# AN ASSESSMENT OF URBAN TREE CANOPY IN CHATHAM COUNTY, GEORGIA

**FEBRUARY 2015**


**PREPARED FOR: THE SAVANNAH TREE FOUNDATION**

**PREPARED BY: PLAN-IT GEO**

OUR MISSION IS TO PRESERVE, PROTECT AND PLANT CANOPY TREES IN CHATHAM COUNTY, GEORGIA. THE SAVANNAH TREE FOUNDATION PROMOTES, THROUGH DIRECT ACTION AND EDUCATION, AN AWARENESS OF TREES AS VITAL ENVIRONMENTAL RESOURCES AND AN IMPORTANT PART OF OUR CULTURAL HERITAGE.

"TO BE GOOD STEWARDS, WE NEED TO KNOW WHAT WE HAVE."

- SAVANNAH TREE FOUNDATION

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**Prepared By**

Plan-It Geo, LLC

**Acknowledgements**

Funding provided by the Savannah Tree Foundation

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**Prepared For**

The Savannah Tree Foundation

SAVANNAH TREE FOUNDATION

*Preserve. Protect. Plant. Since 1982.*

# CONTENTS

# TABLES & FIGURES

## LIST OF TABLES



## LIST OF FIGURES

# Executive Summary

Across Chatham County, trees along streets, in parks, yards, and natural areas constitute a valuable urban and community forest. This resource is a critical element of the region's green infrastructure, contributing to environmental quality, public health, water supply, local economies and aesthetics. Urban forests provide triple bottom line benefits – social, economic, and environmental – yet tree canopy is being lost faster than it is being replaced as shown in this study.

To manage, monitor, protect, and enhance the quality and stream of benefits received from the urban forest, the Savannah Tree Foundation initiated this study to assess:

- The extent of current Urban Tree Canopy (UTC)
- Trends in canopy cover over time
- Priority areas for tree planting, restoration, and protection

This report presents data, maps, and broad recommendations for setting, achieving, and monitoring UTC goals and drafting policy improvements for the benefit of all citizens in Chatham County.

### State of the Tree Canopy

This study analyzed all developed and undeveloped land, water, and marshland in Chatham County, an area of 482 square miles (308,336 acres). Using the county boundary from the Savannah Area GIS (SAGIS), this one-meter resolution land cover analysis reveals a current level of 36% average tree canopy in the County based on 112,205 acres of trees and forest. Tree canopy in the County's nine municipalities ranges from 26% (Tybee Island) to 72% (Vernonburg).

Viewed from above, 10% of the County (30,388 acres) is available for tree planting in lawns and open space. This excludes open space around airports as well as marsh and wetlands, which cover 31% of Chatham County. Another 2% of the County is covered by paved parking lots, where a portion of that space can be used to establish greater tree canopy. There are 44,417 acres of planting potential between vegetated and hardscape areas.

### Historical Trends in Tree Canopy

A prior study by Watson (1993) estimated Chatham County's canopy cover at 50% compared to 36% tree cover now. Task 2 of this assessment quantified that from 1999-2014 Chatham County has lost 21,437 acres

## State of the Tree Canopy*

**36%**

Tree canopy in Chatham County in 2013 (112,205 acres) based on all land, water, and marsh (308,336 acres). Tree canopy averages 41% when based on land area only.

**44,417**

Acres available for tree planting countywide between lawns, open space, and suitable hardscape areas like parking lots

**44%**

Average tree canopy in the City of Savannah in 2013 (28,764 acres)

**$587M**

Total savings in avoided stormwater infrastructure costs provided by existing trees and forests in Chatham County (see CITYgreen, pages 10 & 40)

*Results on this page are based on 2013 aerial imagery from Task 3 of this study. See Methods on page 5. Note that sources vary in reporting the official area of Chatham County depending on how water areas near the Atlantic Ocean and inlets are delineated. The GIS county boundary used for this study provided by SAGIS covers 482 square miles, or 308,336 acres. Other geographic boundaries assessed in this study also differ slightly in total acreage.

## Trends in Tree Canopy

**-21,437**

Acres of canopy loss in Chatham County from 1999-2014, averaging three football fields in size every day

**-39%**

Percentage of canopy loss in Pooler and Port Wentworth between 1996 and 2010, the highest rate of municipalities in Chatham County

**-6,400**

Acres of canopy loss in Savannah between 1996 and 2010 (based on Task 1, see Methods, page 5)

**23%**

Projected tree canopy in 2050 in Chatham County if "Business-As-Usual" trends continue (40,392 acres of additional loss)

of tree canopy – or three football fields every day. This is a conversion of 8% of the county's land area (21,437 / 271,806 acres) from tree covered areas to roads, grass, parking, homes, and other buildings. Maps and charts in this report illustrate the areas of canopy loss, primarily in western Chatham County, broken out by municipality and watershed (drainage area) boundaries.

### Setting Goals for Tree Canopy Cover

Cities across the country set canopy cover goals informally or formally, often through management plans. For every acre of tree canopy that is lost, 70 trees need to be planted and grow to maturity to offset the loss. With data on existing tree canopy, possible planting areas, and historic canopy trends, goals can be established through a visioning and management planning process.

### From Data to Decisions: Next Steps

This study assesses existing and potential tree canopy at multiple scales to support various planning and outreach. The report presents themes, challenges, opportunities, and examples where data can be applied to enhance tree canopy in Chatham County to address economic, environmental, and community needs. Five focus topics were selected to highlight areas for improving tree canopy across Chatham County. On pages 12-20 public health, water resources, environmental equity, schools, and parking lots are looked at through the lens of UTC data. Detailed assessment maps and metrics are provided throughout and in the Appendix.

This is a high-level analysis that requires "thinking big" to leverage local politics, funding, partnerships, and greater awareness in Chatham County. The assessment provides STF and the nine municipalities with information to allocate limited resources to address the negative trend of canopy loss. At the top of the list, a countywide urban forest management plan and/or green infrastructure plan is recommended to create a shared vision and address funding for the protection, expansion, and maintenance of the region's trees and forests.

To balance future development and growth with effective urban forestry planning, government officials must value the region's canopy cover in environmental, social, and economic terms during planning and development decisions. Maintaining and enhancing this green infrastructure will involve increased funding (both public and private), staff, and collaboration for tree planting, maintenance, increased regulatory protection, new partnerships, and education to expand awareness of tree canopy benefits.

# BACKGROUND

### An Assessment of Urban Tree Canopy in Chatham County, GA

In 2012, the Chatham County-Savannah Metropolitan Planning Commission (MPC) established a Natural and Historic Resources Working Group to develop recommendations for the continued protection of the County's natural, cultural and historic resources. After engaging numerous community groups and experts, Recommendation #9 of 13 called for an Urban Forest Master Plan and a "periodic tree and canopy survey".

With funding and leadership by the Savannah Tree Foundation (STF), and geospatial / forestry expertise from consultant Plan-It Geo LLC, the Chatham County Urban Tree Canopy assessment achieves a portion of MPC's Recommendation #9. Maps, data, environmental analysis, and other information are now available countywide on the extent of tree cover, potential planting areas, impervious surfaces, marshland, and other land cover conditions, along with trends in canopy cover change.


**Figure 1: Chatham County, Georgia, the UTC assessment study area.**

Chatham County covers approximately 482 square miles and has a 2014 population of roughly 276,400 (U.S. Census Bureau, 2012). Like most areas of the coast, Chatham County no longer has large stands of virgin forests. Remaining forests vary in appearance. Maritime forest remnants heavy with saw palmetto, oaks and other hardwoods cover many of the upland "necks" that meet tidal creeks and rivers. Much post-agrarian acreage has returned either as secondary growth or as managed pine plantations for the pulp and paper industries. In narrow upland zones on the banks of rivers and in forest remnants throughout, mixed tree species exist with an overstory dominated primarily by live oak, southern red oak, water oak, red maple, sweetgum, magnolia, white oak, and slash, longleaf and loblolly pine (Zydler, 2001).

Canopy cover has been studied before in Chatham County, first in 1993 by Watson (Watson 1993) and again in 2001 by Kramer (Kramer, 2001). This study verifies previously identified trends in tree canopy loss and builds upon the knowledge base of the impacts of population growth and development policies on tree canopy.

### Tree Canopy and Management Planning

Urban forests require management and planning like any other asset in a community, especially if they are to provide an optimal level of services and benefits. This requires local leaders, planners, and residents to contribute their efforts and monetary resources to ensure a vibrant urban forest. To inform management and planning, it is critical to inventory and assess trees and forests periodically to identify safety concerns, maintenance needs, quality, and large trends which can be positive or negative and impact policies and outreach.

Chatham County and individual municipalities lack an urban forest management or green infrastructure plan. The data and trends analysis from this study provide critical information to drive goals, policies, ordinance development and revisions, funding strategies, revisions, and public involvement for a management plan, benefiting all citizens and communities in Chatham County. This report should serve to strengthen local/regional partnerships, build awareness of

urban forest benefits and enable Chatham County municipalities to establish and implement canopy goals and strategies, as well as support the development of an Urban Forest Management Plan.

*What is an Urban Tree Canopy Assessment?* – One tool that is available to assist in sustainable urban natural resource planning is an Urban Tree Canopy (UTC) Assessment, a "top-down" GIS analysis of tree canopy cover, impervious surfaces (developed areas), and other land cover types. UTC studies have been used by more than 300 cities and rural communities nationwide since 2000. The data shows where tree canopy cover exists and where trees can and should be planted in a community. The analysis can also quantify some of the economic and environmental services (benefits) provided by the community's tree cover, including carbon storage and sequestration, air pollution removal, and storm water management as shown in this report.

An urban tree canopy assessment is a big picture landscape-scale study rather than a localized plan or an on-the-ground survey of trees species and tree health. Utilizing a UTC assessment requires "thinking big" about natural resources and the environment, development and regulatory practices, local economies, interdisciplinary collaboration, and the societal desires in our communities.

*How can a UTC study benefit a community?* – With data, maps, and tools to visualize green infrastructure, elected officials and resource managers can plan more intelligently for what is needed and how to get there. UTC data and reporting provide a baseline for environmental planning programs, policy-making, city forestry budgeting and maintenance, and education/outreach/awareness. Many people are visual learners, and a UTC assessment provides critical maps and information to guide planning and development decisions from a city-wide scale to the neighborhood or even individual property scale.

**Valuing Tree Canopy**

From tourism and shade to recreation and clean air, trees and forests can be valued for the benefits and services they provide, both directly and indirectly, as well as for their beauty and sense of place they help create. This study uses the latest, best available science to quantify a subset of the functional and ecosystem services values from Chatham County's urban forest (see Figure 6 on page 10).

While this study focuses on tree canopy, the effort as a whole is really about enhancing benefits of the tree canopy to the community. This includes: public health in terms of air and water quality and the connection between obesity and walkability; economic development in terms of property values, tourism, recreation, and retail vitality; and protecting/managing forests, marshes and watersheds for improved water quality, wildlife habitat and flood risk mitigation. Tree canopy improves our lives in many different ways.

# METHODS

To improve management, planning, policy-making, and outreach, urban forests are routinely inventoried and assessed using **bottom-up** methods such as tree inventories or field plot sampling. **Top-down** methods involve aerial or satellite imagery analysis. Three top-down methods were employed for the Chatham County canopy assessment:

- Task 1: A Spatial Canopy Cover Trends Analysis – to provide a "wall-to-wall" map of changes in canopy and developed areas, land cover data from the National Oceanic and Atmospheric Administration's (NOAA) Coastal Change Analysis Program (C-CAP) were used (specifically 1996, 2006, and 2010). While this is based on coarse resolution (30-meter) satellite imagery, it was the only data available to both quantify and spatially map land cover change across political jurisdictions and drainage areas (watersheds) for multiple time periods.
- Task 2: A Statistical Sampling of Canopy Cover Trends – for a more rigorous statistical sample of trends, a sampling approach with i-Tree Canopy software was used to evaluate "tree vs. non-tree canopy" land cover for 2,250 random points countywide, yielding a 1% standard error (SE) in the measure of canopy cover percent countywide. One-foot resolution aerial images from 1999, 2004, 2009, and 2014 were used (Google, Bing, and other sources).
- Task 3: A Comprehensive Urban Tree Canopy Assessment – this provided a current, accurate, high-resolution baseline of canopy cover and possible planting areas from the county-scale down to individual properties (parcels). The UTC Assessment was based on 1-meter resolution, 2013 aerial imagery from the USDA National Agricultural Imagery Program (NAIP) and 2009 LiDAR data from Savannah Area GIS (SAGIS). Numerous GIS layers from SAGIS, the USGS, and other sources were used to map the following land cover classes: (1) tree canopy, (2) marsh and wetlands, (3) grass and open space, (4) buildings, (5) roads, (6) parking lots, (7) other impervious surfaces (patios, sidewalks, etc.), (8) barren soil / dry vegetation, and (9) water. Once finalized, the land cover data was overlaid and assessed with numerous boundaries to provide metrics at multiple scales.

Important Details on Calculating Percentages of Land Cover vs. Urban Tree Canopy Metrics in this Study

The tasks above each utilized Geographic Information Systems (GIS) to measure existing canopy cover and historical canopy trends. However, percentages were calculated and reported differently for Task 1 and 2 vs. Task 3, as follows.

- For Tasks 1 and 2 above, land cover percentages at the county-level were calculated by dividing each land cover class by the entire county area (308,336 acres) which included all land, water, and marsh area. This provided an apples-to-apples comparison to the Watson (1993) canopy study and allows STF to build upon studies over time in a consistent way that is specific to Chatham County's unique coastal ecosystem.
- For Task 3 above, UTC assessment metrics described on the next page were calculated by dividing UTC types by the land area in Chatham County (271,805 acres), which excludes open water areas mapped through this study. This is consistent with UTC industry protocols developed by the USDA Forest Service (USFS, 2014). See additional details on methods in the Appendix.
- This method allows STF and Chatham County communities to compare tree canopy coverage to other counties and cities (see tree canopy comparisons, Figures 19a & 19b on page 26).

**Tree Canopy Benefits Analysis**

The best available science and modeling software, specifically CITYgreen* and i-Tree tools (www.itreetools.org,), were

used to calculate some of the economic and environmental benefits ("ecosystem services"; see Key Terms below) provided by Chatham County's urban forest. More information on these methods can be found in the Appendix (A-3).

*Information on CITYgreen software can be found at http://www.planningtoolexchange.org/tool/citygreen-0

**Key Terms:** (See Appendix for additional glossary of urban forestry and assessment terms)

Ecosystem Services: Trees are often appreciated for aesthetics but they also contribute to public health, the economy and the environment. This project quantified some of the functional benefits of urban trees, or ecosystem services, specifically carbon storage and sequestration, stormwater regulation, and air pollution mitigation. Other urban forest ecosystem services include energy conservation and provisioning of food and oxygen.

Geographic Information Systems (GIS): Software and technology for viewing, creating, manipulating, analyzing, and sharing spatial data, attribute database tables, and maps. Examples include Esri ArcGIS and open source GIS software.

National Agricultural Imagery Program (NAIP)**:** USDA, Farm Services Agency (FSA), 1-meter leaf-on aerial photography.

Parking Lots: All paved parking areas, primarily on commercial/industrial land uses (does not include driveways or miscellaneous pavement on single family residential lots). This land cover class is based solely on the GIS data layer provided by SAGIS, digitized based off of 2008 aerial imagery, and includes occasional unpaved industrial surfaces.

Possible Planting Area (PPA): Available space for tree planting, derived from the land cover mapping, categorized by:

- PPA Vegetation**:** Areas of grass and open space where tree canopy does not exist and it is biophysically possible to plant trees. Marshland and wetlands were classified separately from PPA. Percent values in this report for PPA are based on plantable space divided by land area (excludes water).
- PPA Impervious: Paved areas void of tree canopy, excluding buildings and roads, where it is biophysically possible to establish tree canopy. Examples include parking lots and patios.
- Total PPA: The addition of PPA Vegetation area and PPA Impervious area.

Unsuitable Planting Area: Areas where it is not feasible to plant trees. For the Chatham County project, roadbeds, buildings, agricultural fields, airports, and marshlands were manually defined as unsuitable planting areas.

Urban Tree Canopy (UTC): The "layer of leaves, branches and stems that cover the ground" (Raciti et al., 2006) when viewed from above; the metric used to quantify the extent, function, and value of Chatham County's urban forest.

**Figure 2: This subdivision in western Chatham County (west of Interstate-95) was intentionally designed with open green space and provides ample tree planting potential.**

# STATE OF THE TREE CANOPY

This report identifies canopy cover trends as a result of deforestation for development, conservation of canopy through planning and regulation, and tree planting over the past several decades. Results are based on Task 3 – Comprehensive UTC Assessment based on 2013 imagery – unless otherwise stated.

### Total Countywide Results

This study encompasses 308,336 acres (482 sq. miles) within Chatham County and provides a snapshot of land cover based on 2013 1-meter NAIP imagery. Trees cover 36% countywide (112,205 acres), of which almost half (47%) is found in unincorporated Chatham County. Approximately 10% of Chatham County is covered by various types of impervious surfaces, and parking lots alone cover 2% (4,853 acres). Total impervious area may be slightly underestimated where tree canopy overhangs roads, buildings, parking lots, and other hardscape surfaces.

### Individual Municipality Results

Across the nine municipalities in Chatham County, tree canopy ranges from 72% (191 acres) in Vernonburg to 26% (419 acres) on Tybee Island. See Figure 3. Based on the land cover mapping, available space for tree planting comprised of grass, open space, parking lots and more (Total PPA), ranges from a high of 28% (242 acres) in Thunderbolt to a low of 6% (16 acres) in Vernonburg. See Table 1.

**Table 1: Percent UTC & plantable area by municipality (based on land area which excludes water)**

| Municipality | Land Area (acres) | UTC (acres) | UTC % | Total Possible Planting % |
|---|---|---|---|---|
| Bloomingdale | 8,760 | 6,185 | 71% | 13% |
| Garden City | 8,982 | 4,939 | 55% | 30% |
| Pooler | 18,857 | 11,848 | 63% | 27% |
| Port Wentworth | 10,388 | 7,100 | 68% | 22% |
| Savannah | 65,066 | 28,764 | 44% | 24% |
| Thunderbolt | 879 | 265 | 30% | 28% |
| Tybee Island | 1,595 | 419 | 26% | 25% |
| Unincorporated | 156,990 | 52,483 | 33% | 11% |
| Vernonburg | 266 | 191 | 72% | 6% |

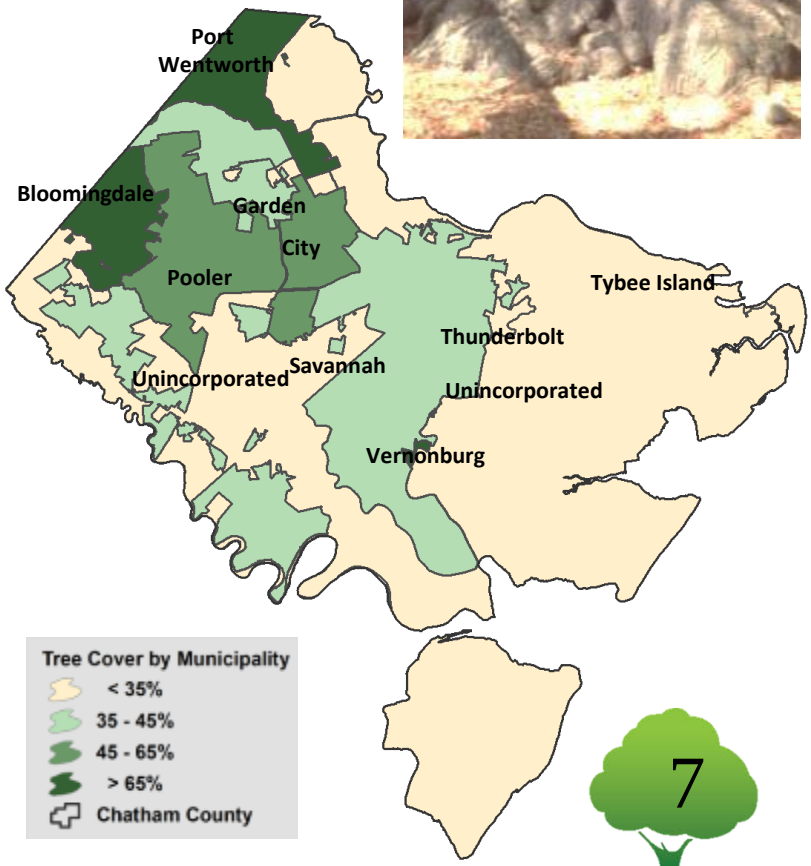
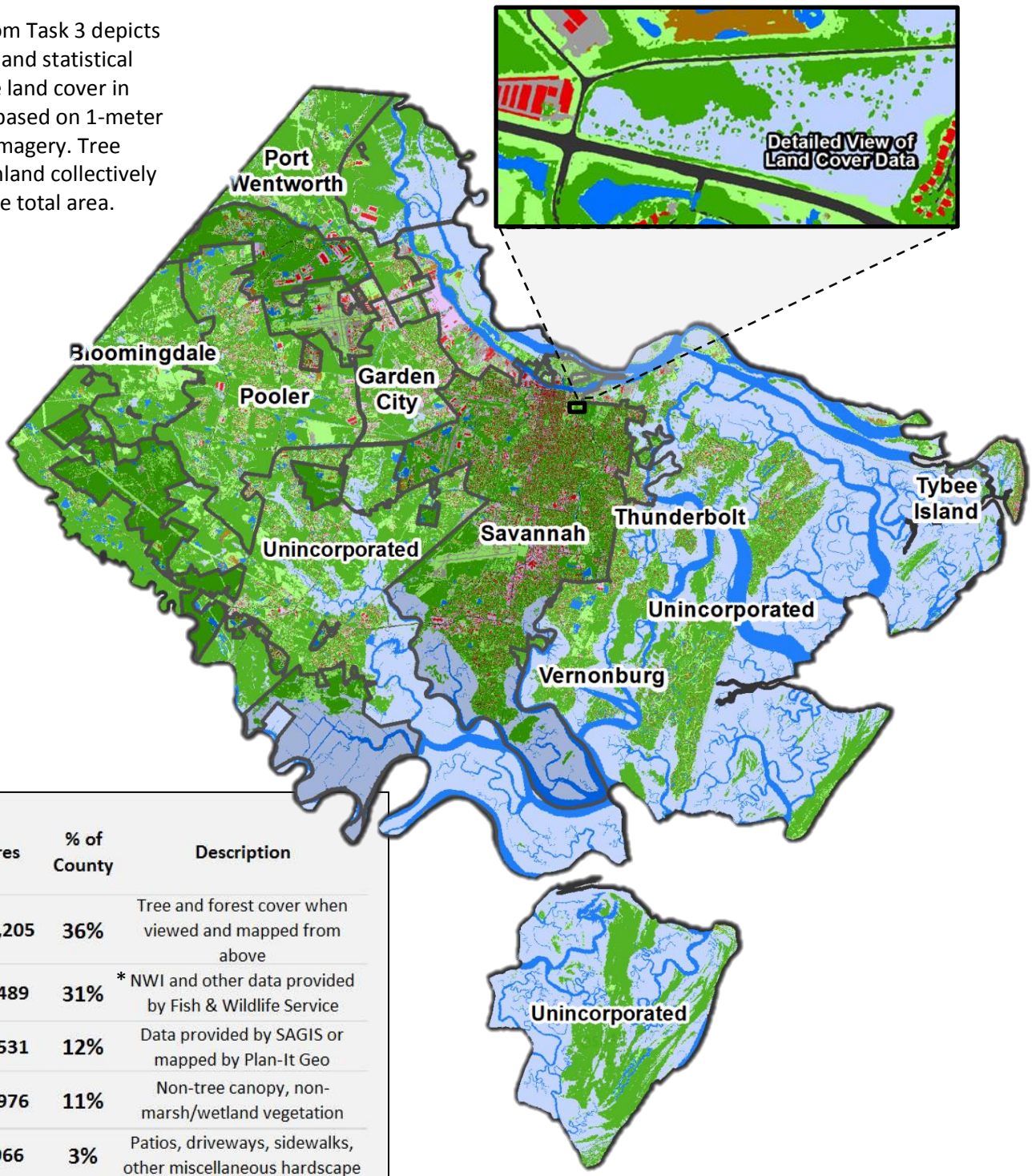



**Figure 3: Percent tree canopy by municipality**

## Detailed Land Cover Results

Figure 4 below from Task 3 depicts the types, extent, and statistical distribution of the land cover in Chatham County based on 1-meter resolution aerial imagery. Tree canopy and marshland collectively make up 2/3 of the total area.




| Land Cover Type | Acres | % of County | Description |
|---|---|---|---|
| Tree Canopy | 112,205 | 36% | Tree and forest cover when viewed and mapped from above |
| Marsh / Wetland | 96,489 | 31% | * NWI and other data provided by Fish & Wildlife Service |
| Water | 36,531 | 12% | Data provided by SAGIS or mapped by Plan-It Geo |
| Grass / Open Space | 33,976 | 11% | Non-tree canopy, non-marsh/wetland vegetation |
| Other Impervious | 9,966 | 3% | Patios, driveways, sidewalks, other miscellaneous hardscape |
| Building | 6,327 | 2% | Data provided by SAGIS |
| Road | 5,962 | 2% | Data provided by SAGIS |
| Parking Lot | 4,853 | 2% | Data provided by SAGIS |
| Soil / Dry Vegetation | 2,027 | 1% | Barren soil/sand or dry vegetation |
| TOTAL | 308,336 | 100% | |

***This map and more results are available in an interactive UTC map book (PDF format). Contact the Savannah Tree Foundation for a copy.***

* NWI = National Wetlands Inventory

**Figure 4: 2014 Chatham County land cover map and summary statistics**

Figure 5 below illustrates the distribution of land cover classes across each municipality. Municipalities with a higher percentage of marshland, wetlands, and water generally have lower tree canopy. See Appendix for additional tables, charts, and maps.

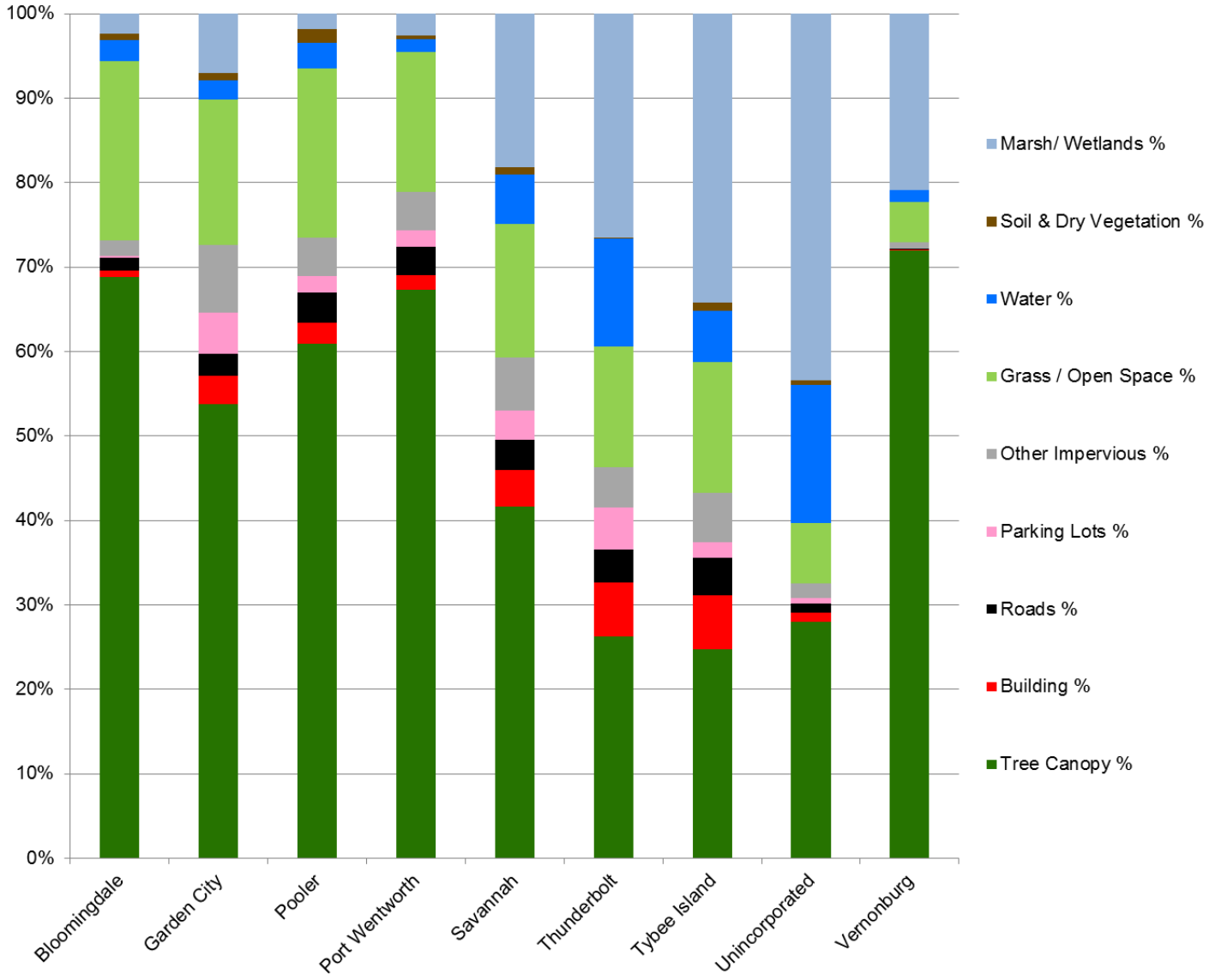



**Figure 5: Distribution of land cover classes by municipality in Chatham County, Georgia (percentages are based on total area including water).**

## Watershed Results

Tree canopy in the County's drainage basins ranges from 35% (2,470 acres) in the Sterling Creek/Ogeechee River basin to 85% (1,658 acres) in the Dasher Creek/Savannah River basin. Outlet Savannah River, the County's largest drainage, has 46% tree cover. The Sterling Creek / Ogeechee River basin ranked lowest in possible planting area with 4% (292 acres), while the Pipemaker Canal basin has the highest at 20% (1,823 acres). See additional results on page 15 and on page 44 in the Appendix.

### Quantifying Ecosystem Benefits of the Tree Canopy in Chatham County

Using the best available science and models such as i-Tree, we can now place a value on some of the benefits and functions provided by trees and forests in Chatham County. The urban forest holds millions of dollars of savings in avoided infrastructure costs, pollution reduction, and stored carbon.

**Air Quality** – trees produce oxygen, capture air pollutants such as particulate matter directly on their leaves, improving public health, and reduce pollution indirectly by lowering air temperatures, reducing the formation of ozone.

- *The existing tree canopy in Chatham County removes 4,842 tons of air pollution annually, valued at $8,500,000.*

**Stormwater and Water Quality** – trees and forests mitigate storm runoff which minimizes flood risk, stabilizes soil, reduces sedimentation in streams and marshland, and absorbs pollutants, thus improving water quality and habitats.*

- *On average, each acre of tree canopy in Chatham County intercepts the equivalent volume of storm water runoff that is managed by engineered detention ponds is valued at roughly $5,000. Extrapolated countywide, this means the County's existing tree canopy provides $587M in storm water regulation over a 20-year financing period.*

**Carbon Storage and Sequestration** – trees accumulate carbon in their biomass; with most species in a temperate forest, the rate and amount increases with age.

- *Chatham County trees store approximately 14.2 million tons of carbon, valued at $274 million, and each year the tree canopy absorbs and sequesters approximately 652,000 tons of carbon dioxide, valued at $12.6 million.*

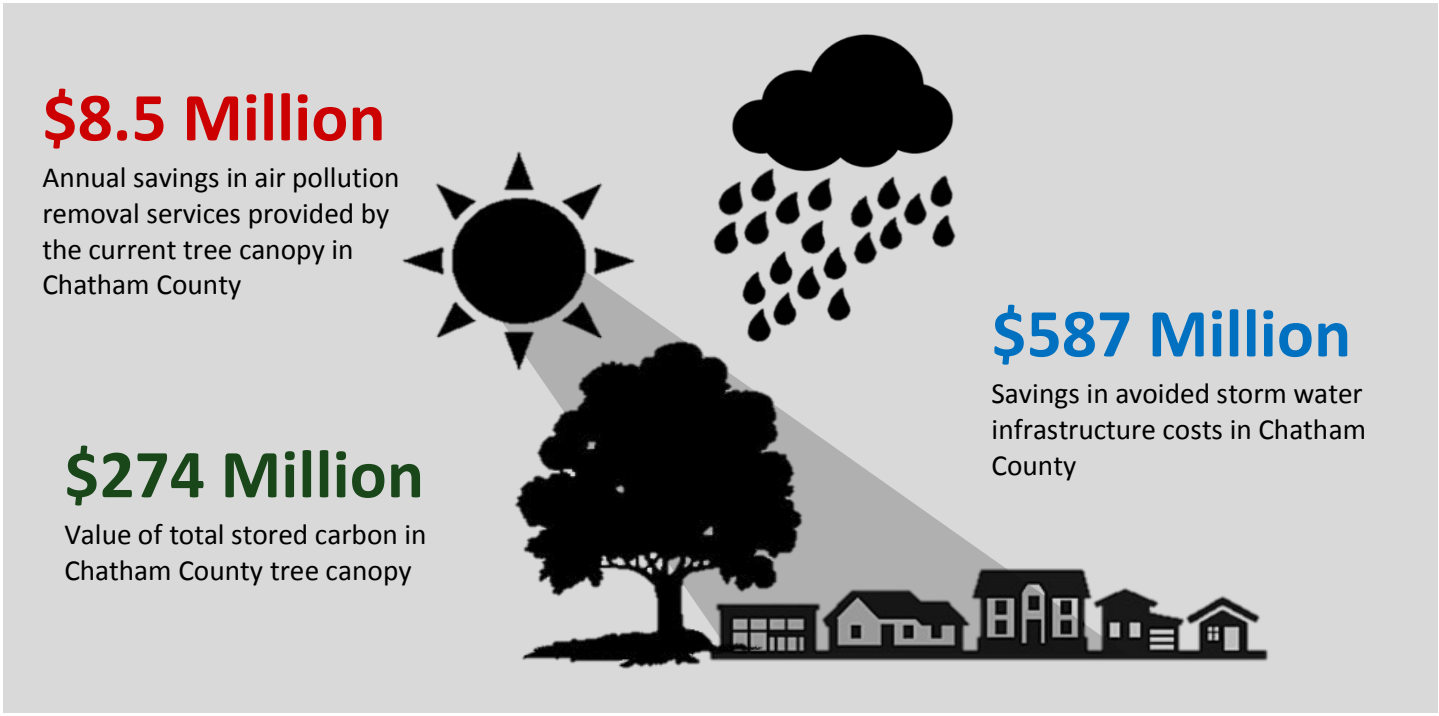



**Figure 6: Quantification of some of the monetary benefits of Chatham County's urban forest ecosystem services (based on 36% countywide tree cover).**

* CITYgreen software uses the Natural Resources Conservation Service Technical Release 55 (NRCS TR55) model to estimate the additional stormwater runoff that would result without trees. The model uses the curve number (CN) system and event-based storms. The values reported are large given the size of the county and remaining canopy. See Appendix page 40 for more information (Agriculture, 2013).

## Canopy Trends

This assessment builds on previous canopy cover studies of Chatham County. A study using satellite imagery from 1992 estimated the countywide tree cover at 50%, offering a prior benchmark for comparison (Watson 1993). Two new approaches, described in the Methods section previously on page 5 and presented here, were used to analyze and compare results in historical canopy cover trends.

*Task 1: Spatial Canopy Cover Trends Analysis*

Land cover data based on 30-meter resolution satellite images for 1996, 2006, and 2010 were available from NOAA's Coastal Change Analysis Program. The data were used to develop maps and statistics of canopy change. Unlike the approach in Task 2 below, areas of canopy loss can be summarized countywide, by municipality, and by drainage area. However the lower quality resolution does not provide the "absolute" measure of tree cover as accurately.

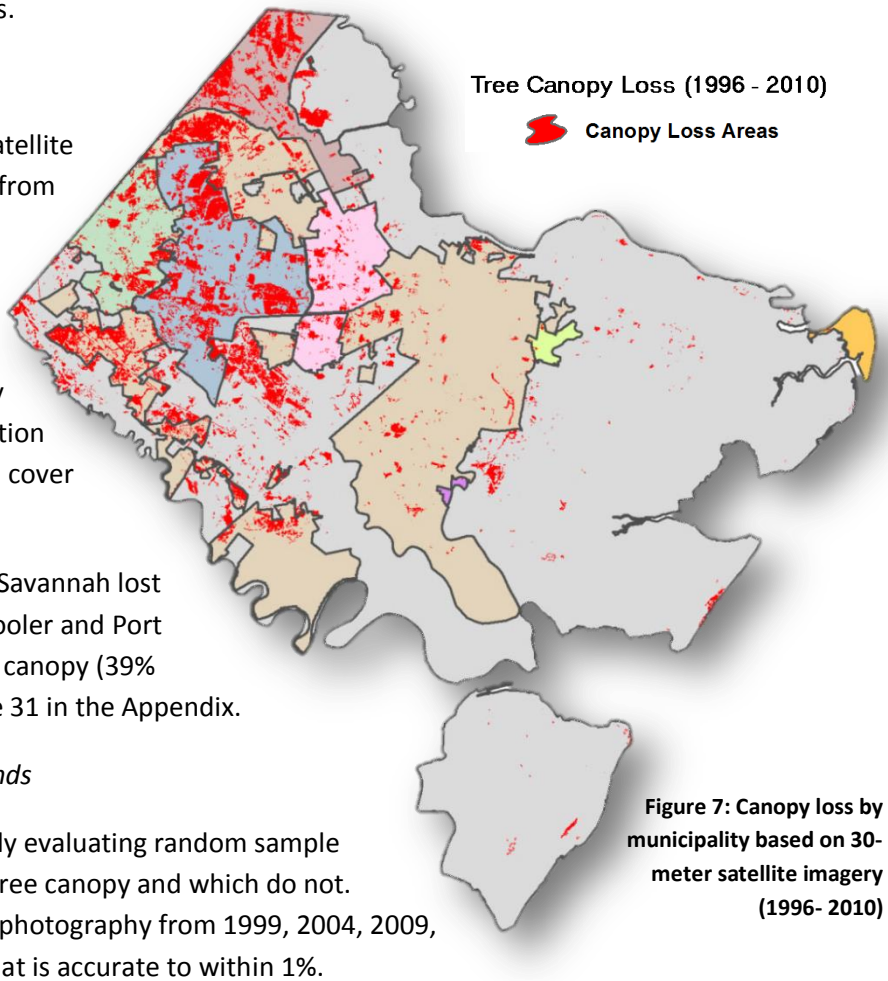



**Figure 7: Canopy loss by municipality based on 30-meter satellite imagery (1996- 2010)**

Based on 30-meter satellite imagery, the City of Savannah lost the greatest tree canopy area (6,429 ac) while Pooler and Port Wentworth lost the greatest percentage of their canopy (39% each). See Table 2 and additional results on page 31 in the Appendix.

*Task 2: Statistical Sampling of Canopy Cover Trends*

In this task, canopy cover was assessed by visually evaluating random sample point locations and tallying which points fall on tree canopy and which do not. 2,250 fixed locations were surveyed using aerial photography from 1999, 2004, 2009, and 2014. This approach provides an estimate that is accurate to within 1%.

Results for all of Chatham County (308,336 acres) can be seen in Figure 8, along with Watson's 1992 estimate of 50%. The loss from 1999 to 2014 alone equates to roughly 21,400 acres, or three football fields every day. This approach and the comprehensive Urban Tree Canopy assessment method based on 1-meter imagery each resulted in 36% tree cover countywide.

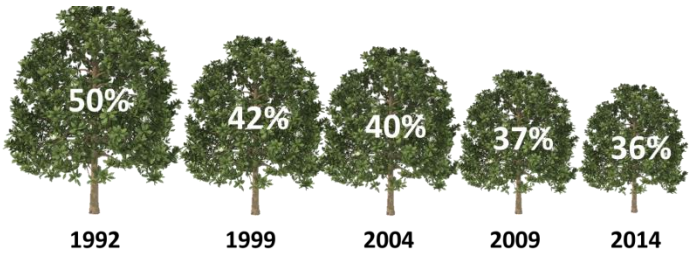



**Figure 8: Trends in tree canopy in Chatham County using a statistical sampling approach, including Watson's 1992 estimate.**

**Table 2: Canopy change by municipality (1996-2010)**

| Municipality | Change in Canopy (Acres) | Change in Canopy* | Loss of Total Canopy** |
|---|---|---|---|
| Bloomingdale | -1,683 | -19% | -30% |
| Garden City | -1,032 | -11% | -24% |
| Pooler | -5,054 | -26% | -39% |
| Port Wentworth | -2,840 | -27% | -39% |
| Savannah | -6,429 | -9% | -29% |
| Thunderbolt | -23 | -2% | -25% |
| Tybee Island | 4 | 0% | 3% |
| Vernonburg | -2 | -1% | -1% |
| Unincorporated | -6,028 | -3% | -13% |
| Chatham County | -23,088 | -7% | -23% |

* Change in canopy refers to the amount of canopy with respect to the **total land area** of the municipality.
**Loss of total canopy refers to the relative loss or gain with respect to **total canopy area.**

# ADVOCATING FOR TREE CANOPY TO BETTER THE ECONOMY, ENVIRONMENT, AND COMMUNITY

Trees and forests in Chatham County represent many benefits to people and places at different scales. This section of the report focuses on five broad areas of influence and importance impacting the lives of Chatham County's residents and businesses. These are not the only areas where trees make a significant impact on the economy, environment, and community, but these have been identified as some of the most important for STF and the community at this time.

Each Area presents:

- Issues important for Chatham County communities.
- The strong relationship these areas have with urban tree canopy.
- Findings and maps from this study that support the area and related issues.
- Possible next steps for STF, municipal managers, and community advocates to develop strategies that promote the important role trees play in building sustainable, healthy communities. More strategies are presented in the Recommendations section (see pages 21-25).

In each of the areas that follow, we hope it will be obvious that trees provide many co-benefits. For example, street trees beautify a landscape while also reducing the urban heat island effect, improving air quality, and promoting walkability and healthy living.

**Public Health**
**pages 13-14**

**Water Resources**
**page 15**

**Environmental Equity**
**page 16**

**Schools**
**pages 17-18**

**Parking Lots**
**pages 19-20**

# PUBLIC HEALTH

***The Issue:***

The 2013 Chatham County Community Health Needs Assessment identified the following public health issues in our community most relevant to trees and their benefits:

- Lung and Bronchus Incidence Rate
- Babies with Low Birth Weight
- Babies with Very Low Birth Weight
- Childhood Obesity and Health
- Access to Healthy Food
- High School Graduation

**Table 3: Average tree canopy along street corridors by municipality.**

| Municipality | Land Area (acres) | UTC in Street (%) |
|---|---|---|
| Bloomingdale | 532 | 37% |
| Garden City | 989 | 33% |
| Pooler | 2163 | 28% |
| Port Wentworth | 1139 | 34% |
| Savannah | 7259 | 34% |
| Thunderbolt | 123 | 36% |
| Tybee Island | 341 | 26% |
| Unincorporated | 6493 | 38% |
| Vernonburg | 7 | 78% |
| Total/Avg. | 13046 | 35% |

An increased effort to address these needs should be focused on the at-risk populations of Chatham County in ZIP codes 31401, 31404, and 31415. View the Community Health Needs Assessment at: https://www.memorialhealth.com/uploadedfiles/content/main/about_us/community_needs_assessment/community%20needs%20assessment.pdf

In addition to these categorical public health issues, local doctors note that of great concern is the large number of Savannah – Chatham County residents who as young adults, and/or still teenagers have children of their own, or end up in the court-prison system. Many households and individuals depend on social services and limited area resources. This cycle of poor health, low education and dependence on government for basic household living monopolizes resources that could otherwise be dispensed for community wide improvement.

***How Trees Relate:***

Trees in the Street Right-of-Way (ROW) in planting areas along the outer edge of pavement, often referred to as street trees, can slow traffic, create more walkable neighborhoods, and filter out harmful pollutants from car exhaust. Table 3 shows how ROW tree canopy compares among Chatham County municipalities. A 2008 study of urban areas revealed that neighborhoods with more greenery were 3 times more likely to have physically active inhabitants, and the residents were 40% less likely to be obese (Orlando, 2010).

To maximize tree benefits for public health, managers and planners should protect and expand tree canopy where people are active and air pollution concentration is highest, such as street corridors, parks, other public spaces, and roadside or industrial buffers. With planning and proper funding, municipalities can directly manage trees where mitigating vehicle noise and air pollution will be most effective.

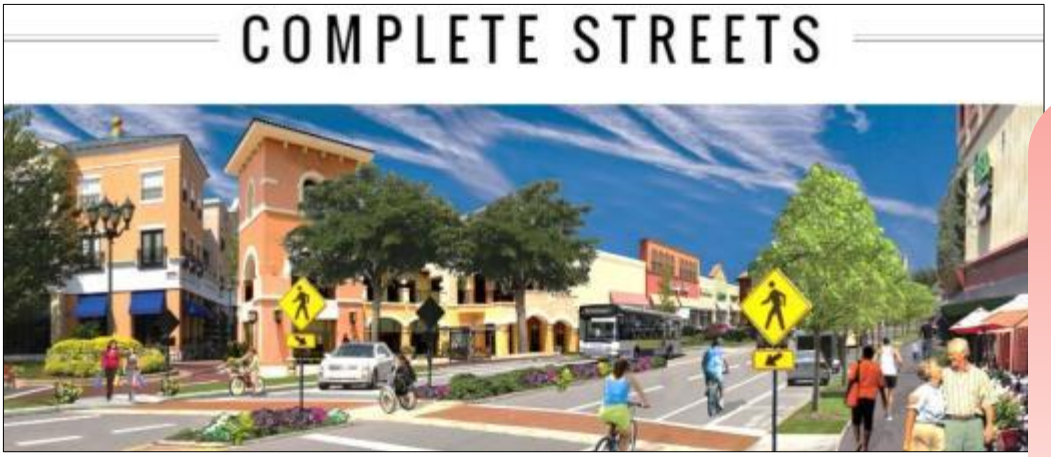



**Figure 9: A depiction of a walkable neighborhood on *www.healthysavannah.org***

***Streets with little tree canopy do not provide a desirable walking or exercise environment. Smart Growth planning principles call for creating streets that are safe for everyone - regardless of the mode of transportation. Street trees play an important role in this paradigm.***

| **93,833** | **4,842 Tons** | **$274 Million** |
|---|---|---|
| **Number of cars in Chatham County whose emissions are mitigated by the urban forest annually*** | **Particulates and ozone filtered by Chatham County's trees annually ($8.5M value) **** | **Total value of carbon dioxide stored in Chatham County's trees**** |

***Possible Next Steps:***

In 2013, *Healthy Savannah* was awarded a grant of $150,000 from *Healthcare Georgia Foundation Childhood Obesity Program* to assist in making Savannah a healthier place to live. The grant is designated to fund community initiatives aimed at decreasing childhood obesity in Chatham County and the City of Savannah. Goals include:

- Strengthen existing community-based collaborations and partnerships to reduce behavioral and environmental risk factors among underserved individuals and communities
- Expand or develop community awareness and health promotion campaigns, building a healthy, more livable community, increasing physical activity in neighborhoods, and increasing the community's interest in healthy kids.

These goals are intended to be achieved through creating a public interest in the development of environmental infrastructure to facilitate physical activity; specifically by way of the Truman Linear Park Trail and Complete Streets.

Through collaboration with Healthy Savannah urban trees can be one aspect of engaging healthy kids in "green careers" through experiential learning and general exposure to nature that may help to increase academic success.

*Based on annual $CO_2$ emissions of a typical passenger vehicle (EPA, Greenhouse Gass Emissions from a Typical Passenger Vehicle 2011)
** Based on the i-Tree suite of software tools

# WATER RESOURCES

***How Trees Relate:***

Through natural processes, trees:

- Filter, intercept, and capture stormwater, decreasing sediments from erosion and preventing polluted runoff from entering marshes and source water

***The Issues:***

- Just under one-third of Chatham County is marshland. These ecologically sensitive areas are home to coastal and marine wildlife. Protection and enhancement of trees in drainage basins enhances water quality and habitat of tributaries, wetlands, and marshlands.
- Aquifers provide 85% of Chatham County's drinking water. Over time, surface water could provide a greater percentage of supply, driving the importance of forest and watershed management.
- Stringent EPA requirements from the Clean Water Act and ongoing flood mitigation planning reinforce the need to protect and manage trees across Chatham County.
- Land conversion from forest to agricultural use to built environments increases non-point source pollution, impacting water quality.

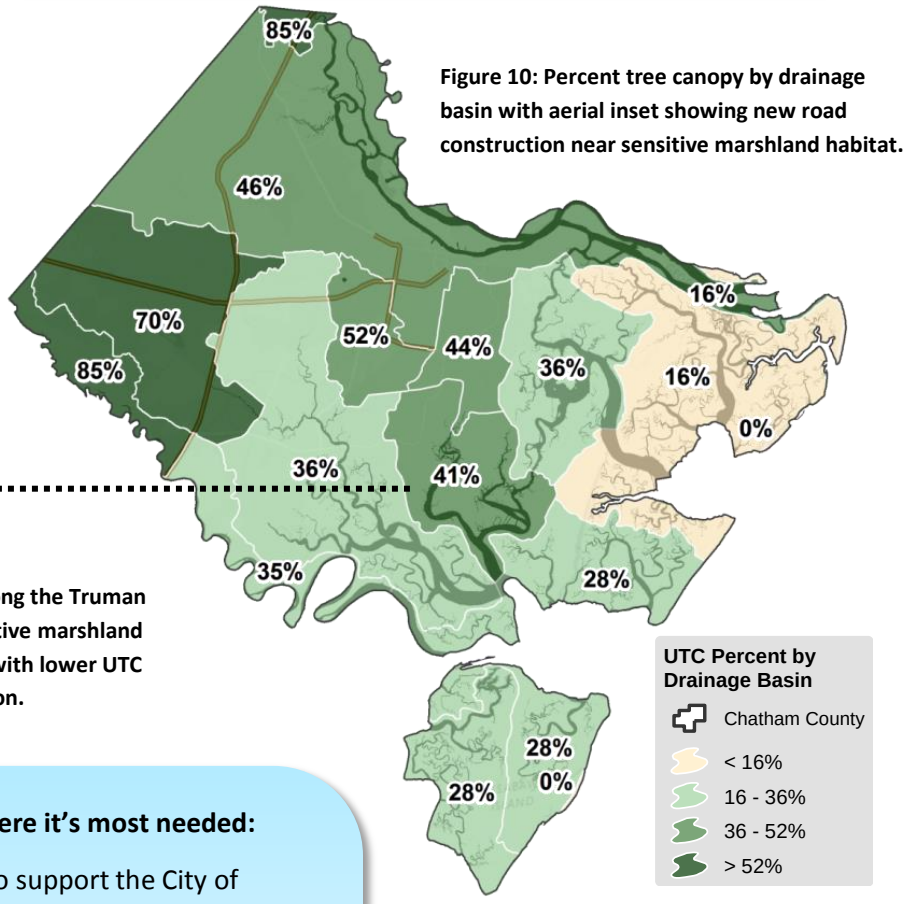



**Figure 10: Percent tree canopy by drainage basin with aerial inset showing new road construction near sensitive marshland habitat.**

## Putting the Data to Use

**Seen in the aerial view above, new road construction along the Truman Parkway and White Bluff impacts tree canopy and sensitive marshland nearby. Use the UTC assessment data to identify areas with lower UTC and high PPA for tree planting and restoration.**

***Possible Next Steps* - reforest and protect where it's most needed:**

- Use the land cover and watershed data to support the City of Savannah's Natural Floodplains Function Plan (NFFP) to ensure that preserving open space and forests will be a key element. Learn more about the NFFP and Flood Risk Mitigation Plan in the Recommendations section (page 21).
- Identify opportunities to reforest watersheds and establish timelines and local goals for slowing forest loss in sensitive areas.
- Collaborate with ecological programs such as NOAA's Coastal Wetlands Initiative and University of Georgia's Adopt-A-Wetland program to protect forested natural areas.

***Related Resources/Links:***

Urban Forestry Watershed Manual

Forests-to-Faucet Partnership

i-Tree Hydro tool

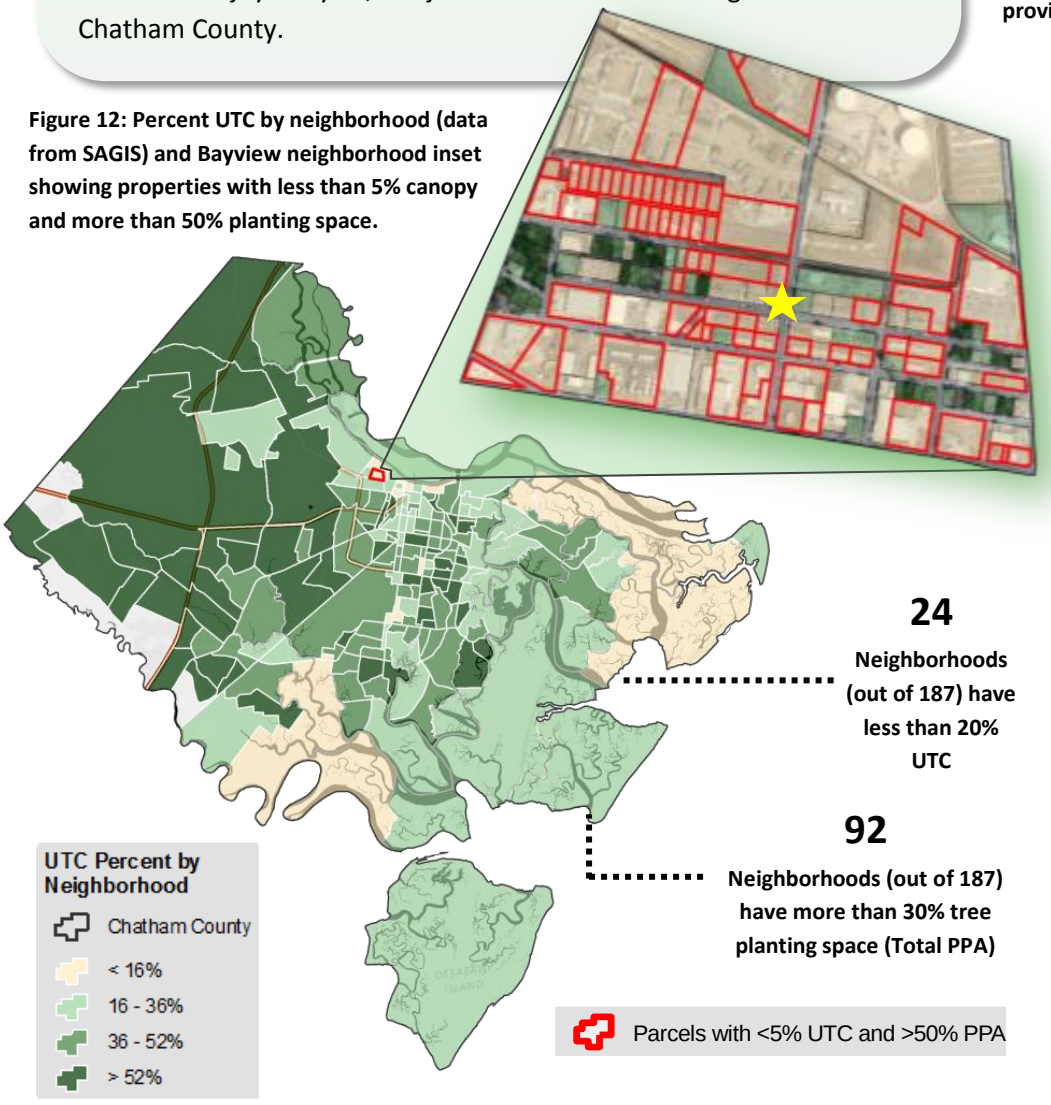
# *Environmental Equity*

***The Issue:***

Nearly 20% of Chatham County residents live below the poverty level (US Census Bureau 2012). A study conducted by the School of Forestry & Wildlife Services at Auburn University, AL indicated that for every 1% increase in per capita income, the demand for forest cover increased by 1.76% (Zhu, 2008). Trees and the benefits they provide should be enjoyed by all, not just the most affluent neighborhoods in Chatham County.

**Figure 11: Low-income housing near Damon St. & Carolan St. without street or yard trees to provide the benefits of tree canopy.**

**Figure 12: Percent UTC by neighborhood (data from SAGIS) and Bayview neighborhood inset showing properties with less than 5% canopy and more than 50% planting space.**




***How Trees Relate:***

Trees strategically planted around a home can save a homeowner hundreds of dollars in electric bills annually. Furthermore, trees can increase the property value of a home as much as 10%.

A thriving urban forest creates a more desirable place to live, reduces crime and stress.

Forested areas help children develop social skills, improve performance in school, and reduce symptoms of Attention Deficit Disorder (Kuo, 2001).

***Possible Next Steps:***

- $ Allocate funds to improve greenscaping and landscaping around mixed income residential neighborhoods
- $ Secure private and public partnerships for public housing to incorporate canopy standards
- $ Collaborate with community centers to engage residents to plant and care for trees

# SCHOOLS

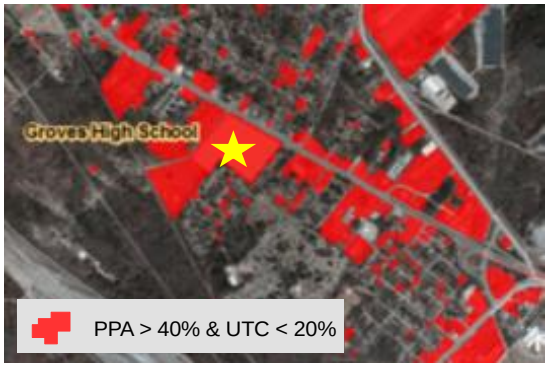



**Figure 13: Parcels near Groves High School with low canopy cover (less than 20%) and high planting potential (greater than 40%).**

***The Issue:***

School grounds are ideal areas to improve the urban forest in Chatham County from the ground up. Trees can improve physical fitness, attention span, outdoor education, and public health.

## Snapshot: Groves High School

**Graduation Rate (2013): 54%**

**Percent tree canopy: 8%**

**Percent open space for planting: 43%**

**Percent covered by parking lot: 21%**

**Percent planting space (soft and hardscapes): 78%**

**Table 4: UTC assessment metrics on High School properties**

| High School Name | Land Area (acres) | UTC (acres) | UTC % | PPA Vegetation (acres) | PPA Vegetation % | Total PPA (acres) | Total PPA % |
|---|---|---|---|---|---|---|---|
| Beach | 31 | 8 | 26% | 6 | 18% | 14 | 44% |
| Groves | 39 | 3 | 8% | 17 | 43% | 31 | 78% |
| Islands | 78 | 39 | 50% | 19 | 24% | 30 | 38% |
| Jenkins | 40 | 9 | 23% | 12 | 31% | 22 | 54% |
| Johnson | 27 | 6 | 21% | 9 | 33% | 16 | 58% |
| New Hampstead | 75 | 43 | 57% | 11 | 15% | 29 | 39% |
| Savannah Arts | 7 | 1 | 8% | 1 | 13% | 5 | 61% |
| SHS - Liberal Studies | 52 | 14 | 26% | 24 | 47% | 33 | 64% |
| Windsor Forest | 25 | 5 | 19% | 11 | 43% | 16 | 65% |
| **OVERALL** | **349** | **122** | **35%** | **100** | **29%** | **179** | **51%** |

***How Trees Relate:***

- Trees beautify school grounds and provide shade from the heat and sun. Furthermore, student tree planting programs help children connect to nature and the environment.
- High tree canopy on school grounds can be linked to improved test scores, lower occurrences of crime, and higher graduation rates (Orlando, Urban Forests Share Links with Healthy Lives 2014).

***Possible Next Steps:***

Develop programs to work with schools to promote tree planting (particularly canopy shade trees) and education for students. *Campus Forestry,* conducted by TreePeople, partners with schools throughout L.A. to engage young people to plant trees. Visit: www.treepeople.org/school-programs.

- Allocate a portion of Educational Special Purpose Local Option Sales Tax (ESPLOST) funding for tree inventory and management plans
- Include urban forestry in school curriculum
- Partner with green industry professionals on green career symposium

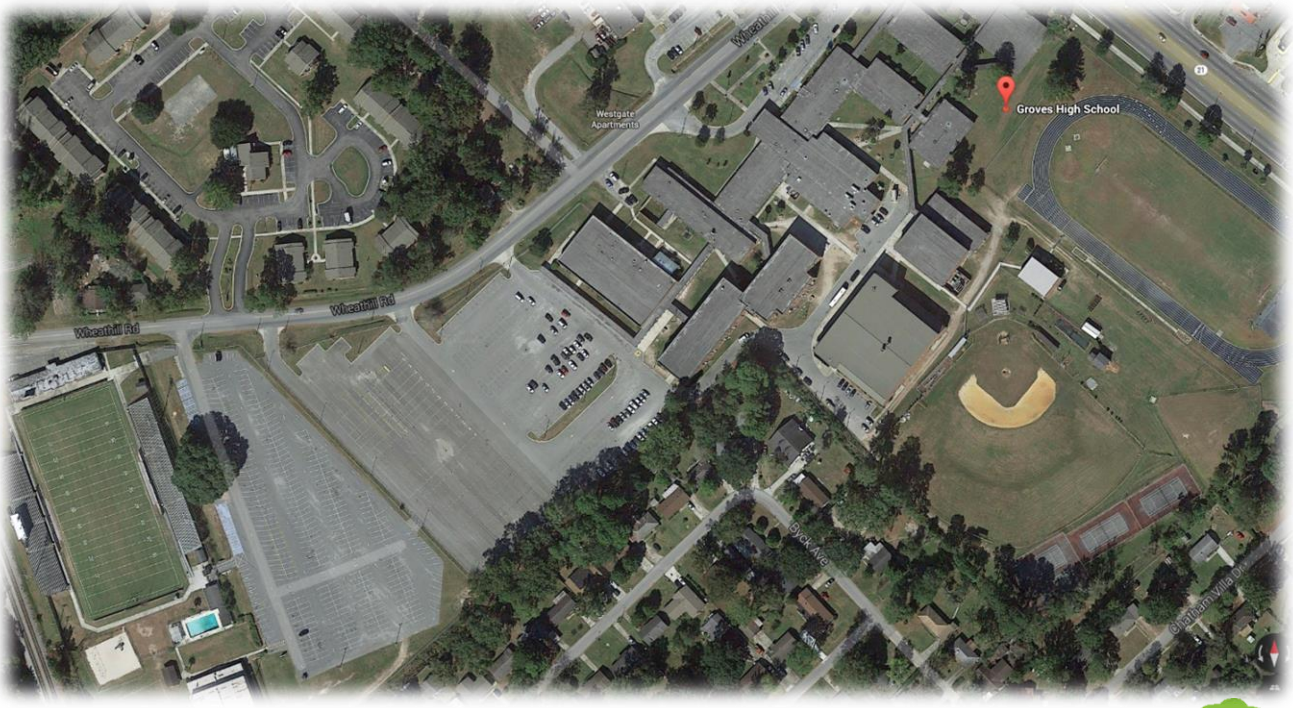



**Figure 14: Street view of tree planting potential at Groves High School and corresponding aerial showing three, large treeless parking lots.**

# *PARKING LOTS*

***The Issue:***

Impervious surfaces trap radiation during the day increasing surface temperatures and creating urban heat islands. Parking lots cover 2% (4,853 acres) of Chatham County.* On these parcels, tree canopy is close to half the County average (21% vs. 36%, respectively) and available planting space averages 48%, 3 times higher than the rest of the county (16%). Through stronger landscaping ordinances, canopy cover can enhance retail values as well create healthier and more pleasant environments.

**Figure 15: Color-infrared aerial view of parcels in Pooler that retained tree canopy (left, on the northeast corner of Coleman Blvd. and Artley Road) vs. did not retain canopy (right, on the southeast corner of Continental Blvd. and Louisville Road).**

*For this study, parking lots were defined as all paved parking areas, primarily on commercial/industrial land uses (does not include driveways or miscellaneous pavement on single family residential lots). This land cover class is based solely on the GIS data layer provided by SAGIS, digitized based off of 2008 aerial imagery, and includes occasional unpaved industrial surfaces.

***How Trees Relate:***

Tree canopy over large hardscape, impervious areas such as parking lots cools surface temperatures on hot sunny days, mitigates storm water runoff and the effects of urban heat islands, and improves air quality and aesthetics. Studies have shown that consumers report a willingness to pay 9-12% more for goods in districts with mature tree canopy (Wolf, 2005).

As seen below in Figure 16, even on the Saturday before Christmas, many parking spaces are empty, indicating greater space is available for trees in parking lots.


**Figure 16. Abercorn at Mall Blvd. in Savannah, GA. Saturday afternoon before Christmas.**

***Possible Next Steps and Related Resources:***

- Strengthen landscaping ordinances in parking lots and enhance stormwater detention ponds. Read "Parking Lot Shade Regulations: Review and Recommendations" from the nonprofit Tree Davis and visit: http://www.isa-arbor.com/education/resources/educ_TreeOrdinanceGuidelines.pdf.
- Work w/Chatham municipalities to strengthen tree ordinances to include strong incentives for more parking lot interior shade and better enforcement for maintenance of trees preserved or planted.

# RECOMMENDATIONS & STRATEGIES

This study mapped land cover across Chatham County, assessed trends, defined some of the benefits of trees, and provided GIS data and map books showing where trees can be planted. Based on the results of this work and meetings with the STF board, broad recommendations and strategies are provided on how to use these results to implement and achieve a variety of community and management objectives in Chatham County and in all political jurisdictions. An ongoing work item for the Savannah Tree Foundation and partners should be to develop overall goals for tree planting and preservation and prioritize those goals based on limited time, money and other resources.

**Policy/Development**

- No Net Loss
- Urban Forest Management Plan
- Scenarios
- Ordinance Improvement
- LEED and SITES Designation

**Funding**

- Development (Grants/Donations)
- Targeting Specific Communities
- Influencing Budgets
- Economic Impacts of Canopy Loss

**Technical**

- Data Distribution
- Future Monitoring of Canopy Change
- i-Tree Hydro
- Financial Quantification
- Key Messages

**Canopy & Outreach**

- Awareness
- Involve Local Governments
- Canopy Goals
- Engage Citizens
- Work with Large and Small Entities
- Form Alliances with Interest Groups

**Figure 17: Organization of recommendations based on the Chatham County UTC assessment**

**Policy and Development**

1. Establish a "No Net Loss" Policy for all of Chatham County.
2. Develop an Urban Forest Management Plan (UFMP) for Chatham County.
    a. Develop a clear, focused, and concise management plan that details benefits communities will receive through the UFMP.
    b. Develop key messages and practical strategies for municipal governments – including zoning boards, tree boards and other recommending bodies.
3. Improve development practices that impact the urban forest quality and quantity:
    a. Work to improve ordinances, starting with preservation of canopy, tree requirements for parking lots, and planting in new developments.
    b. Establish canopy cover percentages for new developments with tree ordinances. Consider requiring that a new development have equal to or more than the established standards for canopy cover.
    c. Establish county wide accepted goals for canopy
4. Develop alternate future scenarios such as likely outcomes with certain policies in place.
5. Develop canopy protection and replanting goals to increase awareness of urban forest benefits. Participate in related planning processes. Examples are:
    a. Chatham County's 5-year updated Multi-Hazard Risk Assessment Plan
        i. For natural hazards associated with disasters (natural and man-made), potential sea level rise, and flooding, the countywide land cover mapping helps to identify vulnerabilities and trends in forest loss that may compound and/or conflict with flood risk mitigation strategies .
    b. Municipal flood risk mitigation planning, specifically:
        i. A Flood Mitigation Plan which will include hazard and vulnerability assessment, and provide mitigation strategies and goal setting. Data from this assessment can be used to help protect existing forest or expand tree cover near source waters and flood-prone areas.
    c. Comprehensive Plan Updates
    d. Other
        i. A Repetitive Loss Area Analysis (RLAA)
        ii. A Natural Floodplains Function Plan (NFFP) where preserving open space, forests, and tree cover can be a key element to enhancing Chatham County's urban forest. The detailed land cover mapping countywide and across watersheds (drainage areas) helps to identify and prioritize natural area and open space preservation for flood mitigation opportunities in Chatham County. This can serve as an example for outlying areas in the County to improve forest conservation in development practices to meet flood risk goals, and strict water quality requirements from the US Environmental Protection Agency (EPA) and meet credit requirements from FEMA's Community Rating System program.
        iii. Coastal Stormwater Supplement (2009) http://www.mpcnaturalresources.org/wp-content/uploads/2010/12/Georgia-CSS-Final-Apr-09.pdf
        iv. Georgia Water Coalition
        v. Georgia Forestry Association
6. Support LEED and SITES Designations for designed environment, both of which enhance eco-benefits.

Existing tree canopy in western Chatham County

A typical subdivision in western Chatham County.

**Figure 18: Aerial view showing canopy loss to new development in Chatham County (Highlands Blvd. in northwestern Savannah, based on 2014 Google imagery)**

The landscape in the aerial view above illustrates a stark contrast in environments. This evokes important planning and design questions for Chatham County communities:

- Should developments preserve more of the existing forest within them?
- Should these types of developments be allowed in ecologically sensitive areas of the county such as riparian corridors and key zones in watershed districts impacting water conveyance and supply?
- Can standards be developed or improved upon for the incorporation of green space? For instance, the City of Savannah ordinance requires 20% greenspace and a projected 50% canopy coverage if planted by the ordinance.

**Funding**

1. Use this data in preparing supportive information for local budget requests to influence municipal ordinances, tree maintenance, and tree planting positively.
2. Data that are specific by community will be beneficial for grant funding since they show prior investments, priority areas in need, and established mechanisms for tracking successes.
3. Consider solutions that meet multiple objectives, for example:
    a. A public/private partnership to irrigate, prune or provide other maintenance of trees in public spaces could create jobs, and if done on bikes with watering devices, promotes physical and mental health.
4. Couple this data with other studies to draw correlations to diminished economic vitality where communities do not have a No Net Loss Policy. Use this data to lobby for increased capital and operating budgets.


**Technical**

1. Distribute the GIS land cover data to all municipalities, county officials, local agencies, and interest groups so that the most current data can be put to use.
2. Working with SAGIS and municipal GIS staff, use the data from this study to identify priority plantings on school properties, underserved public housing areas, and in corridor/neighborhood revitalization and planning projects.
3. Monitor change in canopy every 5 to 10 years. For future studies:
    a. Utilize LiDAR data and 1-meter (or better) imagery from aerial or satellite sources.
    b. Utilize consistent GIS assessment boundaries when calculating canopy cover, for example, as municipal (political) boundaries change through annexation.
    c. Water bodies, marshland, and most wetlands are not naturally forested; therefore they impact the results by changing the total land area in which to calculate percent tree cover at the county and municipal level. In future studies to monitor changes in canopy, ensure that these areas are mapped and utilized consistently or accounted for accordingly.
4. To quantify more localized stormwater and watershed management benefits of the urban forest, utilize i-Tree Hydro or EPA's Storm Water Management Model (SWMM).
5. Use the financial quantification of tree canopy and compare it to engineered project costs that adjust the land to its new land use from "tree farms" to "people farms".
6. The assessment provides a *top-down* approach. Additional *bottom-up* inventory and assessment methods can ground-truth viable planting areas as well as provide data on species composition, condition/quality, safety, and forest structure to augment findings from this assessment.

**Canopy & Outreach**

1. Establish a strong relationship with public and private elementary schools and educators. Regularly present programs at school events.
2. To expand outreach, develop and share an annual report card with broad stakeholders to continue to engage, inform, and recommend actions about the County's canopy.
3. With carefully crafted messages and information on canopy cover trends and priority planting areas:
    a. Establish a rapport through meet & greet type events and joint volunteer tree plantings in different communities and by working with pertinent municipal staff, council members, and community groups to prioritize local needs and sell the message for greater funding and follow-up care.
    b. Concentrate marketing and education efforts on the disinvested areas where the need for trees is greatest. Include all ethnic, age, race, and income groups in natural resource protection and enhancement opportunities.
    c. Look at the smaller communities in Chatham County for opportunities and determine ways to get outlying areas to support stronger canopy protection and planting practices and a management plan.
    d. Through the process, STF will find local support, help establish community tree boards, and gain support for a countywide Urban Forest Management Plan, meanwhile identifying tree planting sites and gaining funding for trees.
4. To assist in goal setting, use Plan-It Geo's "Canopy Calculator" spreadsheet tool to see how different types of trees (e.g. palm vs. live oak) impact canopy cover goals.
    a. The tool can estimate the number and type of trees needed to increase canopy coverage, help visualize how one citizen planting one tree can make a difference, and be a beneficial tool for a new development ordinance.
5. Use the data to show the past and potential loss of hunting ground or wilderness to form an alliance with hunting, fishing and similar interest groups. The development of more land for commercial and residential units impacts how far recreationists have to go for natural areas and the quality of these areas.
6. Explain the direct impacts that trees and forests have on Chatham County communities through education programs. Provide this information in ways people can understand and relate to, such as shade/cooling, public health, stormwater management, and mitigating flood risk.
7. Use UTC data to identify critically important natural areas and work to preserve such areas with existing tree canopy, or explore options for restoring tree canopy.

**COMMUNITREES**

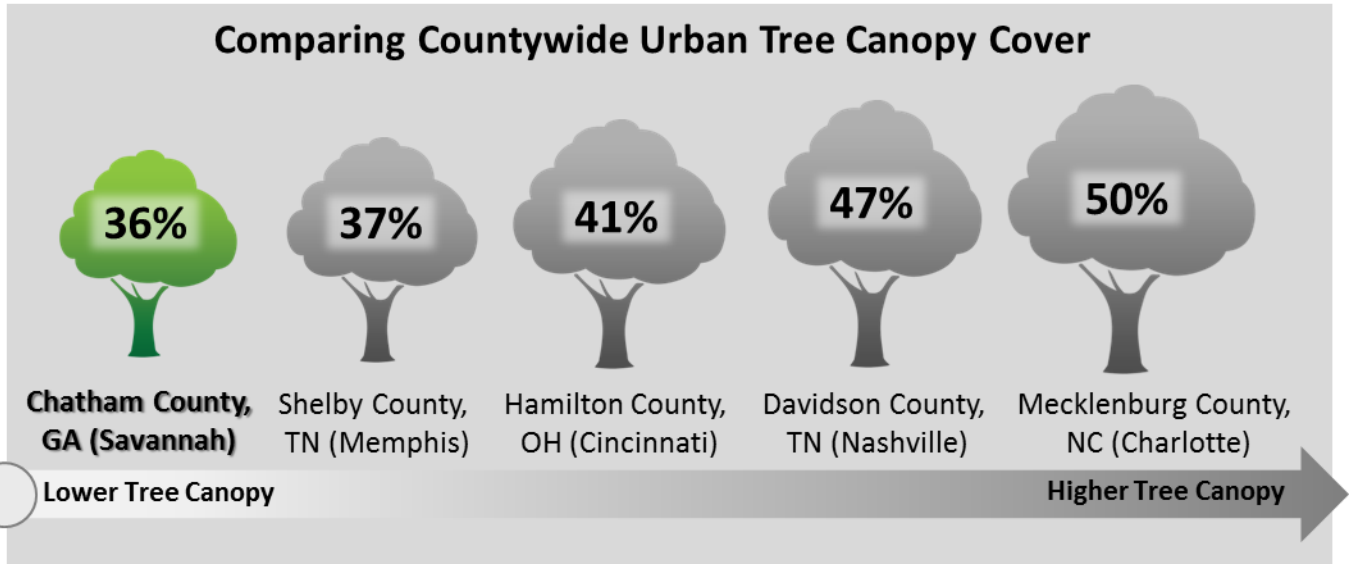
Would you like trees planted on your property? CommuniTrees helps groups plant trees on public sites.

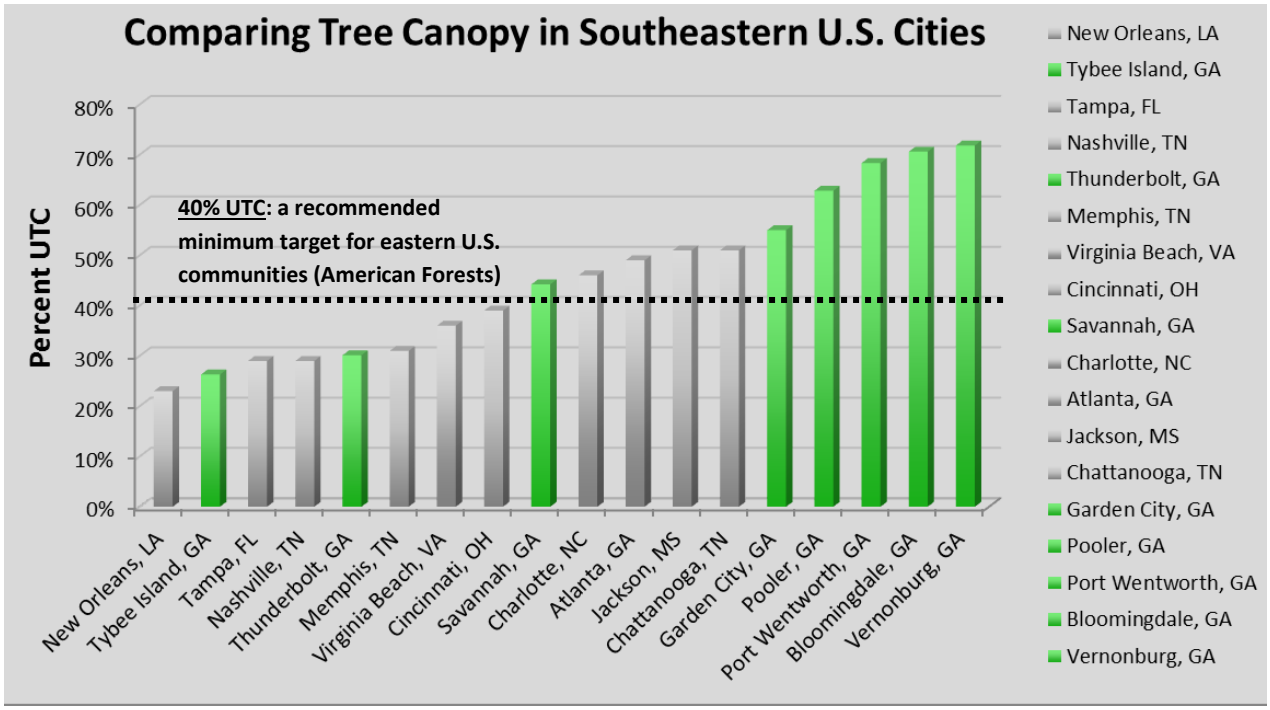
For more information, visit:
http://www.savannahtree.com/programs/communitrees/

# CONCLUSIONS

The Chatham County Urban Tree Canopy Assessment is a planning tool, putting the most reliable data in the hands of decision makers. It establishes the groundwork for unified community efforts to plant and care for trees in Chatham County. An ongoing challenge will be to balance new development, limited funding and resources, and the need for tree maintenance within a shared vision for the community, environment, and economy.

Figures 19a and 19b provide comparisons of tree canopy cover at the county-level and municipal-level for metropolitan areas in the southeastern United States. County percentages are based on total study area while municipal percentages are predominantly based on land area (excludes water). Note that with 31% marshland, tree canopy in Chatham County may be lower than communities without this type of ecosystem, making comparisons difficult. At the municipal level, currently high levels of tree canopy reinforce the need for tree protection during development as the region urbanizes.




**Figures 19a and 19b: Comparing urban tree canopy cover at the county level (top) and municipal level (bottom).**

# APPENDIX

Additional details on the 2014 Chatham County Urban Tree Canopy assessment project are provided including supporting information on:

**A1: Glossary of Terms (pages 28 & 29)**

**A2: Overview of Urban Forest Ecosystem Services (page 30)**

**A3: Detailed Methods (Tasks 1-3) and Comprehensive UTC Assessment Results (pages 31-45)**

**A4: Related Plans/Ordinances and References (pages 46-48)**

## *A1: GLOSSARY OF TERMS AND ACRONYMS*

Definitions for the following terms are offered in the context of urban forest planning, assessment, management, and benefits analysis and are not meant to be complete or exhaustive in nature.

**Air Quality** – The quantity of particulates and other pollutants present in a volume of air relative to necessary compounds such as oxygen. Trees improve air quality by absorbing and trapping air pollutants such as particulate matter, ozone, sulfur dioxide, carbon monoxide, and $CO^2$ and by decreasing volatility by lowering air temperatures.

**Carbon Sequestration** – The rate that carbon is removed from the atmosphere by trees. Carbon is considered a very important element because of its recognized influence on climate regulation as a greenhouse emitter.

**Carbon Storage** – Cumulative amount of carbon stored in the stems, branches and roots of trees over time.

**Ecosystem Services** – Direct and indirect benefits provided by natural systems. The most common ecosystem services associated with urban trees and forests are air quality improvement, carbon sequestration, energy conservation, and storm water mitigation.

**Energy Conservation** – The amount of energy saved due to the presence of trees. Summer cooling through shade, and by wind blocking in the winter reduces total energy used.

**FEMA** – The Federal Emergency Management Agency is an agency of the United States Department of Homeland Security, whose primary purpose is to coordinate the response to a disaster that has occurred in the United States and that overwhelms the resources of local and state authorities.

**Flood Risk Mitigation Plan** – A planning process and document to reduce or eliminate risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP) and proactively prepare for reducing flood losses.

**Geographic Information Systems** (GIS) – Computer mapping systems used to understand how resources are distributed across the Earth's surface.

**Hazard Mitigation Planning** – Planning and guidance (provided by FEMA and contractors) on actions taken to reduce and protect life and property from natural disasters.

**Impervious Surfaces –** Impermeable manmade areas such as roads, buildings and parking lots. These areas restrict stormwater infiltration and contribute to runoff and flooding, and increase the urban heat island effect.

**i-Tree Canopy –** As part of the i-Tree suite developed by the USDA Forest Service, this tool estimates tree cover and tree benefits for a given area with a random sampling process that lets you easily classify ground cover types.

**i-Tree Eco –** As part of the i-Tree suite developed by the USDA Forest Service, this tool is a software application designed to use field data from complete inventories or randomly located plots throughout a community along with local hourly air pollution and meteorological data to quantify urban forest structure, environmental effects, and value to communities.

**LEED –** Leadership in Energy and Environmental Design is a set of rating systems for the design, construction, operation, and maintenance of green buildings, homes and neighborhoods.

**PM 10 & PM 2.5 –** Particulate matter, or particle pollution, is a mixture of solid particles and liquid droplets found in the air. PM10 refers to particulate matter greater than 2.5 microns and less than 10 microns in size. PM2.5 refers to particulate matter less than 2.5 microns in size.

**PPA Total** – Total Possible Planting Area is comprised of non-tree canopy vegetation, such as grass and open space, and impervious surfaces where tree planting is biophysically possible.

**Short Tons** – The short ton is a unit of mass equal to 2,000 pounds (907.18474 kg), that is most commonly used in the United States and known simply as the ton. Elsewhere, a short ton is usually known simply as a "ton", without distinguishing it from the tonne (1,000 kilograms or 2,204.62262 pounds, known as the "metric ton").

**Storm water Runoff Mitigation and Water Quality** – Important ecosystem services related to precipitation events, hydrologic cycles, and urban forests. Trees reduce storm water runoff and improve water quality through rainfall interception, increased soil permeability and infiltration, and erosion control.

**SITES** – The Sustainable Sites Initiative™ (SITES™) is an interdisciplinary effort to transform land development and management practices towards regenerative outcomes. The SITES program has focused on developing a comprehensive, voluntary rating system for sustainable landscapes. Source: http://www.sustainablesites.org/.

**Urban Heat Island Effect** – refers to developed areas that are hotter than surrounding rural areas due to the abundance of man-made materials which absorb the sun's energy much more than trees or other plants, and in turn warm the air around them (Roberts, T. et al., 2010).

**Urban Tree Canopy** (UTC) – defined as the "layer of leaves, branches and stems that cover the ground" (Raciti et al., 2006) when viewed from above; the metric used to quantify the extent, function, and value of Chatham County's urban forest.

**Urban Tree Canopy Assessment** – a top-down GIS analysis of tree canopy cover, impervious surfaces (developed areas), and other land cover types quantifying existing canopy cover and areas where new trees can be planted. UTC data, maps, tools, and reporting provides a green infrastructure baseline for environmental planning programs, policy-making, city forestry budgeting and maintenance, and education/outreach/awareness. A UTC assessment provides maps and information to guide planning and development decisions from a citywide or landscape-scale to the neighborhood or even individual parcel (property) scale.

## A2: Overview of Urban Forest Ecosystem Benefits

Urban forests are an integral part of the character of Chatham County for residents, businesses, tourists, and policy makers. The functions and benefits of trees are referred to as "ecosystem services" and describe the ways that urban forests impact our lives and the environment. Trees are the ultimate multitasker, providing many "co-benefits". For example, trees and forests assist in ground water aquifer recharge and filtering pollutants from the air and water, improving human health and wildlife habitat, while at the same time storing carbon and sequestering pollutants.

The benefits below justify the many reasons to promote, establish, manage, and maintain a robust, "working" urban forest in Chatham County.

### Environmental

**Public Health:**

Trees help clean our air and water. Trees help reduce asthma rates by cooling and purifying the air. They also encourage exercise along walking corridors, parks, and trails, and reduce UV-B exposure by up to 50%.

**Storm water Management:**

Transpiration and interception of rainfall increases soil infiltration which increases water quality and reduces storm water flow. Tree roots hold soil together along stream banks and steep slopes.

**Increased Wildlife Habitat:**

Trees increase biodiversity in urban areas and provide a cleaner habitat to local animal species. Forests filter non-point source pollution and provide for a cleaner marine habitat.

### Economic

**Property Value:**

Healthy trees can increase property value of residential homes by as much as 10%.

**Energy Conservation:**

Trees lower energy demand through summer shade and winter wind block, reducing energy bills and saving money. In turn, this also offsets carbon emissions at power plants.

**Storm water Regulation:**

Trees and forests reduce the need for (or size of) costly infrastructure facilities.

**Tourism:**

More people visit places with a healthy urban forest and studies have shown that retail sales are consistently higher with comfortable landscape settings.

**Worker Productivity:**

Studies show that people who work in offices with trees and other green spaces have reduced stress and have fewer sick days.

### Social

**Test Scores:**

Trees and the natural settings they provide have been shown to boost academic performance at schools.

**Healing and Stress:**

Trees help reduce recovery times from surgery or illness, and studies have shown that views of greenspace and larger areas of greenspace in our places of work and play reduce stress.

**Crime and Domestic Violence:**

Urban forests help build stronger communities. Trees provide settings in which relationships grow stronger and violence is reduced.

**Traffic Safety:**

Studies have shown drivers slow down on streets that have trees. Street geometry plays a large factor in speed but so do trees.

### Task 1: A Spatial Canopy Cover Trends Analysis

The main objective of Task 1 was to tie-in previous studies in Chatham County with the 2014 UTC assessment and to confirm trends. This objective was accomplished by **(1a**) conducting an historical trends analysis using existing 30-meter land cover data for the county and (**1b**) reviewing the positives and negatives of two previous canopy study reports.

### Spatial Canopy Trend Analysis (Task 1a)

Land Use / Land Cover (LULC) changes were assessed focusing on canopy cover and impervious / developed area from 1996, 2006, and 2010 using 30-meter, LANDSAT satellite imagery-derived land cover data from the National Oceanic and Atmospheric Administration's (NOAA) Coastal Change Analysis Program (C-CAP). 25 original land cover classes were simplified to four (4) classes for evaluation; (1) Tree Canopy, (2) Developed Areas, (3) Water, and (4) Other (all other land cover classes). The classifications show pixels based on how they have changed between image acquisition dates, for example, how many pixels changed from tree canopy to development for each time period.

Change was derived by comparing the "from" and "to" land cover classes across the county and broken out for each municipality for each time period. *Key findings from this task not highlighted in the main body of this report include:*

- Between 1996 and 2010, Chatham County lost a total of 23,112 acres of forest, equating to an annual rate of 1,651 acres of tree canopy loss.
- Savannah and Port Wentworth show the greatest loss, at 6,428 acres and 5,054 acres respectively.
- The rate of loss increased from 1,308 acres per year between 1996 and 2006 (13,084 acres) to 2,507 acres per year between 2006 and 2010 (10,028 acres).

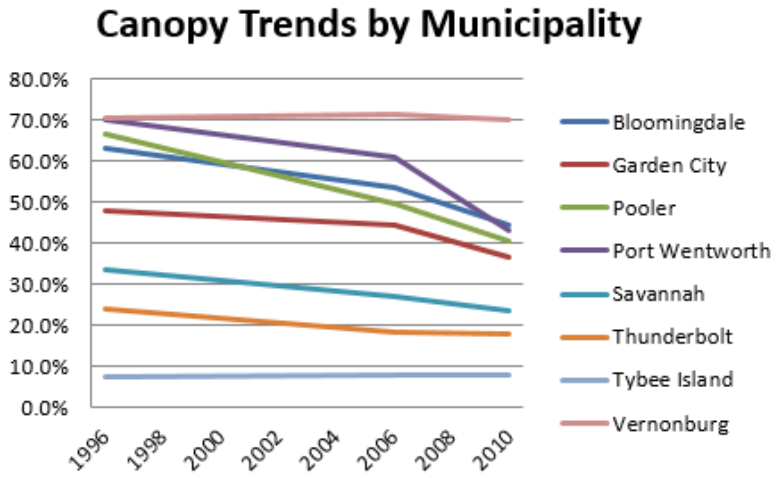



**Figure 20: Task 1 percent tree canopy trends from 1996 to 2010 in Chatham County by municipality.***

### Review of Prior Canopy Studies (Task 1b)

This review describes, compares, and discusses two previous tree canopy cover studies (Watson, 1993 and Kramer, 2001) commissioned by STF. This provides a critique of the usability of each study's results, how well each study builds upon previous studies, and compares each study to the 2014, 1-meter UTC assessment data inputs and methods.

Watson (1993) used the quality data and best analysis methods available at the time to produce the first report of Chatham County's canopy. Remote sensing analysis methods used were simple yet thorough, minimizing possible errors in the analysis results. Interpretation of direct forest loss is difficult (and acknowledged by the author) since each individual analysis unit (60x60 meter pixel) is larger than individual trees. Caution should be used when making assumptions about causality from the land use portion of the analysis. The validity of the land use analysis results is

* Tree canopy percentages in Figure 20 are based on Task 1 coarse resolution satellite imagery and will not match percent tree canopy values by municipality for Task 3 (UTC) which utilized 1-meter imagery and provided better accuracy.

confusing since it is unclear which time period the general land use categories were generated; e.g. were forests cleared after zoning to residential, or was zoning amended to incorporate areas that had already been cleared of forests?

Kramer's 2001 paper lacked a clear explanation of the exact methods utilized, confusing the ability to tie the study results directly to forest loss or change in Chatham County. It is clear that the imagery used in the analysis was 30x30 meter resolution, but the paper does not explicitly state which of the two related methods described was ultimately used. There are deficiencies in both described methods used to conduct the vegetation change analysis, raising serious concerns about the validity of presented results.

While similarities do exist between the two studies, many differences highlight their disjointedness:

1. Watson's study used imagery with pixels that were 60x60 meters while Kramer used imagery with 30x30 meters.
2. Kramer's analysis refers to vegetation only, without an attempt to differentiate forest lands from other vegetation types, while Watson used simplified, conservative methods to estimate losses in forest areas.
3. Kramer focused on land cover change across municipalities in Chatham County while Watson patched together "Neighborhoods" without clear boundaries (making an "apples to apples" comparison very difficult).
4. Through careful analysis, Watson was able to differentiate between "Catastrophic" loss (development) and "Thinning" (attrition and failure to replace) while Kramer provided little in the way of differentiating between vegetation loss to specific development types.
5. Watson provided modeled estimates of change over time. Kramer made no attempt to verify Watson's predicted trends so the studies did not necessarily build upon one another in this specific aspect.
6. Watson's study area focused on developable land areas while Kramer assessed all of Chatham County. Differing extent of scales also make direct comparisons of canopy change challenging.

**Relationship to the Current Study and Recommendations for the Future**

The main advantage of the 2014 Comprehensive Urban Tree Canopy Assessment compared to the previous studies is increased resolution of available imagery and LiDAR for the study area. Additionally, increased computing power and ancillary GIS data allows for accurate differentiation of vegetation types (even individual trees) and impervious surface types. Finally, the acres of canopy, water, marshland, the County, and other assessment boundaries have been clearly identified in the report and spreadsheets, making future comparisons and trends analysis feasible and accurate.

The same source of 30-meter imagery was used in Kramer's study and Task 1 of the 2014 study; however due to the limitations above, this report lists Watson's 50% canopy cover estimate but did not attempt to compare or include results from Kramer's study. A combination of Watson's methods with Kramer's imagery may have provided more useful results, which essentially represents what Task 1 from this study provided.

The following high-level recommendations are provided to ensure that future studies will build successfully upon the understanding of canopy trends in Chatham County:

1. Require an accuracy report and detailed imagery processing methods to accompany all results.
2. Request/receive an archive copy of all data inputs and outputs.
3. Explicitly request a list of desired metrics tables in spreadsheet, GIS, and similar formats (not just charts):
    a. Total area examined in each study.
    b. Forest acres at each time period of the study and forest loss between time periods.

c. Rate of forest loss between each time period and overall rate between earliest and latest time period.
d. Request raw numbers (totals per time period), not just change numbers.
e. Establish a common set of geographies to analyze. Even if boundaries have changed between studies, request metrics are calculated for consistent geographic areas (in addition to updated ones).

### Task 2: A Statistical Sampling of Canopy Cover Trends

Using i-Tree Canopy software, 2,250 points were randomly distributed and evaluated as tree or non-tree cover for four time periods (1999, 2004, 2009, and 2014) based on Google imagery and similar freely available sources. All points were then used to determine the statistical canopy cover percent for each time period. This point-based method provides a better "absolute accuracy" than coarse resolution satellite data used in Task 1 because each measurement unit (the pixel at each point location) is evaluated to the proper land cover type with a high level of accuracy. The resulting rates of change were used to predict future tree canopy across the county if "Business as Usual" losses continue. Additional industry standards can be found at http://www.itreetools.org/canopy/index.php.

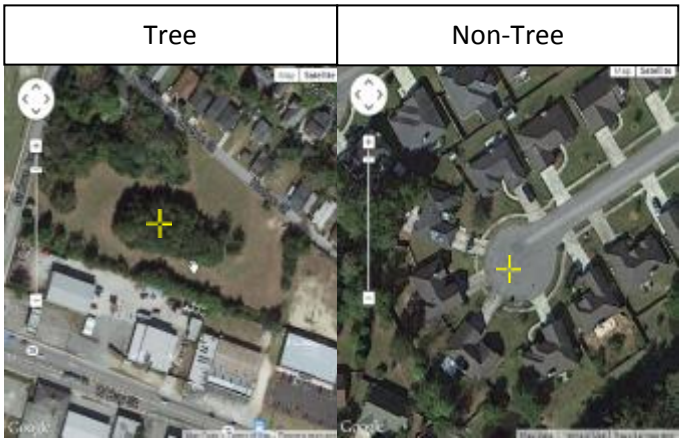



**Figure 21: Examples of Tree vs. Non-Tree random point locations and classifications, respectively, in i-Tree Canopy software**


**Figure 22: Example of a random point location using i-Tree Canopy where canopy loss near Savannah, GA International Airport was captured with the Task 2 sampling approach.**

*Key findings from this task include:*

1. From 1999 to 2014 tree canopy percent decreased from 41.7% to 36.4%, accurate to within 1% standard error (SE).
2. At current rates of decline, tree canopy percent is expected to be 33.8% in 2020 and dip below 30% by around 2032. By 2050 canopy cover could be as low as 24.2%.

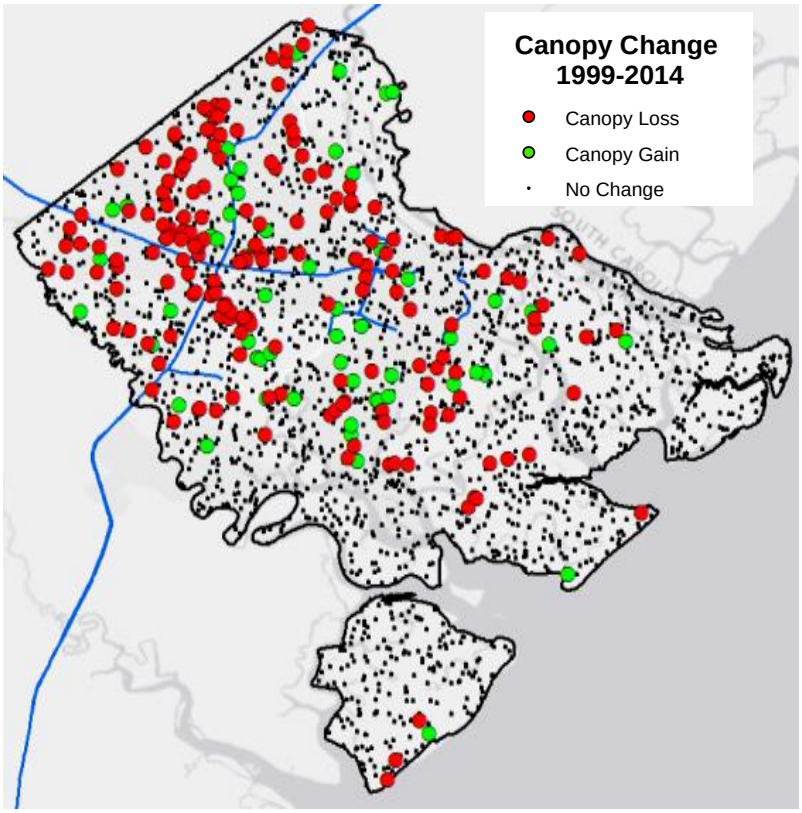



**Figure 23: Sample Points from i-Tree Canopy statistical sampling**

## Task 3: A Comprehensive Urban Tree Canopy Assessment

### Land Cover Classification

The 2014 UTC assessment conducted for Chatham County provides an accurate evaluation of canopy and other land cover at many geographic scales. Aerial photography (2013 National Agricultural Imagery Program) at 1-meter pixel resolution and spring 2009 LiDAR were used as the basis for land cover mapping. Object-Based Image Analysis (OBIA) classification results were combined with numerous GIS data provided by SAGIS to produce the following nine land cover classes across Chatham County: (1) buildings, (2) other impervious, (3) parking lots, (4) roads, (5) soil/dry vegetation, (6) tree canopy, (7) vegetation, (8) water and (9) wetlands. Specifically, automated OBIA impervious surfaces were augmented with existing buildings, roads and parking lots (provided by Savannah Areas GIS), and water was mapped using remote sensing methods augmented by manual digitizing at 1:1,000 scale.


**Figure 24: Example of general land cover types**

Once finalized, the land cover raster GIS data was the input to assessing boundaries to provide UTC metrics at multiple scales.

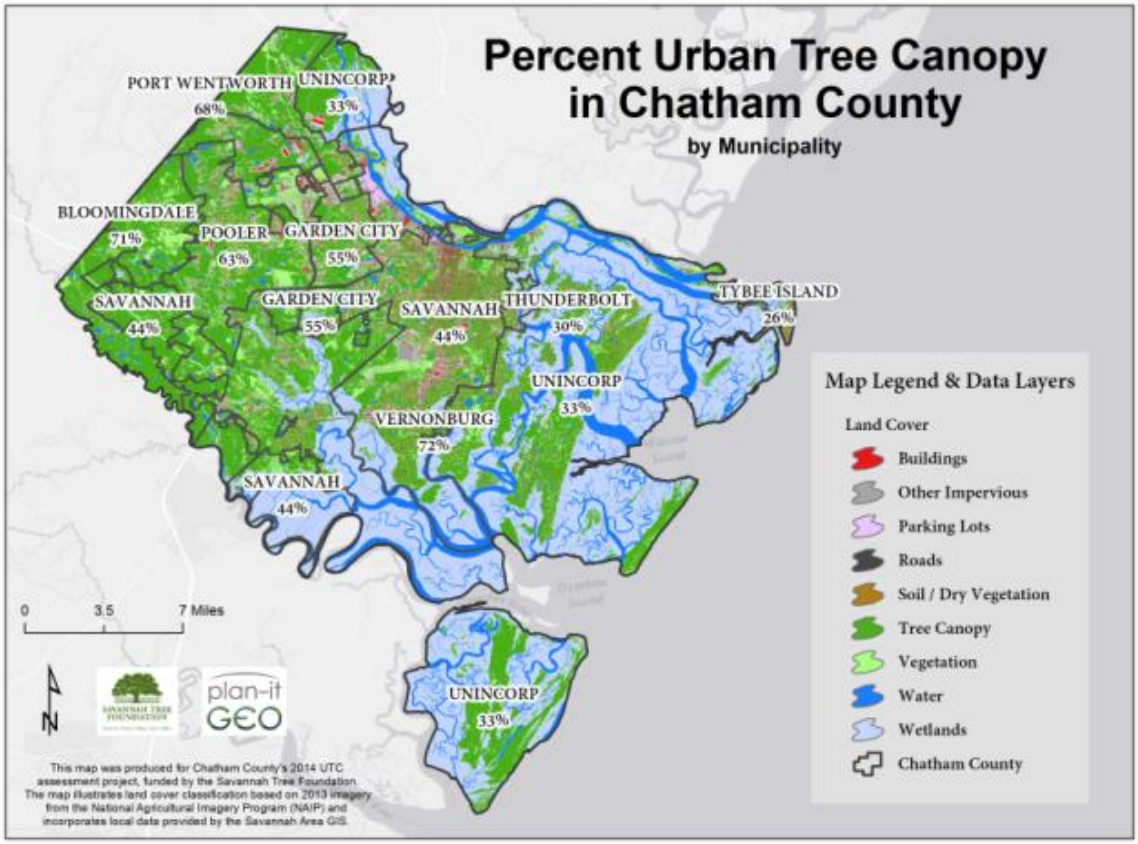



**Figure 25: Map of land cover & percent UTC by municipality**

**Land Cover Accuracy**

Land cover accuracy assessment was performed in two geographic regions, focusing on (1) all areas of Chatham County, and (2) remaining municipal areas after excluding unincorporated lands.

**Accuracy Assessment**

Classification accuracy serves two main purposes: First, accuracy assessments provide internal information to GIS technicians producing the classification about where land cover mapping processes need to be improved and where they are effective. Second, measures of accuracy provide information about how to use the classification and how well land cover classes are expected to estimate actual land cover on the ground. Even with high resolution imagery, very small differences in classification methodology and image quality can have a large impact on overall map area estimations. The classification accuracy error matrices illustrated in Tables 5 and 6 contain standard error data that report the high and low values that could be expected for any comparison between the classification data and what was actually on the ground in 2013.

Step 1: One thousand (1,000) sample points were randomly distributed across the study area and assigned a random numeric value. Random values ensure sample points are geographically distributed across the entire study area.

Step 2: Sorting from lowest random value to highest, each sample point was referenced using the NAIP imagery and assigned one of the five land cover classes ("Ref_ID") mentioned above.

Step 3: If a reference value could not be discerned from the imagery, the point was dropped from the accuracy analysis.

Step 4: An automated script was then used to assign values from the classification ("Eval_ID").

Step 5: Misclassified points (where reference ID does not equal evaluation ID) and corresponding land cover were inspected for necessary corrections to the land cover.* These steps were repeated until accuracy targets are met.

* Note that by manually correcting errors in land cover mapping at specific locations associated with accuracy points, bias is introduced to the error matrix results. This means that matrix results based on a new set of randomly collected accuracy points will result in different accuracies.

**Table 5: Standard error matrix for land cover classification in Chatham County. Note the value "76" near the top right is discussed on the next page.**

| Classification Data | Reference Data: Tree Canopy | Vegetation | Impervious | Soil / Dry Veg. | Water | Total Reference Pixels |
|---|---|---|---|---|---|---|
| Tree Canopy | 386 | 9 | 0 | 0 | 0 | 395 |
| Vegetation | 6 | 219 | 2 | 0 | 76 | 303 |
| Impervious | 2 | 10 | 91 | 1 | 3 | 107 |
| Soil / Dry Veg. | 1 | 2 | 0 | 8 | 0 | 11 |
| Water | 1 | 3 | 0 | 1 | 170 | 175 |
| Total | 396 | 243 | 93 | 10 | 249 | 991 |

Overall Accuracy = 88%

| Producer's Accuracy | | User's Accuracy | |
|---|---|---|---|
| Tree Canopy | 97% | Tree Canopy | 98% |
| Veg. / Open Space | 90% | Veg. / Open Space | 72% |
| Impervious | 98% | Impervious | 85% |
| Bare Ground / Soil | 80% | Bare Ground / Soil | 73% |
| Water | 68% | Water | 97% |

**Table 6: Standard error matrix for land cover classification excluding unincorporated areas in Chatham County. An explanation for this second error matrix is provided on the next page.**

| Classification Data | Reference Data: Tree Canopy | Vegetation / Marsh | Impervious | Soil / Dry Veg. | Total Reference Pixels |
|---|---|---|---|---|---|
| Tree Canopy | 386 | 9 | 0 | 0 | 395 |
| Vegetation / Marsh | 7 | 468 | 2 | 1 | 478 |
| Impervious | 2 | 13 | 91 | 1 | 107 |
| Soil / Dry Veg. | 1 | 2 | 0 | 8 | 11 |
| Total | 396 | 492 | 93 | 10 | 991 |

Overall Accuracy = 96%

| Producer's Accuracy | | User's Accuracy | |
|---|---|---|---|
| Tree Canopy | 97% | Tree Canopy | 98% |
| Veg. / Marsh | 95% | Veg. / Marsh | 98% |
| Impervious | 98% | Impervious | 85% |
| Bare Ground / Soil | 80% | Bare Ground / Soil | 73% |

### Error Matrix Interpretation and Results

Interpretation of results of the standard error matrix indicates land cover mapping represented true on-the-ground conditions with 88% overall accuracy for all of Chatham County and 96% for municipalities. Table 5 focuses on all of Chatham County and aggregates water and marshland together while separating this pairing from all other classes. Table 6 focuses only on incorporated areas of the County where water is not separated from other land cover classes and marshland is included as a general vegetation type along with grass and open space areas.

The reason two versions were created and that Table 5 has lower overall accuracy is explained almost entirely by the value of 76 near the top right (under the Reference Data column for Water). This shows that 76 out of 249 points were manually identified as water by visual interpretation (i.e. reference data in the columns) but these points were classified as Vegetation (grass / open space) in the remote sensing analysis (classification data in the rows).

The accuracy is higher for municipal areas due only to human interpretation between marsh areas inundated with varying levels of water vs. other vegetation. In short, a single pixel or area can represent both water and vegetation, and different manual interpretation of the reference points dictates the final overall accuracy. Therefore, given the primary purpose of this study was to map tree canopy, classes are aggregated and both tables are provided to demonstrate the high accuracy (96%) of the primary classifications: tree canopy, impervious surface, vegetation, and soil / dry vegetation.

### Additional Explanation and Examples

Statistical relationships between the reference pixels (representing the true conditions on the ground) and the intersecting classified pixels are used to understand how closely the entire classified map represents the Chatham County landscape. The error matrix represents the intersection of reference pixels manually identified by a human observer (columns) and classification category of pixels in the classified image (rows). The white boxes along the diagonals of the matrix represent agreement between the two. Off-diagonal values represent the number of pixels manually referenced to the column class that were classified as another category in the classification image.

Overall accuracy is computed by dividing the total number of correct pixels by the total number of pixels reported in the matrix (for Table 6, municipal areas: 386+468+91+8 = 953 / 991 = 96%), and the matrix can be used to calculate per class accuracy percent. For example, 386 points were manually identified in the reference map as Tree Canopy, and 396 of those pixels were classified as Tree Canopy in the classification map. This relationship is called the “Producer’s Accuracy” and is calculated by dividing the agreement pixel total (diagonal) by the reference pixel total (column total). Therefore, the Producer’s Accuracy for Tree Canopy is calculated as: (386/396 = .97), meaning that we can expect that ~97% of all tree canopy in the Chatham County study area were captured in the classification map.

Conversely, the “User’s Accuracy” is calculated by dividing the number of agreement pixels total by the total number of classified pixels in the row category. For example, 386 classification pixels intersecting reference pixels were classified as Tree Canopy, but 9 pixels were identified as Vegetation (grass / open space) or Marshland in the reference map. Therefore, the User’s Accuracy for Tree Canopy is calculated as: (386/395 = 0.98), meaning that pixels classified as Tree Canopy in the classification were actual grass, open space, or marshland. It is important to recognize that the Producer’s and User’s accuracy percent values are based on a sample of the true ground cover, represented by the reference pixels at each sample point.

## 3rd Party Review of Land Cover Classification Map Accuracy

The U.S. Forest Service's "Urban Forestry South" in Athens, GA, provided a 3rd party review of the land cover mapping accuracy. An excerpt of the report provided by Dudley Hartel is below. The full 3rd party accuracy assessment report is available from the Savannah Tree Foundation.

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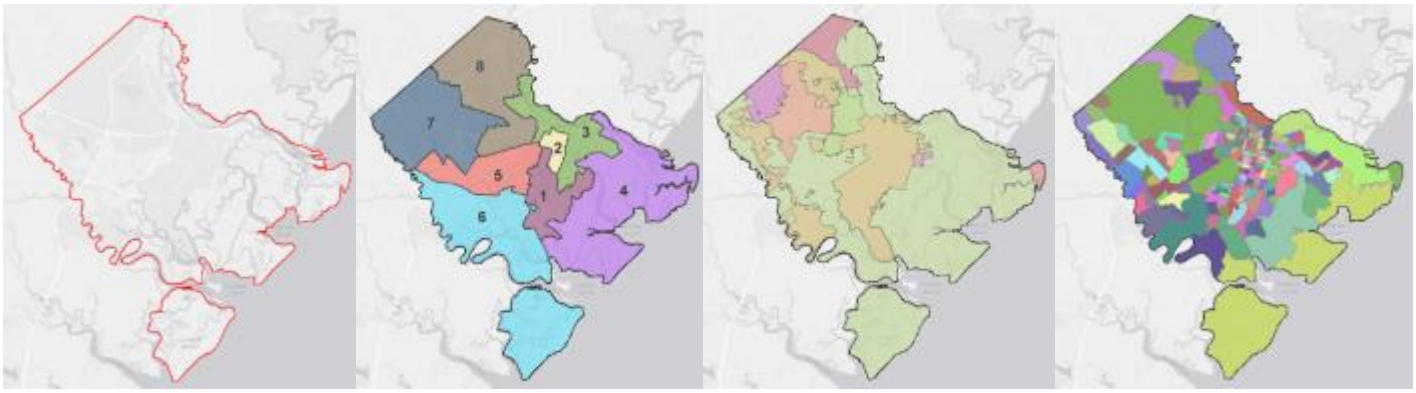
*For the municipal boundary area, my overall accuracy assessment was just under 95% with a 98% tree canopy accuracy. Following the development of my assessment & accuracy matrix I then look at a subsample (actually nearly all) of the objects classified that differed from the visual classification. I then reevaluated the point to determine where the two classification processes had diverged in "opinion" and in nearly all cases can "justify" the object classification in the vendor provided land cover. The biggest area of disagreement arises between water vs. marsh grass/low vegetation followed by pavement/building edges; I used grass/low vegetation even in natural areas (including commercial forestland) where my random points landed in woodland openings larger than about 3 meters, however, the most likely "error" was interpretation of tree shadows in residential and commercial land uses where I used nearby context and easily identified lawn edges as a guide for my assessment at a particular shaded point.*

*For the unincorporated areas which had a higher proportion of coastal wetland I had a higher percentage of marsh/water errors which was reflected in an overall accuracy of 89% but with a 98% tree canopy accuracy.*

*Overall, however, the land cover classification is a very good representation of the imagery and users of the data and products produced from it should be able to place a high degree of confidence in the results.*

## Assessment Boundaries

Assessment boundaries provide geographic units linked to where we live, work and play. Land cover and UTC metrics were assessed for the GIS boundaries seen in Figure 26 below. Note this report does not include results for every scale shown below. Results were summarized in the complete UTC Assessment spreadsheet delivered to STF as part of this study. These metrics provide data for resource managers, planners, and outreach groups at different spatial scales that are applicable to unique ownerships and use cases.



**Chatham County Boundary: 1 Feature**

**County Commissioner / SCCPSS* Districts: 8 Features**

**Municipalities: 9 Features**

**Neighborhoods: 198 Features**

**Drainage Basins: 21 Features**

**ROW and Parcels: 115,000**

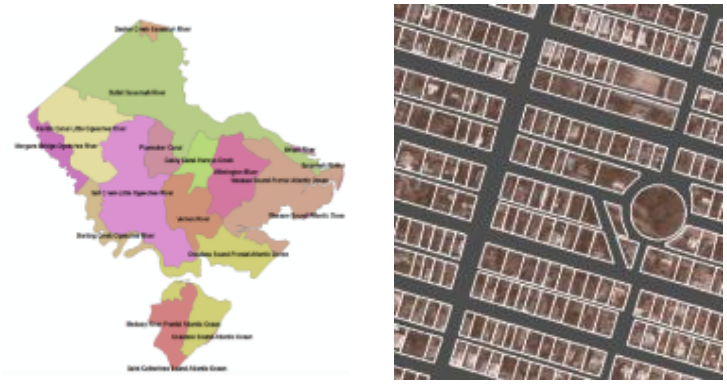


**Figure 26: Geographic scales assessed through the Chatham County UTC assessment project.**

* Savannah / Chatham County Public School System (SCCPSS) Districts

## Ecosystem Services

First-order estimates of urban forest ecosystem services were calculated using i-Tree and CITYgreen software.

Air quality and carbon storage and sequestration benefits were calculated using i-Tree Canopy software, developed by David J. Nowak, Jefferey T. Walton, and Eric J. Greenfield with the USDA Forest Service. Using data points in i-Tree Canopy from Task 2 (see page 33 for Task 2 details), tree benefit estimates were calculated in tons (T) using monetary value models for each benefit. The parameter "all" was used to represent a rural/urban mix.

| Abbr. | Benefit Description | Value | ±SE | Amount | ±SE |
|---|---|---|---|---|---|
| CO | Carbon Monoxide removed annually | $8,643.89 | ±241.11 | 15.54 T | ±0.43 |
| NO2 | Nitrogen Dioxide removed annually | $51,653.54 | ±1,440.80 | 370.42 T | ±10.33 |
| O3 | Ozone removed annually | $2,549,725.33 | ±71,120.86 | 3,272.55 T | ±91.28 |
| PM2.5 | Particulate Matter less than 2.5 microns removed annually | $4,156,948.89 | ±115,952.01 | 117.37 T | ±3.27 |
| SO2 | Sulfur Dioxide removed annually | $19,947.20 | ±556.40 | 428.52 T | ±11.95 |
| PM10* | Particulate Matter greater than 2.5 microns and less than 10 microns removed annually | $1,690,006.89 | ±47,140.27 | 637.85 T | ±17.79 |
| CO2seq | Carbon Dioxide sequestered annually in trees | $12,615,678.44 | ±351,895.90 | 651,523.97 T | ±18,173.31 |
| CO2stor | Carbon Dioxide stored in trees (Note: this benefit is not an annual rate) | $274,828,806.88 | ±7,665,947.67 | 14,193,256.20 T | ±395,900.13 |

*i-Tree Canopy Annual Tree Benefit Estimates based on these values in lbs/acre/yr and $/T/yr: CO 0.275 @ $558.18 | NO2 6.561 @ $139.94 | O3 57.964 @ $781.88 | PM2.5 2.079 @ $35,543.74 | SO2 7.590 @ $46.71 | PM10* 11.298 @ $2,658.93 | CO2seq 11,539.995 @ $19.43 | CO2stor is a total biomass amount of 251,395.359 @ $19.43*
*Note: Standard errors of removal amounts and benefits were calculated based on standard errors of sampled and classified points.*

**Figure 27: i-Tree Canopy tree benefits estimates report (based on 36.4% tree canopy countywide, including all land, water, and marsh)**

For a complete methodology of *i-Tree Canopy Air Pollutant, Carbon Storage & Sequestration, and Monetary Value Model Descriptions*, refer to: http://www.itreetools.org/canopy/resources/iTree_Canopy_Methodology.pdf

Stormwater runoff mitigation benefits were calculated using CITYgreen, a GIS-based software developed by American Forests using research from the U.S. Forest Service and Natural Resources Conservation Service (NRCS). This software uses the NRCS TR55 model to estimate the additional stormwater runoff without tree canopy. This is sometimes referred to as a land cover replacement model.

The model is based on soils, the average 2-year precipitation event, slope, and runoff coefficients known as curve numbers (CN). A higher CN results in higher runoff. The change between total stormwater quantity (volume) from the modeled storm event for existing tree canopy conditions vs. the replacement land cover type (typically a higher CN) is used to place a value on the existing forested land cover. Two of the parameters that were used are described below.

- Construction cost per cubic foot (cu. ft.): $3/cu. ft. was used as a conservative average for stormwater facility construction cost to manage the additional runoff increase mitigated by existing trees.
- Replacement Land Cover Type: when tree canopy is "replaced" in the CITYgreen model, the replacement land cover chosen was Open Space - Grass/Scattered Trees: Grass cover 50% - 75%. This provides a more conservative estimate than replacing the tree canopy with commercial or residential development which has a much higher curve number (CN).

## Business-As-Usual Scenario of Canopy Cover in years 2020, 2030, 2040, and 2050

Business-as-Usual (BAU) canopy scenarios were developed utilizing data from Task 2 and Task 3 of this assessment. Task 1 data were omitted from BAU scenario projections due to the variable nature and reduced absolute accuracy of 30-meter resolution land cover data. Using a linear regression model, forecasted countywide canopy projections were developed for the years 2020, 2030, 2040, and 2050.

**Table 7. Business as Usual tree canopy projections**

| Method of Derived UTC | UTC % | Year | Acres of UTC* |
|---|---|---|---|
| Task 2 i-Canopy Assessment | 41.7% | 1999 | 128,576 |
| Task 2 i-Canopy Assessment | 39.7% | 2004 | 122,409 |
| Task 2 i-Canopy Assessment | 37.1% | 2009 | 114,393 |
| Task 3 Land Cover Assessment | 36.4% | 2013 | 112,205 |
| BAU Projection | 33.8% | 2020 | 104,218 |
| BAU Projection | 30.3% | 2030 | 93,426 |
| BAU Projection | 26.8% | 2040 | 82,634 |
| BAU Projection | 23.3% | 2050 | 71,842 |

*Based on 2014 Total Area of Chatham County

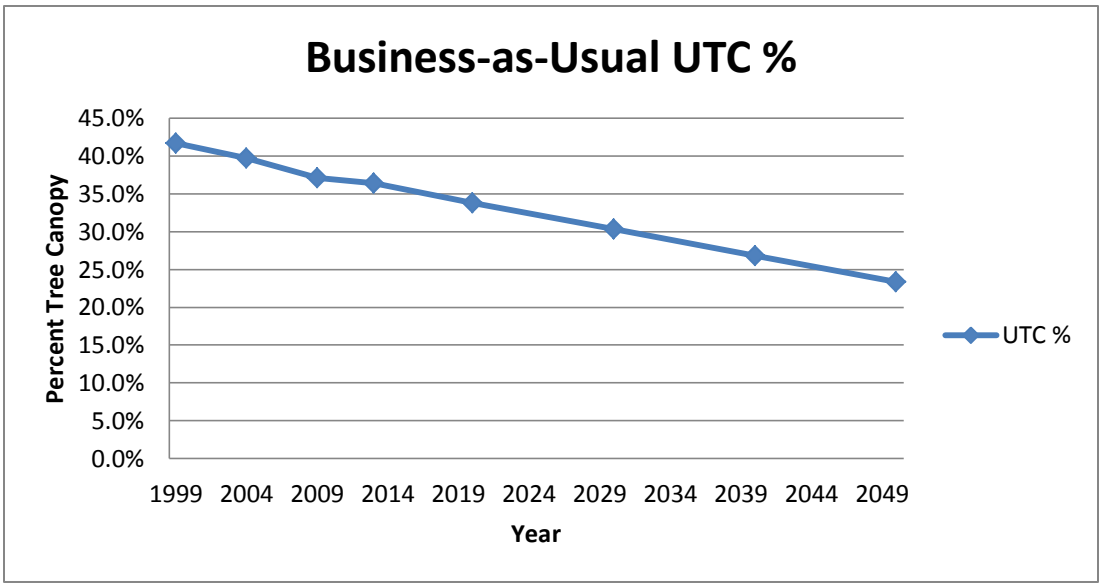



**Figure 28: Annual decline in UTC percent implementing a "Business-as-Usual" scenario.**

## UTC Assessment Boundaries

Land cover metrics were assessed for the GIS boundaries on page 39 and provided in separate maps and GIS data layers. The maps and tables on the following pages provide more comprehensive results for several boundaries assessed in this study. Note that in Table 8, the UTC % is shown as 41.3%, based on total land area excluding water area.

Note: Several geographic assessment boundaries provided by SAGIS do not cover the entire county boundary particularly in portions of coastal areas, resulting in variable acreage totals for scales assessed in this project. For example, the Chatham County boundary and drainage area boundaries cover 308,336 acres while the total area for the GIS layers for municipalities summarize to slightly less than 308,000 acres.

## Countywide UTC Results

**Table 8: Countywide UTC results**

| | Total Acres | Land Area (acres) | UTC (acres) | UTC % | PPA Vegetation (acres) | PPA Vegetation % | PPA Impervious (acres) | PPA Impervious % | Total PPA (acres) | Total PPA % | Unsuitable UTC "Land" (acres) | Unsuitable UTC "Land" % | Unsuitable UTC "Water" (acres) | Total Unsuitable (acres) | Total Unsuitable % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chatham County | 308,336 | 271,805 | 112,204 | 41.3% | 30,388 | 11.2% | 14,029 | 5.2% | 44,417 | 16.3% | 115,185 | 42.4% | 36,531 | 151,715 | 49.2% |

*Total Possible planting area is the sum of PPA Vegetation and PPA Impervious

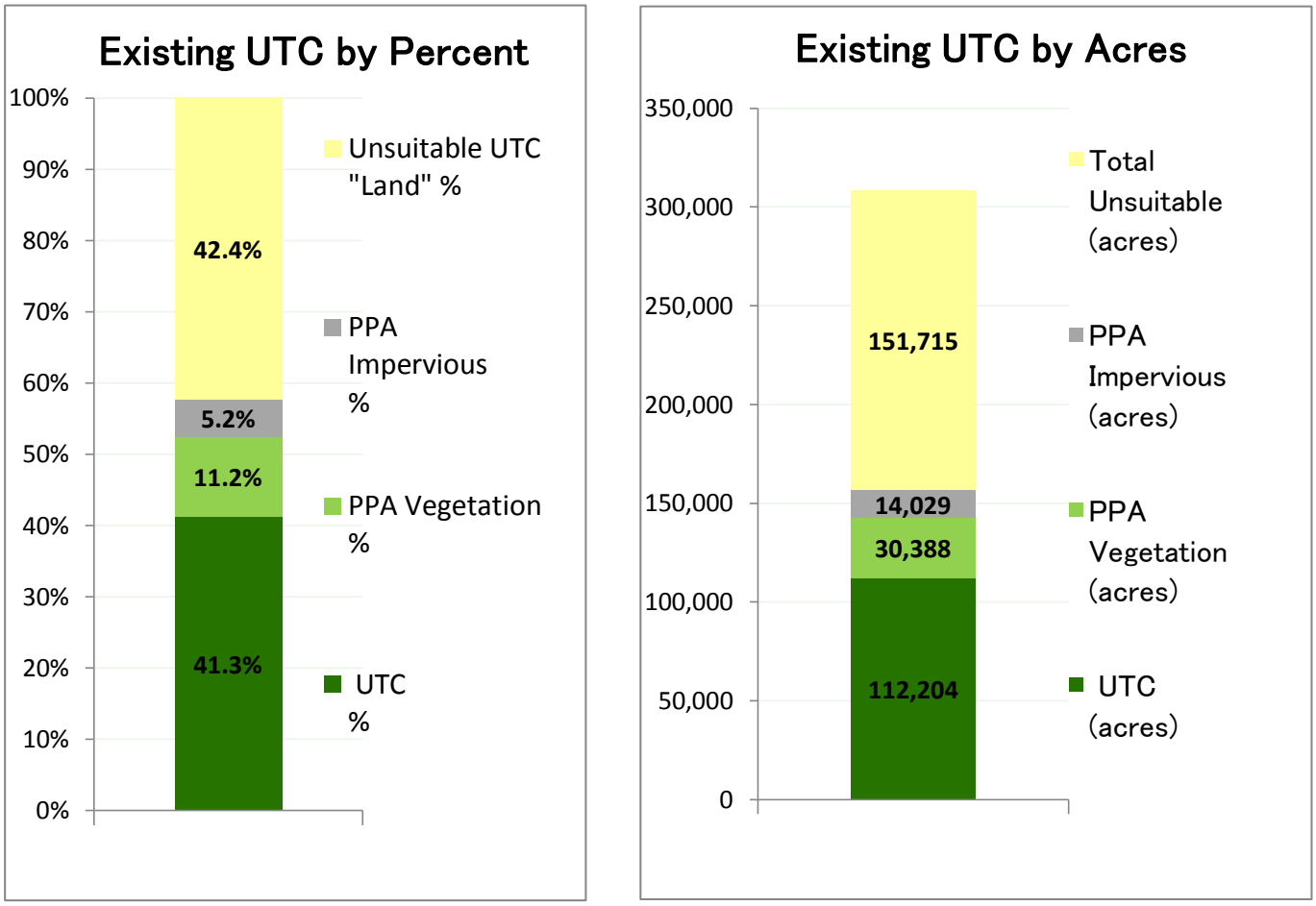



**Figure 29: Chatham County UTC assessment metrics in percent (left) based on land area excluding water areas and Acres (right) based on total area given water areas are a type of unsuitable UTC.**

## Existing Tree Canopy and Possible Planting Area Results for Municipalities

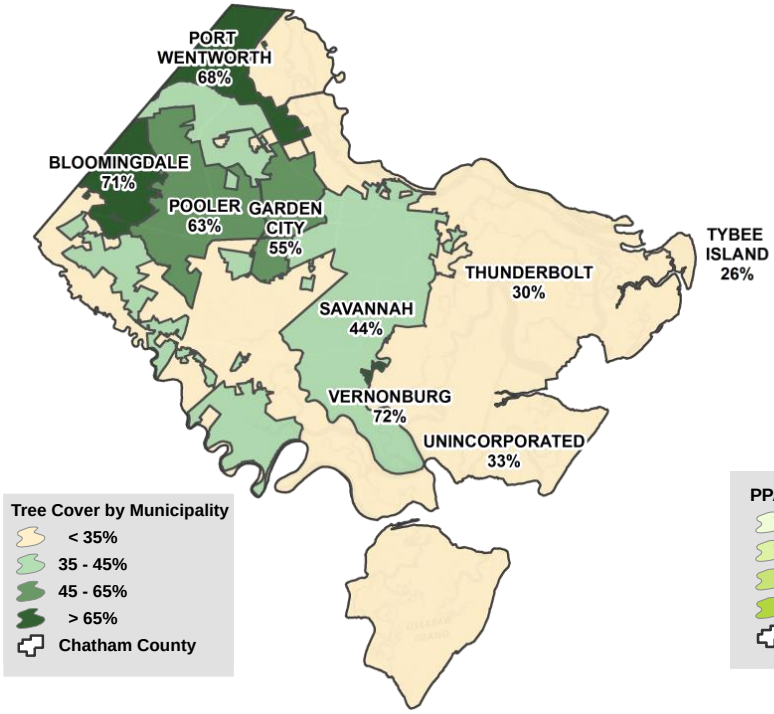



Figure 30: Percent UTC by municipality

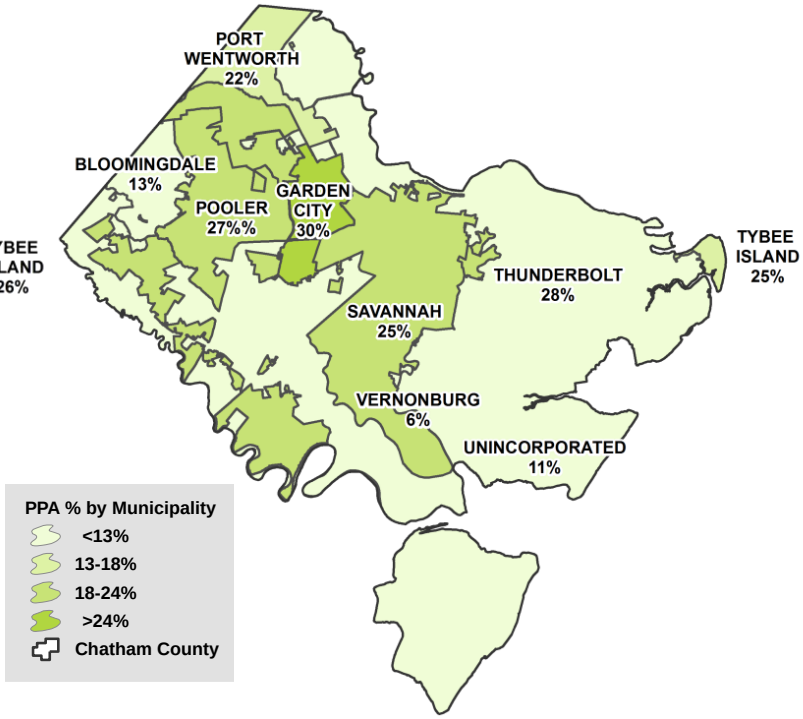



Figure 31: Percent Total Possible Planting Area by municipality

Table 9: UTC Results by municipalities (percentages based on land area excluding water)

| Municipality | Total Acres | Land Area (acres) | % of Total City Area | UTC (acres) | UTC % | Distribution of UTC % | PPA Vegetation (acres) | PPA Vegetation % | PPA Impervious (acres) | PPA Impervious % | Total Possible Planting (acres) | Total Possible Planting % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bloomingdale | 8,987 | 8,760 | 3.2% | 6,185 | 71% | 6% | 954 | 11% | 160 | 2% | 1,114 | 13% |
| Garden City | 9,182 | 8,982 | 3.3% | 4,939 | 55% | 4% | 1,556 | 17% | 1,178 | 13% | 2,734 | 30% |
| Pooler | 19,452 | 18,857 | 6.9% | 11,848 | 63% | 11% | 3,753 | 20% | 1,253 | 7% | 5,006 | 27% |
| Port Wentworth | 10,549 | 10,388 | 3.8% | 7,100 | 68% | 6% | 1,644 | 16% | 687 | 7% | 2,331 | 22% |
| Savannah | 69,153 | 65,066 | 23.9% | 28,764 | 44% | 26% | 9,431 | 14% | 5,958 | 9% | 15,389 | 24% |
| Thunderbolt | 1,008 | 879 | 0.3% | 265 | 30% | 0% | 143 | 16% | 99 | 11% | 242 | 28% |
| Tybee Island | 1,697 | 1,595 | 0.6% | 419 | 26% | 0% | 261 | 16% | 130 | 8% | 391 | 25% |
| Unincorporated | 187,658 | 156,990 | 57.8% | 52,483 | 33% | 47% | 12,631 | 8% | 4,560 | 3% | 17,190 | 11% |
| Vernonburg | 270 | 266 | 0.1% | 191 | 72% | 0% | 13 | 5% | 3 | 1% | 16 | 6% |
| OVERALL | 307,957 | 271,782 | 88.3% | 112,193 | 41% | 100% | 30,386 | 11% | 14,028 | 5% | 44,414 | 16% |

## Existing Tree Canopy and Possible Planting Area Results for Drainage Basins

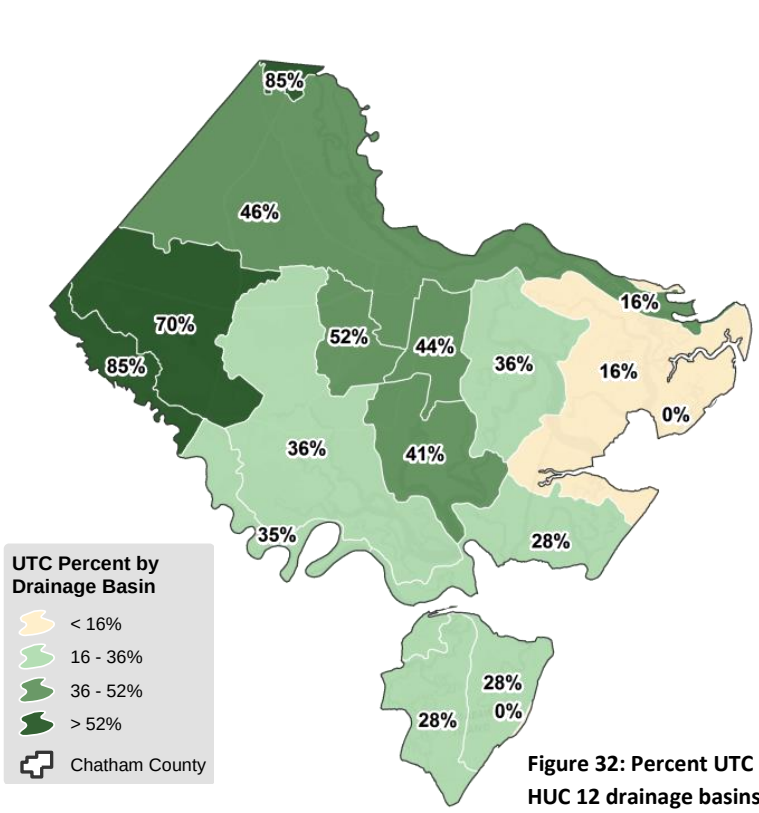



Figure 32: Percent UTC by HUC 12 drainage basins

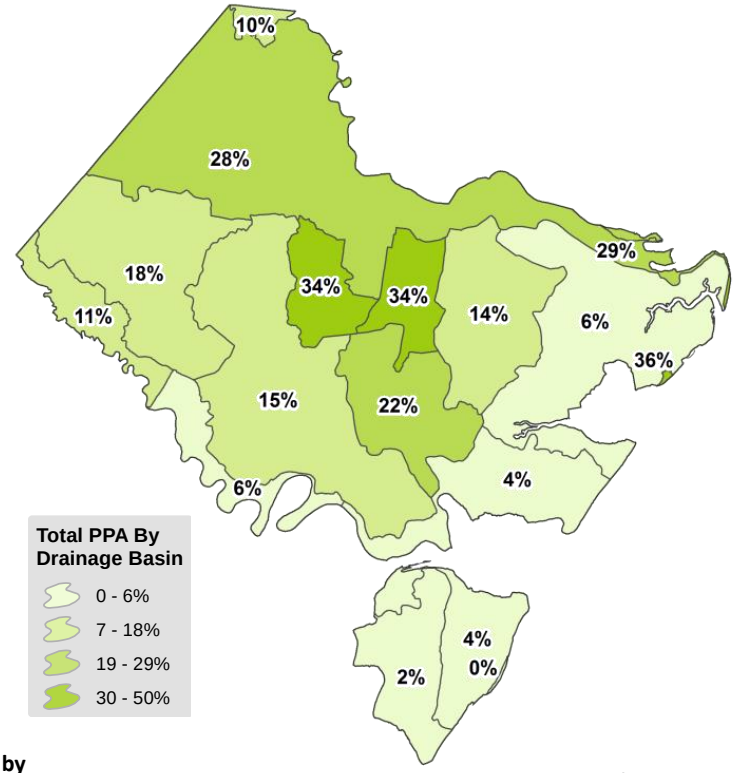



Figure 33: Percent Total PPA by HUC 12 drainage basins

**Table 10: UTC Results by HUC 12 drainage basins***

| Drainage Basin Name | Total Acres | Land Area (acres) | % of Total County Area | UTC (acres) | UTC % | Distribution of UTC % | PPA Vegetation (acres) | PPA Vegetation % | PPA Impervious (acres) | PPA Impervious % | Total Possible Planting (acres) | Total Possible Planting % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlantic Ocean | 2 | 2 | 0% | 0 | 0% | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Casey Canal-Haneys Creek | 8,809 | 8,695 | 3% | 3,816 | 44% | 3% | 1,659 | 19% | 1,209 | 14% | 2,975 | 34% |
| Dasher Creek-Savannah River | 2,002 | 1,941 | 1% | 1,658 | 85% | 1% | 151 | 8% | 36 | 2% | 186 | 10% |
| Hardin Canal-Little Ogeechee River | 30,473 | 29,789 | 11% | 20,873 | 70% | 19% | 4,438 | 15% | 877 | 3% | 5,315 | 18% |
| Medway River-Frontal Atlantic Ocean | 14,136 | 12,203 | 4% | 3,477 | 28% | 3% | 298 | 2% | 4 | 0% | 302 | 2% |
| Morgans Bridge-Ogeechee River | 8,582 | 8,035 | 3% | 6,846 | 85% | 6% | 792 | 10% | 80 | 1% | 872 | 11% |
| Ossabaw Sound-Atlantic Ocean | 182 | 3 | 0% | 0 | 0% | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Ossabaw Sound-Frontal Atlantic Ocean | 31,800 | 27,293 | 10% | 7,542 | 28% | 7% | 1,140 | 4% | 57 | 0% | 1,197 | 4% |
| Outlet Savannah River | 69,559 | 61,701 | 23% | 28,498 | 46% | 25% | 9,070 | 15% | 6,845 | 11% | 17,077 | 28% |
| Pipemaker Canal | 9,217 | 8,908 | 3% | 4,619 | 52% | 4% | 1,524 | 17% | 1,162 | 13% | 2,985 | 34% |
| Saint Catherines Sound-Atlantic Ocean | 1 | 0 | 0% | 0 | 0% | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Salt Creek-Little Ogeechee River | 46,838 | 41,412 | 15% | 14,767 | 36% | 13% | 4,759 | 11% | 1,510 | 4% | 6,362 | 15% |
| Savannah River-Atlantic Ocean | 248 | 248 | 0% | 38 | 15% | 0% | 76 | 31% | 48 | 19% | 124 | 50% |
| Sterling Creek-Ogeechee River | 9,047 | 7,064 | 3% | 2,470 | 35% | 2% | 292 | 4% | 105 | 1% | 397 | 6% |
| Vernon River | 17,894 | 15,139 | 6% | 6,165 | 41% | 5% | 2,114 | 14% | 1,150 | 8% | 3,323 | 22% |
| Wassaw Sound-Atlantic Ocean | 175 | 54 | 0% | 0 | 0% | 0% | 19 | 36% | 0 | 0% | 19 | 36% |
| Wassaw Sound-Frontal Atlantic Ocean | 37,913 | 31,643 | 12% | 5,161 | 16% | 5% | 1,523 | 5% | 288 | 1% | 1,811 | 6% |
| Wilmington River | 20,944 | 17,167 | 6% | 6,193 | 36% | 6% | 1,853 | 11% | 630 | 4% | 2,483 | 14% |
| Wright River | 514 | 509 | 0% | 81 | 16% | 0% | 122 | 24% | 28 | 6% | 150 | 29% |
| OVERALL | 308,336 | 271,805 | 100% | 112,204 | 41% | 100% | 30,388 | 11% | 14,029 | 101% | 44,417 | 16% |

*19 drainage basins are included in Table 10 above; however two basins were excluded from the maps above in Figures 31 and 32 due to their small size – Atlantic Ocean basin (2 acres) and Saint Catherines Sound Atlantic Ocean basin (1 acre).

## Existing Tree Canopy and Possible Planting Area Results for Parcels containing one or more Parking Lots

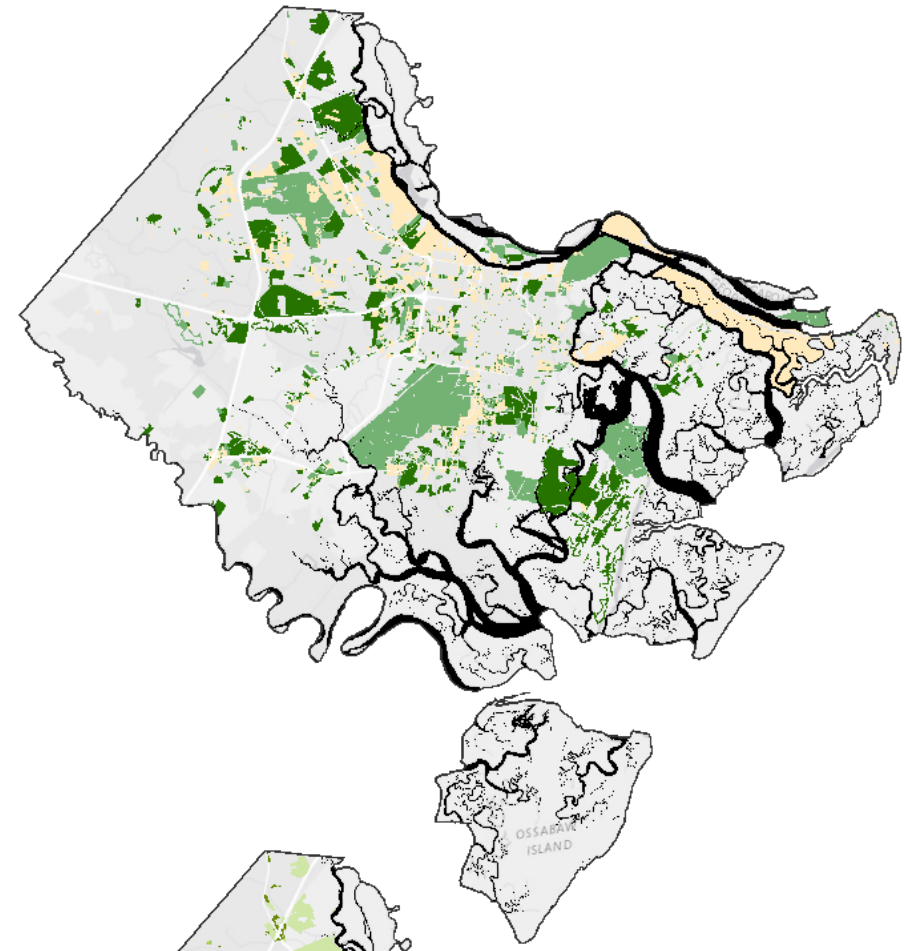



**Figure 34: Percent UTC in parcels containing parking lots**

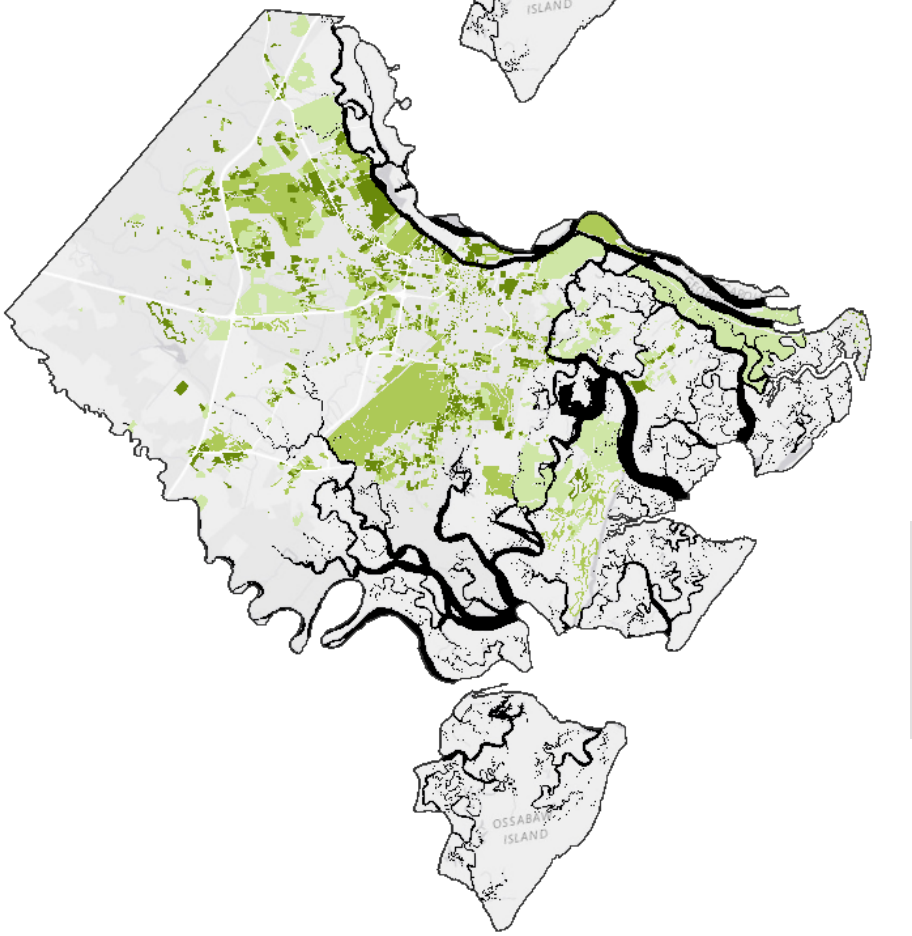



**Figure 35: Percent PPA in parcels containing parking lots**

**MPC Historic and Natural Resources Working Group Recommendations (2012)**

1. Create a Resource Database: This would be a multi-year process involving the creation of a website and nomination form to allow the community to nominate resources worthy of protection. Resources might include historic/archaeological sites, neighborhoods, viewsheds, corridors, cultural landscapes, significant trees, natural resources, habitat, etc. It would be necessary to develop some criteria to evaluate and prioritize the resources. It would also entail considerable research and an on-the-ground survey of resources throughout the County. Partnerships could be established with community organizations to assist with creative outreach efforts. This Resource Database would serve as the basis for developing protection mechanisms.

2. Conduct Small/Specific Area Plans: Based on the Resource Database results, conduct small/specific area plans which would include existing conditions documentation, analysis of opportunities and threats, and protective implementation strategies, likely in the form of overlays. These plans would necessitate a high level of community participation. The Plans would be incorporated into the Comprehensive Plan and Zoning Ordinance when complete. In the short term, Small/Specific Area Plans could be conducted based on neighborhood interest and need.

3. Conduct Corridor Plans: Similar to Small/Specific Area plans, corridor plans would focus on transportation corridors including adjacent land. Based on the Resource Database results, these plans would include existing conditions documentation, analysis of opportunities and threats, and protective implementation strategies, likely in the form of overlays. These plans would necessitate a high level of community participation. The Plans would be incorporated into the Comprehensive Plan, Zoning Ordinance and the Long Range Transportation Plan when complete. In the short term, Corridor Plans could be conducted based on community interested and need, for example, Victory Drive. This could serve as a model for future plans.

4. Encourage Pursuit of Federal and State Designations: The Resource Database could guide the identification of eligible properties, districts, and corridors. The responsibility for the designations would primarily lie with non-profits or other private organizations (such as neighborhood associations) with the support of local government agencies.

5. Revise the Development Review Process Part I (short-term): Revising the development review process to include staff comments regarding the impacts on historic and natural resources could be instituted as an MPC policy change prior to the completion of the database and would be relatively low cost. Staff will also inform the applicant of any identified resources. The comments would not be binding but would instead allow Review Bodies to consider them in their deliberations. The criteria for evaluation would include the eligibility criteria for listing on the National Register of Historic Places (for historic resources) and critical natural areas identified through the State Coastal Georgia Land Conservation Initiative (for natural areas).

6. Revise the Development Review Process Part II (long-term): Revise the development review process and amend the zoning ordinance to require Review Bodies to consider the impact on resources and require mitigation efforts on projects which have a negative impact. It would be necessary to have the Resource Database complete to effectively implement this.

7. Survey and Valuation of Trees for Municipal Projects: On all locally managed municipal projects, encourage City and County to require a complete survey and valuation of trees that may be impacted, both directly and indirectly, prior to finalizing a conceptual design.

8. Revise the County Tree Ordinance: Revise the Chatham County Land Disturbing Activities Ordinance to more closely resemble the City's Tree Ordinance.

9. Create an Urban Forestry Master Plan: The City and County should create an Urban Forestry Master Plan which establishes a vision and sets long and short term goals for accomplishment. This Plan could include a periodic tree and canopy survey and tree management database. The City has an Urban Forestry Master Plan from the 1980s that could serve as a model but needs updating.

10. Pursue Local Historic Designations: Encourage the City and County to designate eligible City and County-owned properties as historic districts/properties.

11. Easements: Encourage local non-profits to actively pursue conservation easements, specifically targeting properties identified in the Resource Database.

12. Establish Funding Strategy for the Resource Protection Commission: Develop a long-term funding strategy for the Chatham County Resource Protection Commission. This Commission is tasked with protecting sites of ecological and historical value through fee-simple purchase, easements, etc. County-wide.

13. Education/Outreach: Encourage local non-profits to conduct education and outreach campaigns promoting natural and historic resources.

**Flood Risk Mitigation Plan (FEMA)**

To read full report, visit:
http://engineering.chathamcounty.org/Portals/Engineering/forms/floodzones/flood%20mitigation%20plan.pdf

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*All photos in this report were taken by the Savannah Tree Foundation or Plan-It Geo.*