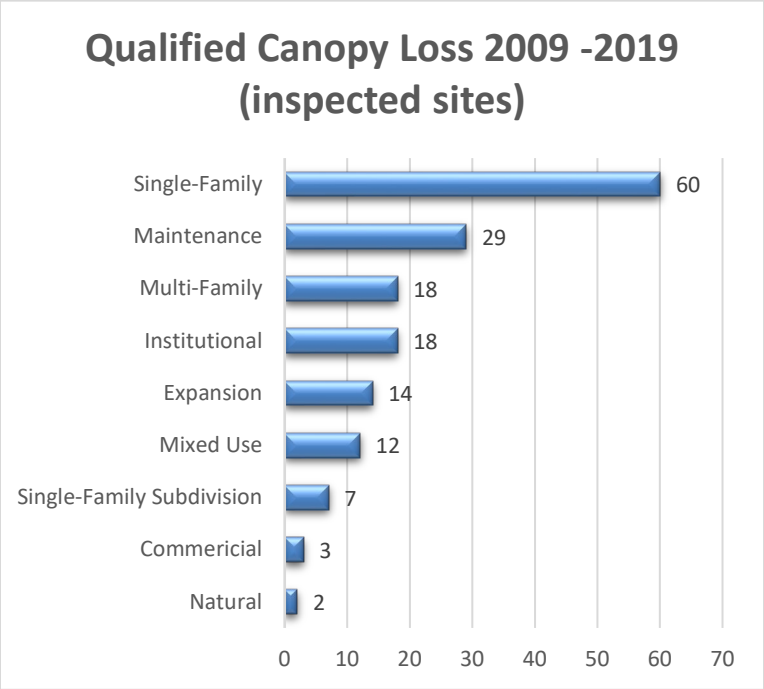
On January 26, 2021, the project team guided the final site visit with a small group of ESB members, city staff, and citizens. The team met at Legacy Park to discuss the site visit findings, perform a walking tour, and answer questions about the study's methodology, all while observing the gain or loss of canopy coverage on the property. These observations were then incorporated into the study.

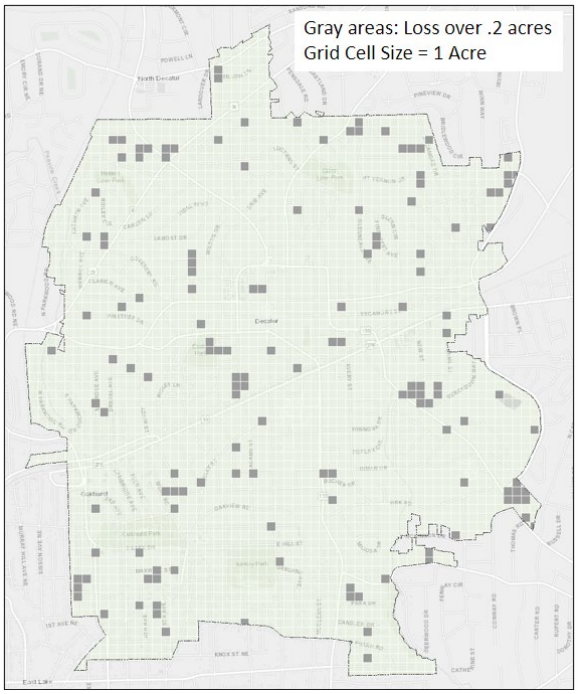
QUALIFYING GAIN AND LOSS IN THE TREE CANOPY

In addition to the organized ground-truthing exercise, our project team performed additional site visits to "qualify" the change at each site. The goal of qualifying the change was to identify the reasons for the canopy change (i.e., single-family redevelopment, street tree growth, etc.).

Qualifying Loss

The project team visited each of the 163 one-acre sites identified as canopy loss over .2 acres, shown on the map on the right, to determine the cause of the loss visually. The graph on the left generalizes the different reasons for canopy loss into nine categories. The most prevalent cause for canopy loss between 2009 and 2019 was due to single-family redevelopment. The second most prevalent cause is maintenance. Maintenance is categorized by activities such as discretionary tree removal, tree trimming along powerlines or along utility corridors, and tree loss due to storms. The institutional category identifies canopy loss in areas used for education, utilities, or government-owned properties.



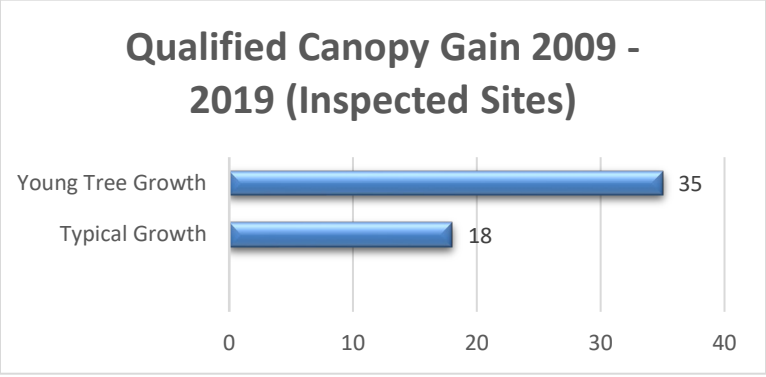


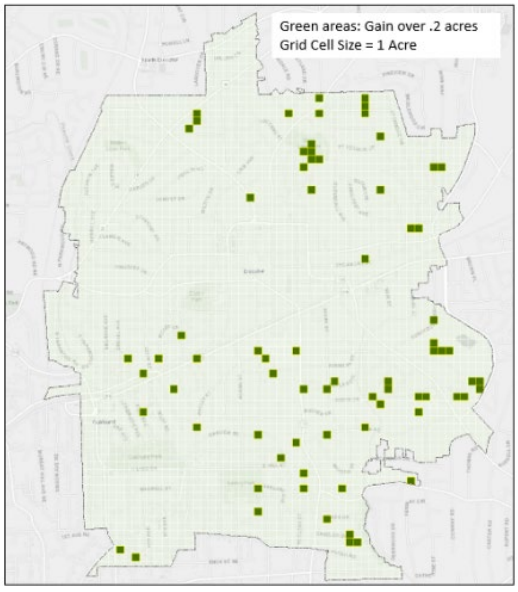
Qualifying Gain

Site visits were completed at each of the 53 one-acre sites identified as canopy gain over .2 acres, shown on the map on the right below, to determine the reason for the observed growth. The graph on the left below generalizes the two reasons for canopy gain. Most of the past decade's noticeable canopy growth has come from fast-growing, young trees planted near or slightly before 2009. Slower growth from mature trees was also observed, as expected, though not as prominently as growth from younger trees. Tree-planting programs have proven to do an excellent job stabilizing the City's canopy between 2009 and 2019. These programs include parks and street tree planting, as well as tree plantings within the Decatur Cemetery.

Post-development tree replacement such as the Knob Hill, Glenn Court, Oakhurst Commons, and Brownstones at Decatur developments also showed fast young tree growth.

Oakhurst Commons Street Trees





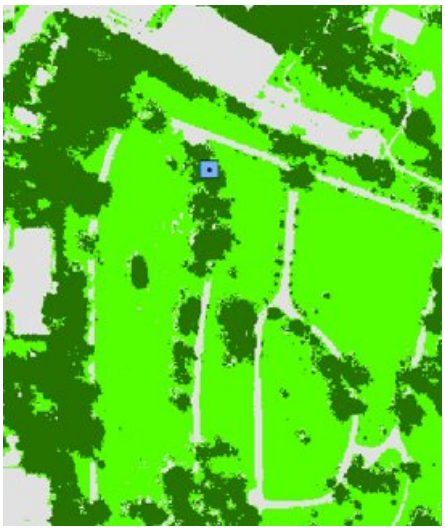
ACCURACY: ASSESSING THE CANOPY ASSESSMENT

This study follows the land cover assessment methodology established in the *Food and Agricultural Organization (FAO) of the United Nations, Map Accuracy Assessment and Area Estimation: A Practical Guide, 2016* document. For detailed methods, please refer to the section following document http://www.fao.org/3/a-i5601e.pdf

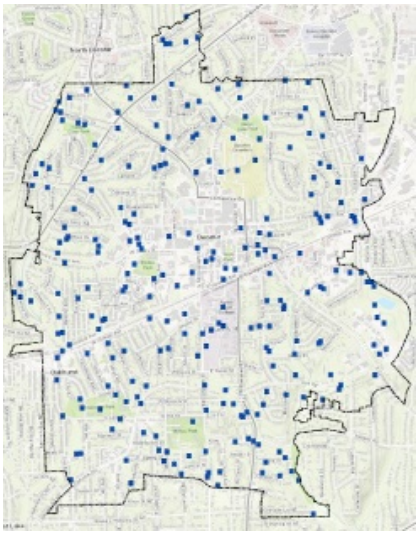
1. This study used 250 randomly stratified points (shown below right) to create a sample set of random locations distributed across Decatur.
2. Using Google Earth historical imagery, we compared our Iso Cluster Unsupervised Classification model results to the Google Earth imagery (shown below left.) This comparison was used as our inputs into the error matrix described in the FAO manual listed above.
3. Overall Accuracy was 89% - 93%, well above the industry standard, around 75% accuracy.

	2009	2013	2017	2019
Trees	**93%**	**89%**	**97%**	**98%**
Non-Tree Vegetation	87%	80%	82%	81%
Non-Vegetation	91%	95%	96%	85%
Overal Accuracy	**90%**	**90%**	**93%**	**91%**

Overall Accuracy Assessment Table.



A random point falling within the Decatur Cemetery. Left is showing aerial imagery. Right is showing the canopy model.



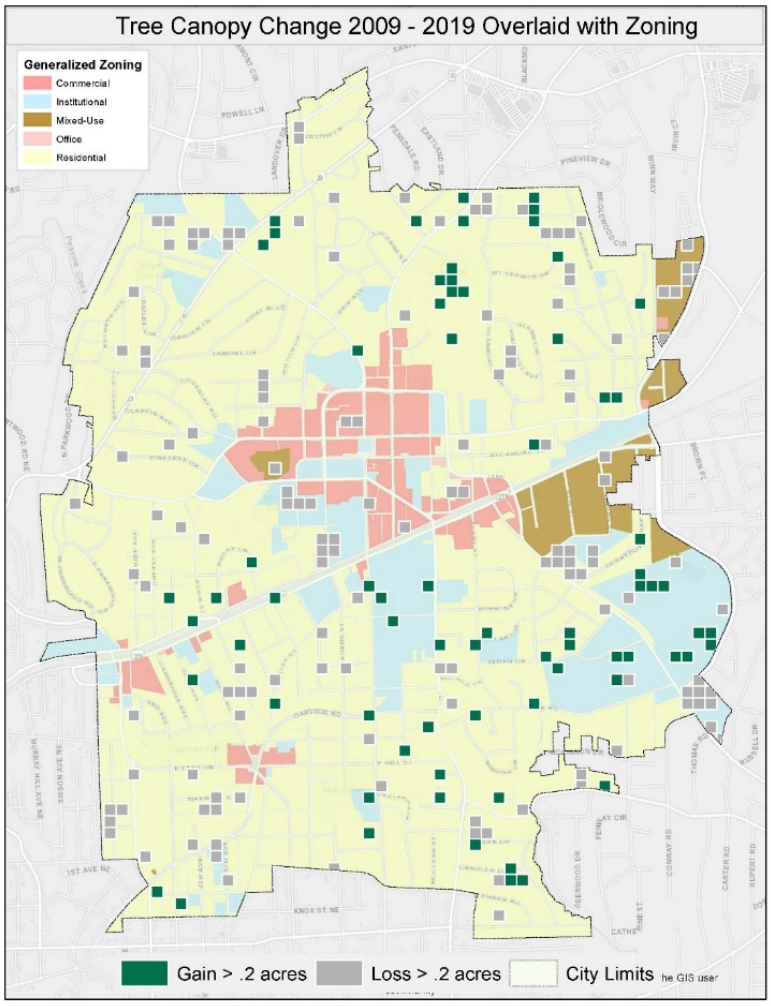
250 random points used for quality checks

RESULTS AND ANALYSIS

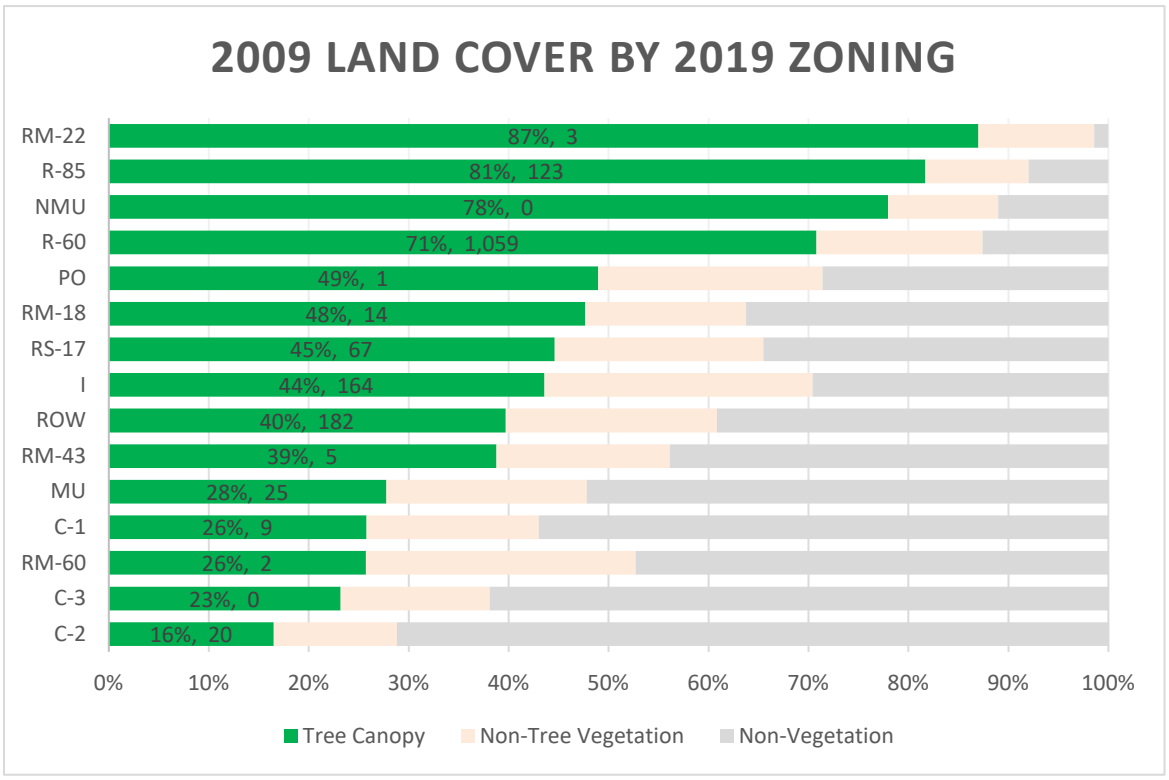
Below is a series of thematic maps showing change analysis and the current state of Decatur's tree canopy in September of 2019.

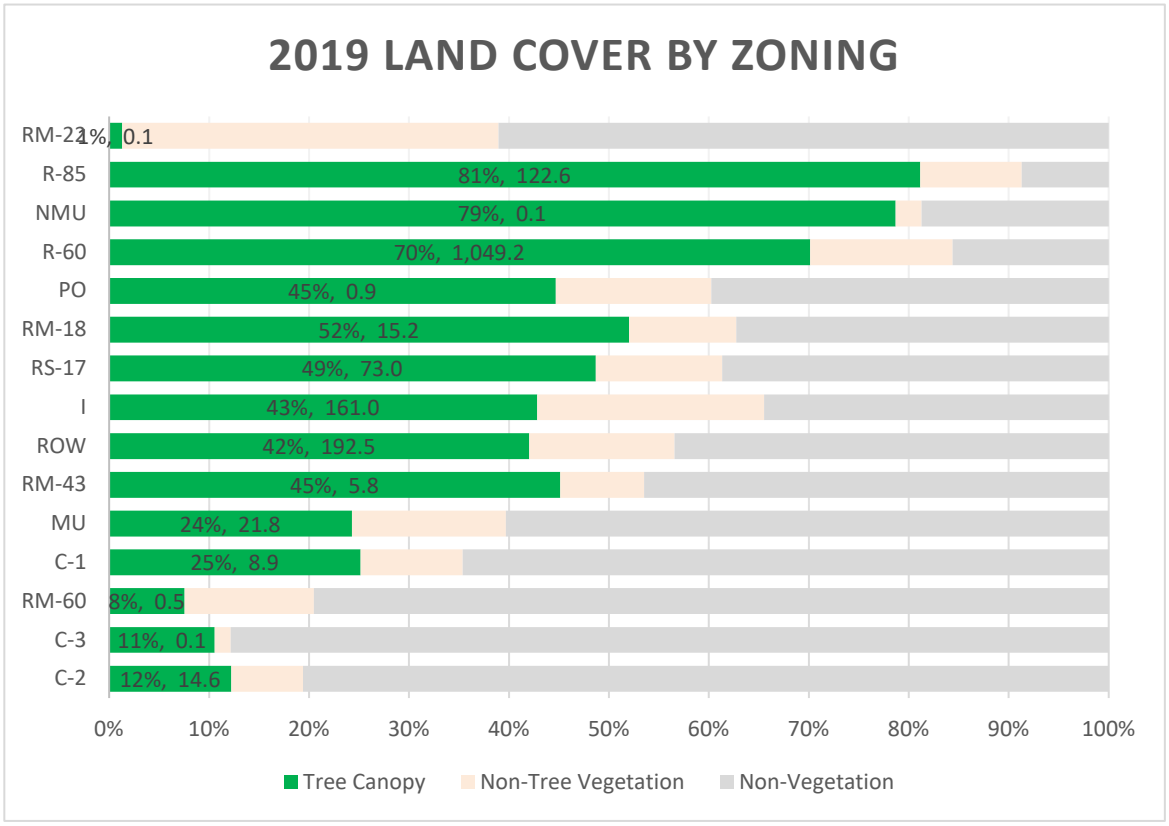
ZONING

The map below shows an aggregated map of Decatur's zoning categories overlaid with the one-acre grid cells indicating loss or gain of .2 acres. Similar land uses such as R-60, R-85, and RM-22 are all grouped as Residential, while C-1, C-2, and C3 are all grouped as Commercial, etc. Note that most of the City is zoned Residential, which is significant because greater than 70% of the City's tree canopy covers single-family zoned areas. This is where the most canopy change has occurred.



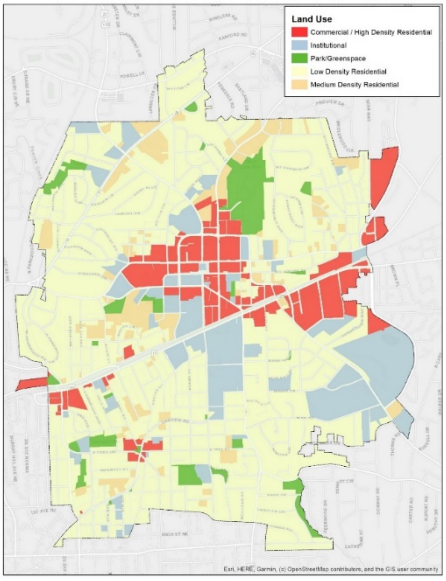
The graphs below describe the 2009 and 2019 land cover by zoning districts. Each bar in the chart represents a zoning category with the percent and acres of cover for tree canopy, non-tree vegetation, and non-vegetation.


2009 LAND COVER BY 2019 ZONING
RM-22
R-85
NMU
R-60
PO
RM-18
RS-17
I
ROW
RM-43
MU
C-1
RM-60
C-3
C-2
87%, 3
81%, 123
78%, 0
71%, 1,059
49%, 1
48%, 14
45%, 67
44%, 164
40%, 182
39%, 5
28%, 25
26%, 9
26%, 2
23%, 0
16%, 20
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Tree Canopy
Non-Tree Vegetation
Non-Vegetation

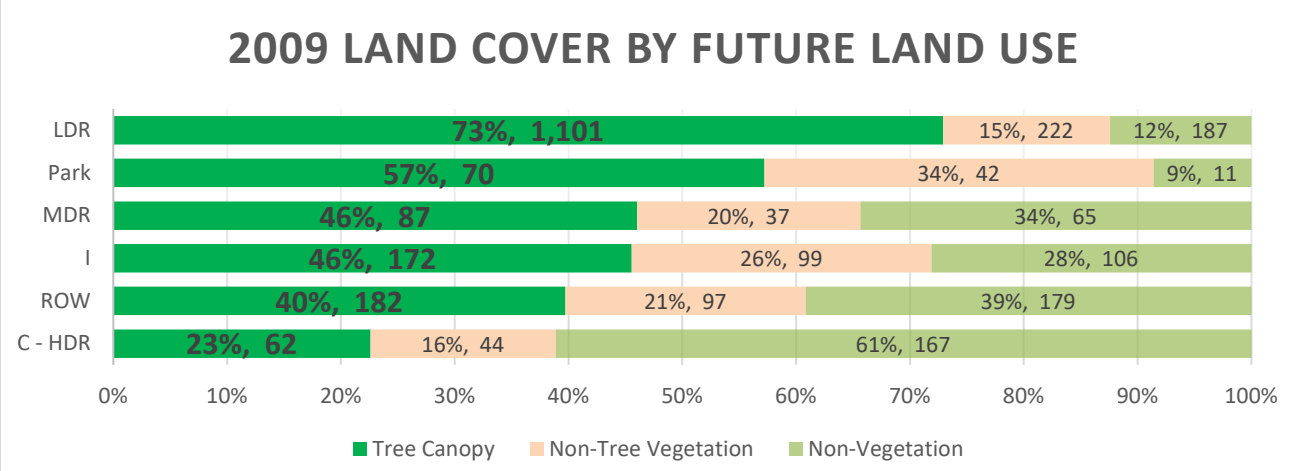

2019 LAND COVER BY ZONING
RM-22
R-85
NMU
R-60
PO
RM-18
RS-17
I
ROW
RM-43
MU
C-1
RM-60
C-3
C-2
1%, 0.1
81%, 122.6
79%, 0.1
70%, 1,049.2
45%, 0.9
52%, 15.2
49%, 73.0
43%, 161.0
42%, 192.5
45%, 5.8
24%, 21.8
25%, 8.9
8%, 0.5
11%, 0.1
12%, 14.6
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Tree Canopy
Non-Tree Vegetation
Non-Vegetation

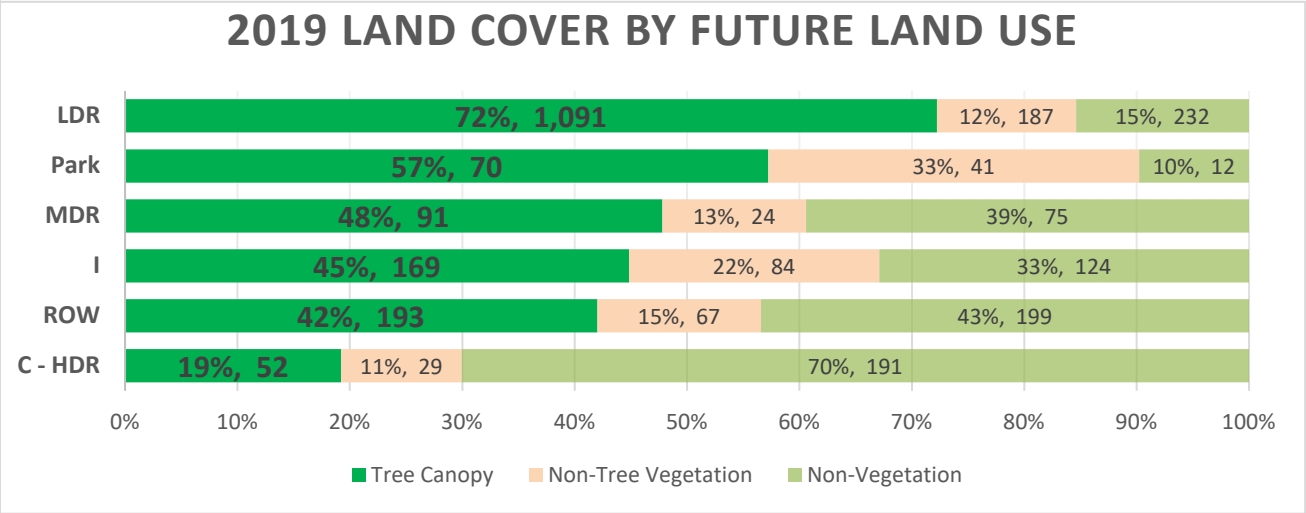
FUTURE LAND USE

The map on the right depicts the City's future land use as of January 2021.



The charts below describe the 2009 and 2019 land cover by future land use categories. Each bar in the graph represents a future land use category with the percent and acres of tree canopy, non-tree vegetation, and non-vegetation shown in each bar.





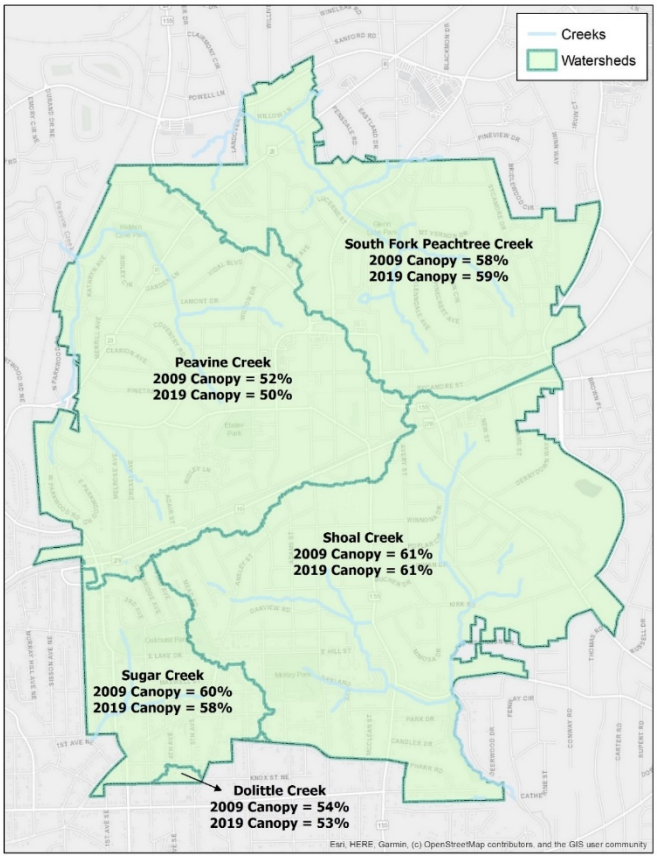
SUBWATERSHED

The City of Decatur contains portions of five subwatersheds described by the United States Geologic Survey's (USGS) Hydrologic Unit Code (HUC 12) category. A subwatershed is an area of land that drains all the rivers, streams, and rainfall to a single location.

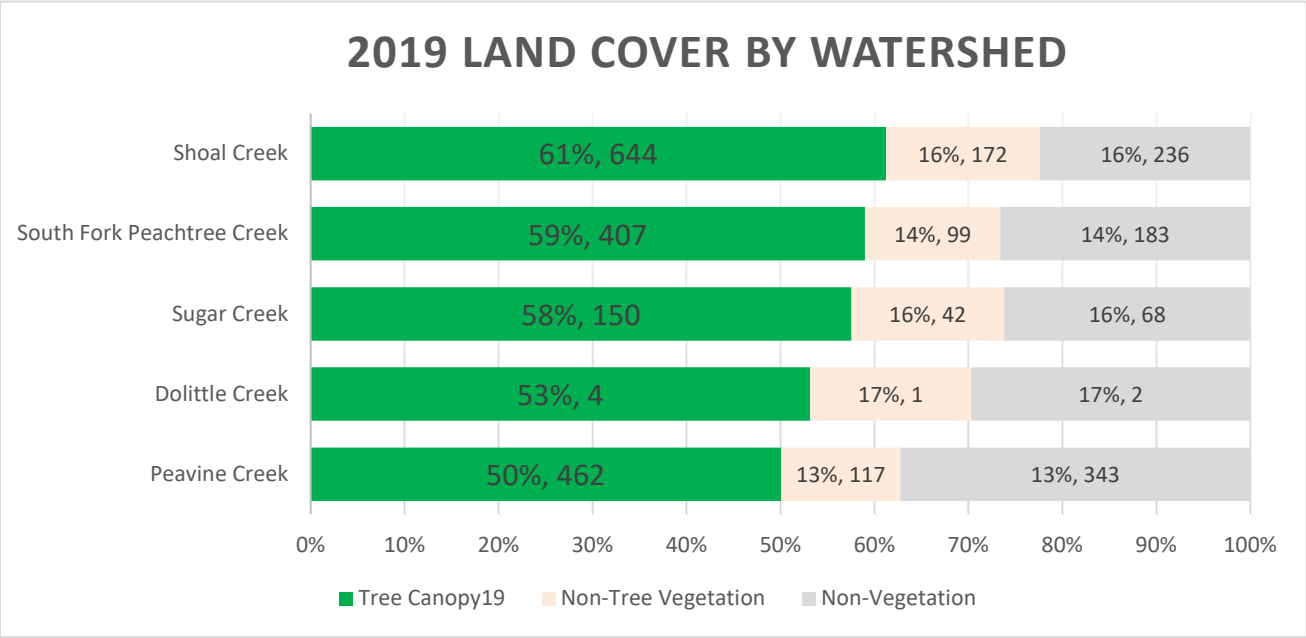
The South Fork Peachtree Creek and Peavine Creek subwatersheds empty into the South Fork Peachtree Creek Watershed and eventually drain into the Gulf of Mexico through the Apalachicola Basin. The Shoal Creek, Sugar Creek, and Dolittle Creek subwatersheds empty into the Shoal Creek-South River Watershed and eventually drain into the Atlantic Ocean through the Altamaha Basin.

The map to the right illustrates portions of the five subwatersheds located in the City, with a tree canopy coverage percentage for 2009 and 2019.

The canopy changes noted on this map are within the margin of error and should be considered stable and negligible. Peavine Creek Subwatershed includes much of downtown and has considerably less canopy coverage than the other subwatersheds.

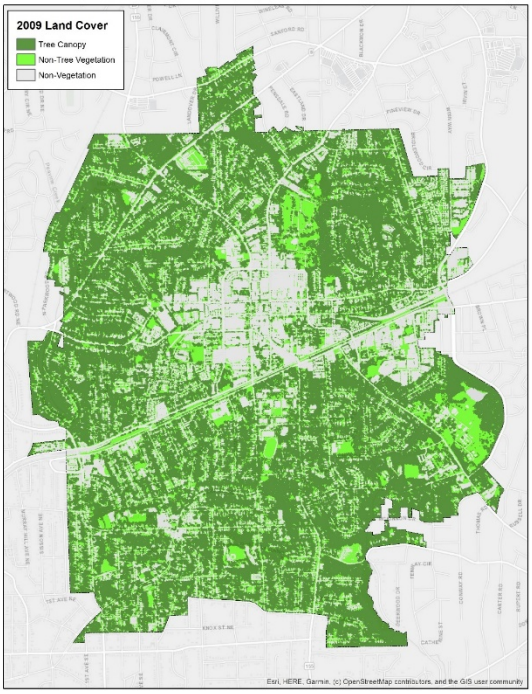


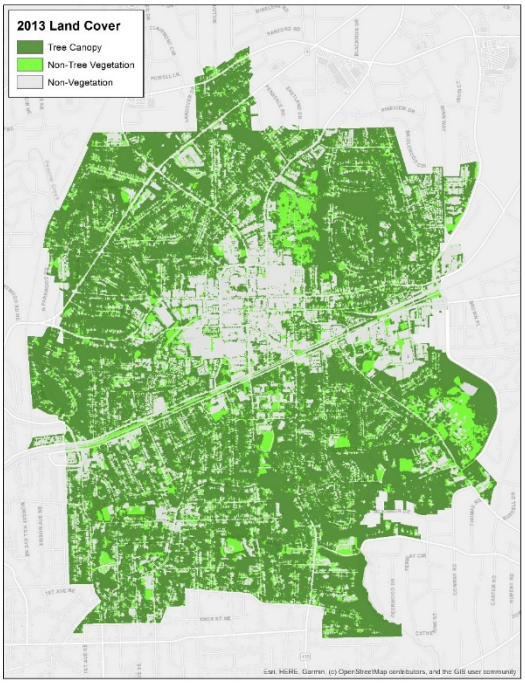
Decatur Subwatersheds and 2009 and 2019 tree canopy coverage

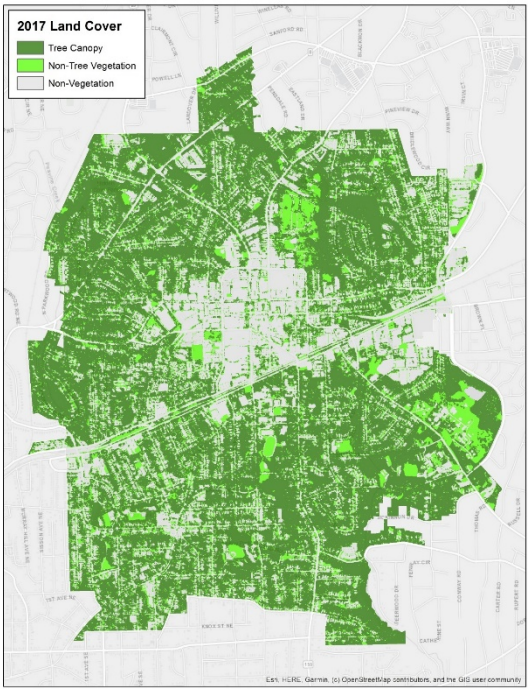


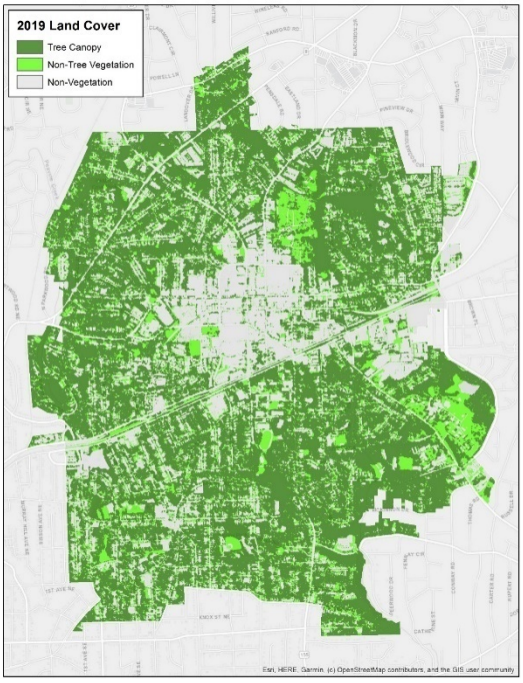
LAND COVER 2009, 2013, 2017, AND 2019

These figures illustrate City-wide results from the tree canopy analysis. The data on these maps was derived from 1-meter resolution NAIP photography (described in the Methodology section) to create each tree canopy coverage layer shown below for each year analyzed in this study. The 2009 and 2019 layers were then aggregated to the city-wide one-acre grid cells for change analysis (also described in the Methodology section above.) Dark green represents tree canopy, light green represents Non-Tree Vegetation, and grey represents Non-Vegetation.



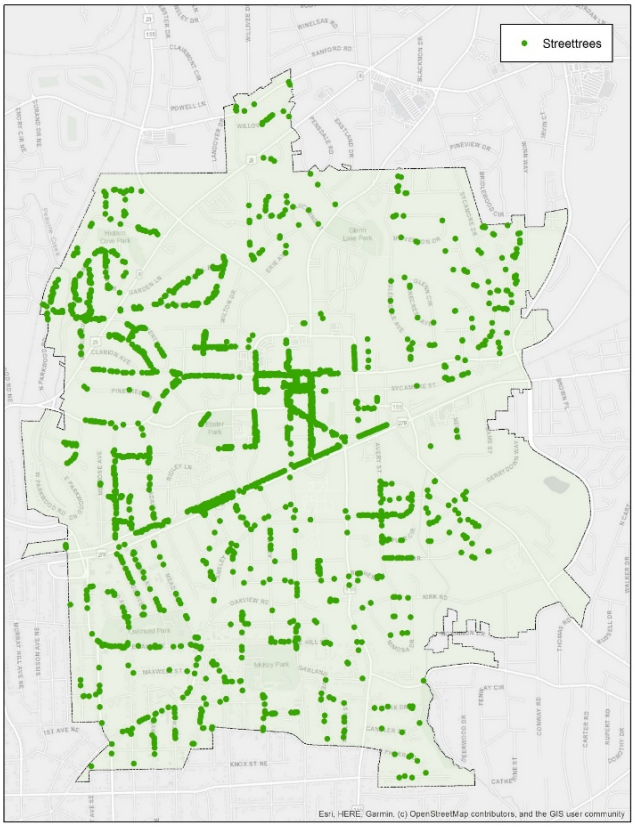


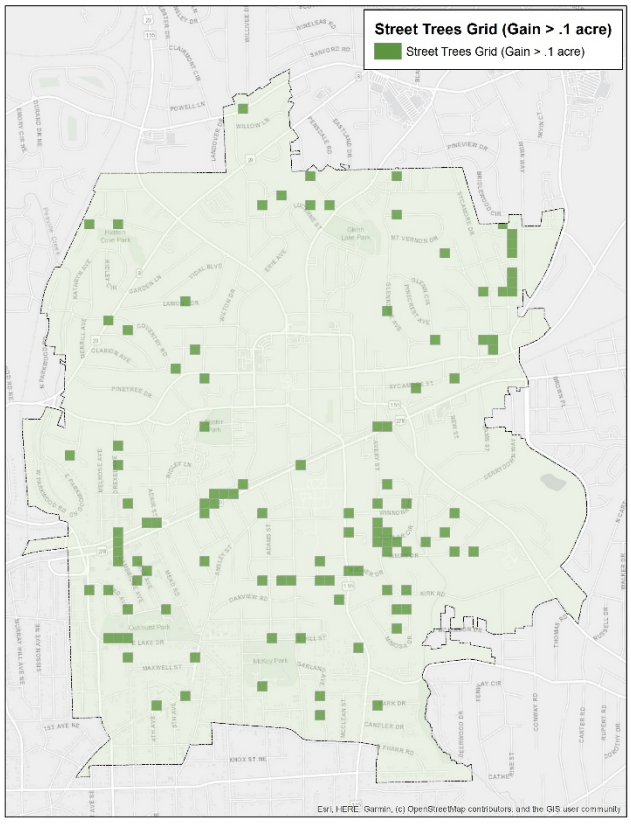




STREET TREES

Street trees are an essential element in a vibrant cityscape and are critical when considering a tree canopy strategy. The map on the left depicts locations of trees within the City's rights-of-way. Tree locations were initially collected in a field study performed around 2010 and continuously maintained by the City. The map on the right depicts the one-acre grids where we observed gain greater than 0.1 acres over the past ten years. In this case, 0.1 acres were used to highlight street tree growth because many of the street trees are mature, which can grow slower than young, recently planted trees. This relationship is a good indicator that street trees and other organized tree-planting programs effectively increase the City's tree canopy coverage, or at minimum, mitigate overall canopy losses.





IMPLICATIONS AND RECOMMENDATIONS

THE FUTURE OF THE CITY'S TREES

- Tree canopy qualitative values are stable.
- Most of the City's trees are on private property – low-density residential.
- Single-Family redevelopment is the most significant cause of the loss of the tree canopy.
- Development has steadily increased over the last decade.
- 40% of the City's Right-of-Way (i.e., streets) are covered with the tree canopy.
- Much canopy was gained in newer developments through younger tree growth, street trees, tree plantings.
- Older trees are abundant in Decatur. Consider strategies for renewal and replanting.

FOR CONSIDERATION

- Protect remaining large tracts of undisturbed forest and woodland areas. Consider measures to reduce the impact of invasive plants.
- Identify methods for reducing tree loss during the redevelopment of single-family properties.
- Consider "conservation subdivision" measures for new small lot and townhouse developments.
- Ensure continued planting of trees that have similar canopies to trees removed and encourage the use of native and naturalized non-invasive trees to create a diverse, sustainable urban canopy.

APPENDIX

I-TREE CANOPY REPORT

i-Tree is a free tool created by the USDA Forest Service to provide an easy method for estimating tree canopy and assessing a changing canopy's benefits and impacts. I-Tree Canopy generates random points that the user then is required to classify as tree canopy or other land use types (trees, lakes, impervious surfaces, etc.) Once the user classifies the random points, the tool will provide a report highlighting tree canopy benefits based on the study area's percent coverage. i-Tree Canopy is an excellent tool for estimating these values, but there are some limitations.

The main limitation of the application is overall accuracy. The assessment's accuracy tends to depend on the user's ability to discern between the canopy and non-canopy areas. The low quality of some of the images can be challenging for novice users. Another limitation in the application is that it uses Google Earth imagery (collected in the winter) during the leaf-off season.

Nonetheless, i-Tree Canopy is a valuable and powerful tool. Our team used the i-Tree Canopy calculations with our results to show a more accurate assessment. The table below represents this analysis.

For further research, or if you are interested in performing your own i-Tree Canopy analysis, visit the *i-Tree Canopy* website. https://canopy.itreetools.org/

I-TREE CANOPY ECOSYSTEM BENEFITS – 2019 CANOPY

Benefit	Benefit Description	Value (USD)	Amount (Tons)
CO	Carbon Monoxide removed annually	$ 1,388	0.87
NO2	Nitrogen Dioxide removed annually	$ 1,915	5.01
O3	Ozone removed annually	$ 64,077	44.05
PM2.5	Particulate Matter less than 2.5 microns removed annually	$ 155,701	2.66
SO2	Sulfur Dioxide removed annually	$ 294	2.58
PM 10	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$ 65,590	10.46
CO2 seq	CO2 sequestered annually in trees	$ 388,344	8,349.69
CO2 stored	CO2 stored in trees (not an annual rate)	$ 9,799,982	210,706.99

i-Tree Canopy Annual Tree Benefit Estimates based on these values in lbs/acre/yr and USD/T/yr: CO 1.246 @ 1,333.50 USD | NO2 5.952 @ 382.41 USD | O3 51.980 @ 1,454.50 USD | PM2.5 3.177 @ 58,466.48 USD | SO2 3.085 @ 114.36 USD | PM10* 12.538 @ 6,268.44 USD | CO2seq 10,010.267 @ 46.51 USD | CO2 stored is a total biomass amount of 251,395.359 @ 46.51 USD

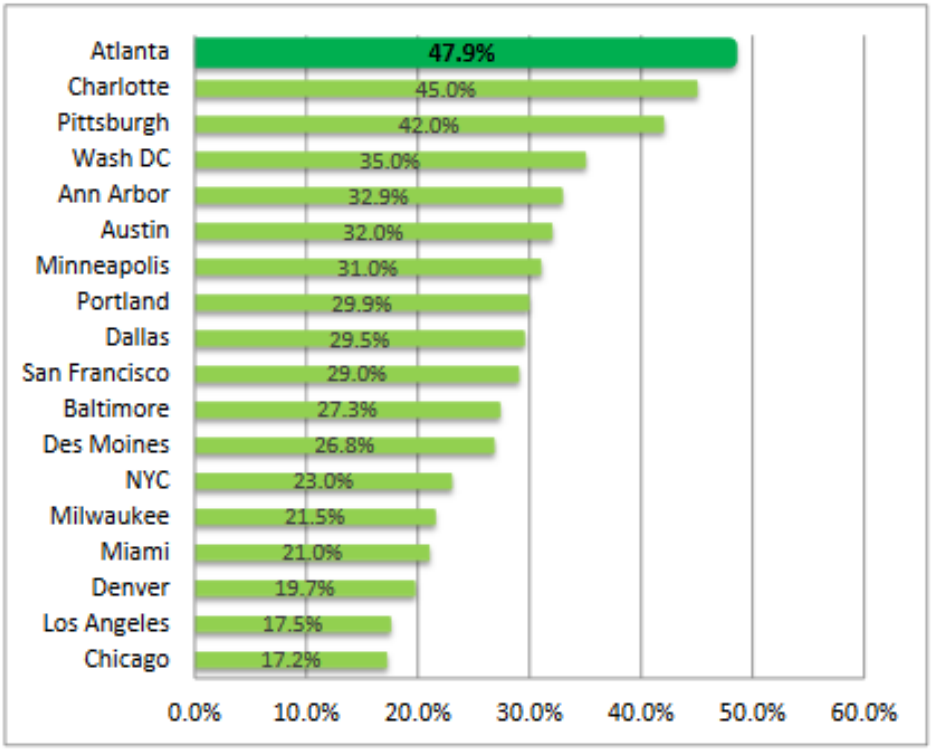
CREATING THE NEXT

COMPARISON OF CITIES

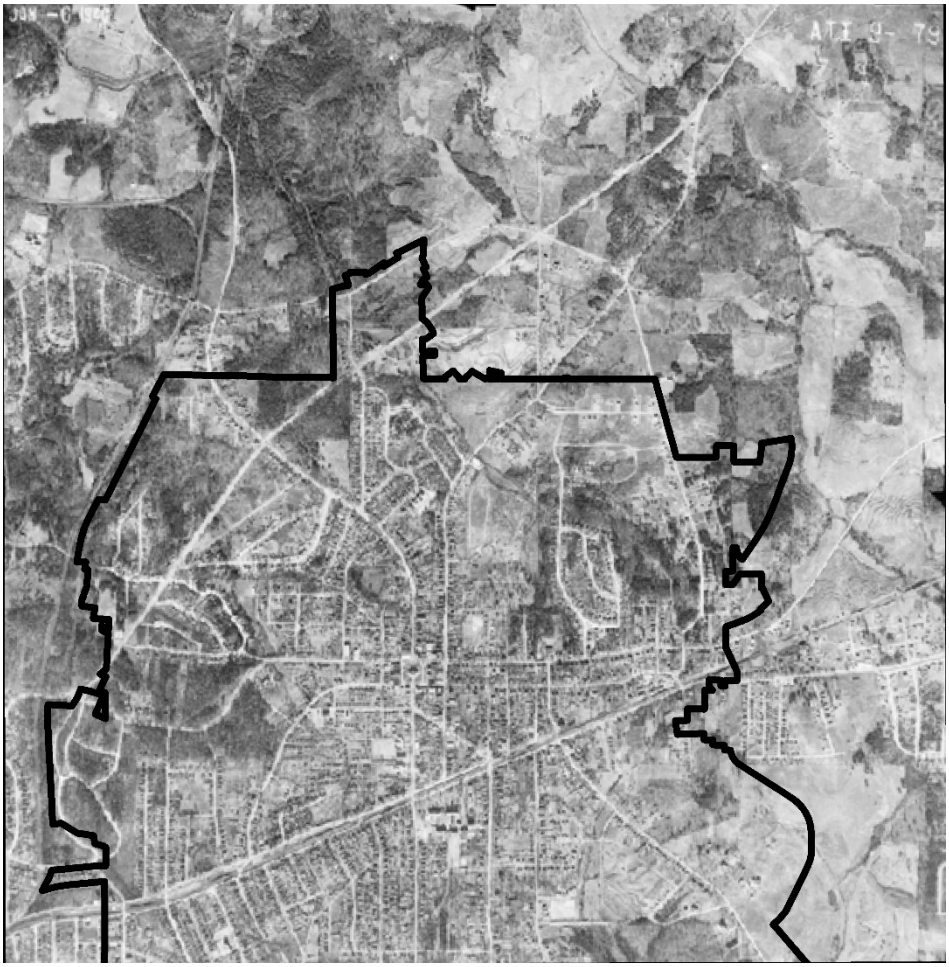
A quick comparison of tree canopy coverage for other cities in the Atlanta area:

Atlanta Region Comparison Cities	Year	Percent Tree Canopy Coverage
City of Atlanta	2014	47.9%
City of Avondale Estates	2015	54.0%
City of Norcross	2015	41.1%
City of Chamblee	2017	35.5%
City of Sandy Springs	2017	60.3%
City of Brookhaven	2019	44.0%

This table was developed and published in the 2014 City of Atlanta Urban Tree Canopy Study by the Georgia Tech Center for Geographic Information Systems. This table compares urban tree canopy percentages (UTC %) with other major metropolitan areas in the United States.



Percent Tree Canopy Estimates. Source: Atlanta Urban Tree Canopy Study



For reference only - Aerial Imagery of 1940 North Decatur overlayed with current city limits. The image above shows Decatur with less tree coverage than today. As we move from an agricultural society to an urban culture, evidence shows at a macro level, trees tend to replenish.

Imagery Source: Digital Library of Georgia and GALILEO, in association with the UGA Science Library Map Collection