A Compilation of Urban Tree Studies

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Acknowledgements

The Urban & Community Forestry Financial Assistance Program administered by the Georgia Forestry Commission has funded a number of tree canopy studies, community tree inventories, and CITYgreen® analysis in the past 10 years. Similar studies have been conducted across the United States. Until this time, a complete synopsis of Georgia's studies, compared to those from across the U.S. has not been compiled. This document is an informational and educational tool intended to serve as a valuable resource for communities that are just beginning to manage their community forests.

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Table of Contents

Introduction

More than sixty percent of Georgia's citizens live within an urban area. These citizens greatly benefit from the trees that grow in Georgia's communities. Trees have many benefits. They provide oxygen, filter air and water, reduce water runoff, increase property values, and provide habitat for urban wildlife, just to name a few.

Tree inventories, CITYgreen® analyses and tree canopy studies are three methods used to measure the quantity and quality of the trees within urban forests. Each method requires unique procedures, measures different parameters and provides its own conclusions. However, each method is useful within certain guidelines.

A tree inventory gathers information about individual trees within a given area. The immediate purpose of this type of study is to determine the characteristics and needs of the trees, while the long term purpose is to develop a management program for the urban forest. The data is gathered through field inspections of trees.

CITYgreen® analyses map the urban ecology and measure the economic benefits of trees and green space. The purpose of this type of study is to attach real dollar values to tree cover benefits. CITYgreen® gathers information from aerial photographs and field inspections.

A tree canopy study measures the amount of area that is covered with a tree canopy. Tree canopy can be visualized as the connectedness of the tops of trees (tree crowns) if you are looking down on the earth's surface from outer space. Streets and other infrastructure can be covered with tree canopy from this view. The main purposes for this type of study are to measure the change in canopy cover over time, and to make decisions to affect this change. This type of study uses satellite and/or aerial photographs that are analyzed by computers or manually.

The Georgia Forestry Commission, through grant funds provided by the USDA Forest Service Urban & Community Forestry Financial Assistance Program, has provided cities of all sizes from across the state of Georgia with funding to conduct tree inventories, CITYgreen® analyses and tree canopy studies. The findings from these grant projects are highlighted in this document.

Section 1

Street Tree Inventories

Street tree inventories catalog the quantity and quality of trees along public streets.

Street tree inventories are used for a wide variety of purposes. They help answer questions about the types of trees in the community and their condition, and give a better understanding of the urban forest resource. Conducting a tree inventory is the first step to moving from a reactive management program to a comprehensive urban forest management program.

An inventory typically requires the counting of all trees within the public right-of way. For each tree, gather data pertaining to its species, diameter, location, health and maintenance needs. To be most effective, an inventory should be continually updated, and linked to a Geographic Information System (GIS). Inventories range in cost from a few thousand dollars to tens of thousands of dollars.

An inventory is ideal for communities that have:

- An existing street tree inventory in need of updating.
- A tree maintenance staff who wants to become more efficient and develop an inventory-based management program.
- A functional in-house Geographical Information System (GIS).
- Staff available to manage the data (as trees are planted, maintained or removed).

A sophisticated inventory can help:

- Improve your work scheduling and cyclical maintenance program.
- Improve your ability to respond to storm damage.
- Enhance your efficiency when responding to constituents' requests.
- Locate all trees of a single species, in case of a disease outbreak.

City of Ashburn, Georgia

Publication Title:

Urban Tree Management Program (Phase 1)
Urban & Community Forestry Grant 94-6

Publication Date:

1995

Partners:

Community Tree Board
Ashburn/Turner County Chamber of Commerce
Cooperative Extension Service
Turner County Farm Bureau's Women's Committee
Rose Garden Club
Boy & Girl Scouts
FFA
Kiwanis
Rotary
Local Businesses
Local Citizens
Technical Forestry Services – Consultant

Project Overview:

The city desired to begin a long-term comprehensive tree management program that was community based and sustainable. Ashburn had a population of 4,850 and was located in south central Georgia between State Highways 112, 32 and 159 and Interstate 75.

Major Findings and Activities:

A total of 1,960 trees and 471 planting spaces were inventoried. There were a total of 75 different species with Dogwood (26%), Southern Pines (22%) and Crapemyrtles (14%) being the most common. Of the recommended management activities, 173 live and 19 dead trees were recommended to be removed. The total value of the urban forest was estimated to be $1,773,544.

Methodology:

An Urban Forest Development Plan was developed by an urban forestry consultant. This plan has four main components: develop an urban tree program structure; involve the community; educate the public, city officials and employees

and the tree board; and develop long-term, stable funding.

The first phase included the inventorying of a Street and Park Tree Inventory. This inventory provided the tree board with a current assessment of the community trees.

Cost of Study:

Total Project	**$16,376**
Consultant	$6,200
Personnel	$7,800
Supplies	$2,376

The cost to complete the inventory was $4,736.00, which was cash paid to the consultant.

Time to Conduct Study:

This project was completed in four months.

City of Athens – Clarke County, Georgia

Publication Title:

Athens – Clarke County, Street Tree Inventory – Phase I, II, III, IV
Urban & Community Forestry Grant # 94-7, # 95-53

Publication Date:

1992 - 1996

Partners:

Athens – Clarke County
Urban Tree Advisory Committee
Dudley Hartel, Consulting Urban Forester

Project Overview:

This project was started in 1992 with a sample inventory to estimate the total number of trees and the number of hazardous trees. The trees throughout the city including rights-of-way and parks were inventoried.

Major Findings:

In Central City Park, 422 trees were inventoried. Flowering Cherry trees comprised the largest species (37.44%). No other species was over 10%. The majority of the trees were less than 12" DBH and 70% of the trees were in the 71-80 condition class.

In Tatnall Square Park, 285 trees were inventoried. Crepe Myrtles comprise 27% and Southern Magnolias comprised 24%. No other species was over 10%. As the size of the trees increased, the number of trees decreased. Over 25% of the trees were 2" DBH or less and 70% of the trees were in the 71-80 condition class.

For the whole city, a total of 10,144 trees were inventoried. Dogwood (24%), Water Oak (15%) and Loblolly Pines (5%) were the most common. Of the recommended management activities, 265 live and 97 dead trees were recommended to be removed.

Methodology:

An urban forestry consultant firm was hired to conduct the inventory.

Cost of Study:

	1994	1995
Data Collection	$10,000	$4,000
Administration	$950	$1,777
Supplies		$300
Overhead	$1,314	$729
Total	$12,264	$6806

Time to Conduct Study:

This inventory was completed during a five year period.

City of Avondale Estates

Publication Title:

City of Avondale Estates Tree Inventory & Management Plan
Urban & Community Forestry Grant # 94-11

Publication Date:

1994

Partners:

City of Avondale Estates
Arborguard Tree Specialists

Project Overview:

The city trims, removes and replaces the trees on public properties and rights-of-way, but on a haphazard basis. The city desired a system whereby they have a complete assessment of all of the public trees and available planting spaces. The inventory covered all city streets and parks.

Methodology:

A local firm of arborists prepared the survey, format and incorporated specifics concerning survivability, site problems, pests, and diseases. Each tree was tagged, measured and inventoried. A report including field data, species and size distribution, species characteristics, condition, form, problems and conditions was prepared. City staff assisted with data input and tree evaluation.

Cost of Study:

Item	**Cost**
Data Collection	$14,000
Data Entry	$1,000
Total	$15,000

Time to Conduct Study:

The original inventory took six months to complete.

City of Macon, Georgia

Publication Title:

City of Macon Shade Tree Inventory (Phase III and IV)
Urban & Community Forestry Grants # 94-41, #95-53

Publication Date:

1994, 1995

Partners:

City of Macon

Project Overview:

The City of Macon started a street tree inventory in 1992. The City of Macon has a city forester on staff. Macon has a total of 525 miles of streets and an estimated 84,000 tree sites (170 sites per mile).

Major Findings:

An additional 4100 trees were inventoried.

Methodology:

The city forester conducted the inventory with the assistance of the Public Works Department. The data inventoried included: location, tree species, size class, condition rating, and maintenance needs. It took an average of 5 minutes to assess each tree or site.

Cost of Study:

Item	**1994**	**1995**
Data Collection (Consultant)	$14,000	$4,000
City Personnel	$1,000	$1,777
Supplies		$300
Overhead (12%)		$729
Total	$15,000	$6,806

Time to Conduct Study:

The inventory took a total of 2 months to complete for each year.

City of Acworth, Georgia

Publication Title:

Tree Maintenance and Inventory
Urban & Community Forestry Grant # 95-2

Publication Date:

1995

Partners:

City of Acworth
Local Volunteers

Project Overview:

The City of Acworth has planted many trees throughout the years. Many of these trees were planted in recreational areas and other public

Methodology:

The city used city employees and volunteers to compile the inventory. They collected the following data: tree species, location, condition and date planted. This information was entered into a computer program.

Cost of Study:

Item	**Cost**
Data Collection	$270
City Personnel	$3,330
Supplies	$400
Overhead	$102
Total	$4,102

Time to Conduct Study:

The inventory took a total of 6 months to complete for each year.

County of Chatham, Georgia

Publication Title:

Chatham County Urban Forest Inventory
Urban & Community Forestry Grant # 95-16

Publication Date:

1996

Partners:

Chatham County

Project Overview:

Chatham County developed an inventory of the existing urban forest. This inventory was compatible with their GIS System.

Methodology:

An urban forestry consulting firm was hired to conduct the inventory. A portable GPS unit was purchased. The county and consultant converted digitized tax parcel maps into street addresses.

Cost of Study:

Item	Cost
GPS Unit	$6,000
Tax Parcel Conversion	$2,750
Data Collection	$25,000
Computer	$2,500
Total	$45,250

Time to Conduct Study:

The inventory was completed in five months.

City of Hartwell, Georgia

Publication Title:

Street Tree Inventory
Urban & Community Forestry Grant # 95-43

Publication Date:

1996

Partners:

City of Hartwell
Garden Clubs of Hartwell
Hartwell / Hart County Clean & Beautiful
Hart County Schools
Technical Forestry Services

Project Overview:

The city desired to gather information about the number, composition, distribution and condition of the city's street trees. This information was used to begin a long-term management of the trees, including removal, replacement, planting, pruning and maintenance.

Major Findings:

A total of 1,606 observations were made, including 1,400 trees and 206 vacant planting sites. The trees and sites were relatively evenly distributed throughout the city. Water oaks represented 21% of all street trees. There were a total of 71 different tree species. Nearly one half of the trees were less than 9 inches in diameter. The largest tree was a 48" DBH Scarlet Oak.

A majority of the trees were in good condition and 33% were fair. At least 75 trees showed signs of dieback.

The most frequently recommended maintenance activity was pruning. A total of 568 trees required pruning. This pruning was concentrated on several streets. Twelve percent of the trees were recommended to be removed.

The urban forest was estimated to be valued at $1,141,571.

Methodology:

An urban forestry consulting firm conducted the inventory of all trees and vacant planting sites along the rights-of-way within the city limits. The data gathered

included: location, species, size, condition, management needs, tree/site descriptors and growth stage. The city provided maps, right-of-way width information, office space and volunteers.

Cost of Study:

Item	Cost
Grant Writing	$300
Data Collection	$3,388
Staff Support	$320
City Facilities	$100
“State of Trees” Brochure	$1,280
Volunteers	$130
Overhead	$662
Total	$6,180

Time to Conduct Study:

This inventory took two months to complete.

City of Savannah, Georgia

Publication Title:

Savannah Forest Inventory Conversion
Urban & Community Forestry Grant # 95-68

Publication Date:

1996

Partners:

City of Savannah Parks and Tree Department
City Forester
City Information Services Department

Project Overview:

The city developed an inventory of their existing urban forest. The data was used to assist in long-range planning.

Methodology:

A consulting firm was hired to conduct the inventory. This firm converted digitized tax parcel maps to street addresses, transferred existing data to a new software package and added new tree data.

Cost of Study:

Item	**Cost**
GPS Units	$11,780
Tax Parcel Conversion	$2,750
Data Collection	$30,000
Software	$15,170
Data Verification	$37,500
Total	$97,200

Time to Conduct Study:

This project took six months to complete.

City of Metter, Georgia

Publication Title:

Management of Metter's Tree Resource
Urban & Community Forestry Grant # 96-34

Publication Date:

1996

Partners:

City of Metter
Technical Forestry Services

Project Overview:

The city demonstrated a proactive approach to urban tree management by determining the number of trees within the city limits. The inventory covered the entire city and included hazardous trees and plantable spaces.

Major Findings:

More than 4,000 trees and 1,000 plantable spaces were inventoried. There were more than 900 hazardous trees identified for removal.

Methodology:

An urban forestry consulting firm identified and evaluated hazardous trees, management needs and vacant planting spaces. This data was inputted into a computer software system.

Cost of Study:

Item	Cost
Data Collection	$9,948
Labor	$6,140
Total	$19,088

Time to Conduct Study:

This project was completed in six months.

City of Valdosta, Georgia

Publication Title:

Street Tree Inventory – Phase I
Urban & Community Forestry Grant # 95-82

Publication Date:

1996

Partners:

Valdosta Parks, Recreation and Community Affairs Department
Technical Forestry Services

Project Overview:

Designated areas were surveyed and data collected about existing trees and vacant plantable areas. These areas were along high traffic routes and high visibility areas.

Major Findings:

A total of 1,472 observations were made, including 1,022 trees and 450 vacant planting sites. There were 908 street trees, 104 park trees and 10 trees at Mathis Auditorium. A third of the trees were Crape myrtles, another 14 % were Flowering Dogwoods. Southern Pines composed 11%. Over fifty percent of the trees were less than 8" DBH. The largest tree was a 59" DBH Live Oak. Over seventy percent of the trees were in good or fair condition.

Forty percent of the trees were vigorous and traffic/sight clearance was the needed by the greatest number of trees. There were 17 dead trees and 121 live trees that needed to be removed. There were no insect or disease problems noted.

The total value of the urban forest was estimated at $1,087,686.

Methodology:

A consulting urban forester collected information on the trees and planting spaces. Data that was collected included: location, species, diameter, condition, management needs, environmental factors, and growth stage. The tree data was inputted into a software package.

Cost of Study:

Item	Cost
Computer	$5,090
Software	$4,710
Data Collection (Consultant)	$3,012
Total	$12,812

Time to Conduct Study:

This project was completed in six months.

City of Duluth, Georgia

Publication Title:

Tree Inventory and “CITYgreen” Measures
Urban & Community Forestry Grant # 97-13

Publication Date:

1998

Partners:

City of Duluth
Duluth High School
- National Honor Society
- Key Club
- Interact

Local Citizens

Project Overview:

The city desired to assess the trees and plantable spaces along rights-of-way, within parks, on private properties and along a greenway.

Methodology:

An urban forestry consulting firm inventoried all significant trees within the rights-of-way. The consultant trained city employees who in turn trained volunteers to inventory trees in city parks and on private properties.

Cost of Study:

Item	**Cost**
Personnel	$7,820
Computer	$3,800
Software	$2,950
Aerial Photography	$1,600
Supplies	$2,500
Consultant	$4,000
Overheard (12%)	$2,288
Total	$24,958

Time to Conduct Study:

The project took six months to complete.

City of Milledgeville, Georgia

Publication Title:

Historic Downtown Tree Inventory and Maintenance Master Plan
Urban & Community Forestry Grant # 98-37

Publication Date:

1998

Partners:

City of Milledgeville
Tree Board
Technical Forestry Services

Project Overview:

The downtown area was a National Register Historic District and a Local Historic District. A preliminary count estimated that there were 1,200 trees in this area. A long range plan for this area was needed.

Major Findings:

A total of 1,913 trees and 489 planting spaces were inventoried. There were a total of 93 different species with Dogwood (25%), Crapemyrtles (13%) and Water Oak (8%) being the most common. The average diameter of all trees was 12 inches. Of the recommended management activities, 191 live and 28 dead trees were recommended to be removed. The total value of the urban forest was estimated to be $5,831,798.

Methodology:

An urban forestry consultant completed the inventory and inputted the data into a software system.

Cost of Study:

Item	**Cost**
Data Collection (Consultant)	$6,500
Education	$1,500
Plantings	$2,000
Total	$10,000

Time to Conduct Study:

The project took six months to complete.

City of Oxford, Georgia

Publication Title:

Community Tree Inventory and Community Tree Program
Urban & Community Forestry Grant # 98-41

Publication Date:

1998

Partners:

City of Oxford
Oxford College of Emory University
The Oxford's Women's Club
City of Oxford Beautification Committee
The Amitie Club

Project Overview:

The City of Oxford needed baseline information about their public trees. This information was used to begin a community tree management program.

Major Findings:

A total of 1,592 trees and 201 planting spaces were inventoried. There were a total of 77 different species with Water Oak (15%), Dogwood (15%) and Crapemyrtles (7%) being the most common. The average diameter of all trees was 13 inches. Of the recommended management activities, 169 live and 17 dead trees were recommended to be removed. The total value of the urban forest was estimated to be $4,073,362.

Methodology:

A part-time consulting urban forester inventoried the trees within the rights-of-way. The data was inputted into a computer software system. Management of the trees began after the data was compiled and management plan was written.

Cost of Study:

Item	**Cost**
Data Collection (consultant)	$2,250
Tree Management (consultant)	$4,800
Pruning and Removals	$4,000
Personnel	$4,025
Total	$15,075

Time to Conduct Study:

The project took six months to complete.

City of Darien, Georgia

Publication Title:

Community Tree Inventory & Management Program
Urban & Community Forestry Grant # 98-12

Publication Date:

1998

Partners:

City of Darien
McIntosh County Board of Commissioners
Coastal Georgia Regional Development Center
Historic Preservation Commission
Darien Chamber of Commerce
Technical Forestry Services

Project Overview:

The city gathered information about their public trees and prioritized a maintenance plan.

Major Findings:

A total of 1891 trees and 546 planting spaces were inventoried. There were a total of 60 different species with Live Oak (21%), Laurel Oak (11%) and Southern Pines (10%) being the most common. The average diameter of all trees was 13 inches. Of the recommended management activities, 339 live and 26 dead trees were recommended to be removed. The total value of the urban forest was estimated to be $5,723,141.

Methodology:

An urban forestry consulting firm inventoried the city trees and developed a priority system for tree work, maintenance standards and brochures. The consultant was assisted by city employees and volunteers.

Cost of Study:

Item	**Cost**
Inventory (consultant)	$3,600
Management Plan	$800
Brochures	$1,670
Assistance	$6,642
Total	$12,712

Time to Conduct Study:

The project took seven months to complete.

City of Newborn, Georgia

Publication Title:

Town Tree Inventory and Town Tree Program
Urban & Community Forestry Grant # 99-34

Publication Date:

1999

Partners:

Newborn Tree Board
City of Newborn
Friends of Newborn

Project Overview:

The Town of Newborn began a comprehensive town tree program with a street tree inventory, management plan and tree ordinance.

Major Findings:

A total of 396 trees and 255 planting spaces were inventoried. There were a total of 40 different species with Water Oak (18%), Crepe Myrtle (14%) and Willow Oak (10%) being the most common. The average diameter of all trees was 13 inches. Of the recommended management activities, 26 live and 3 dead trees were recommended to be removed. The total value of the urban forest was estimated to be $1,157,663.

Methodology:

An urban forestry consulting firm completed the inventory with the assistance of city employees and volunteers. The tree board set standards and specifications for tree maintenance activities. The city began managing their urban forest resource.

Cost of Study:

Item	Cost
Inventory (consultant)	$3,200
Pruning and Removal	$1,200
Assistance	$2,275
Total	$6,675

Time to Conduct Study:

The project took six months to complete.

City of Rhine, Georgia

Publication Title:

Pondtown Forestry Management Plan
Urban & Community Forestry Grant # 99-41

Publication Date:

1999

Partners:

Rhine Ladies Club
Rhine Recreation Committee
Rhine Volunteer Fire Department
Local Churches

Project Overview:

The city desired a tree inventory and ordinance that would identify existing trees on city rights-of-way as well as develop a plan for future management and plantings. The city proposed to plan additional trees in identified vacant planting spaces.

Methodology:

An urban forestry consulting firm inventoried the trees located on city rights-of-way. Tree species, size and condition were recorded for each tree. GPS coordinates were used to accurately record the location of each tree. A tree ordinance was written to protect existing trees and require new trees to be planted.

Cost of Study:

Item	**Cost**
Data Collection (Consultant)	$5,000
Tree Planting	$5,000
Total	$10,000

Time to Conduct Study:

The project took ten months to complete.

City of Washington, Georgia

Publication Title:

Tree Inventory 2000
Urban & Community Forestry Grant # 00-39

Publication Date:

June 7, 2001

Partners:

University of Georgia Forestry School
Georgia Forestry Commission
City of Washington
Dudley Hartel, Consulting Urban Forester

Project Overview:

The city had an old tree inventory that was outdated. The new inventory would locate, identify and map the existing trees.

Major Findings:

A total of 1,746 trees were inventoried. Approximately 491 of these trees were along city streets and 1,255 were located on other property owned or managed by the city. Tree condition, diameter distribution and expected lifecycle were above average for the majority of the trees. This was influenced by the number of trees that were growing in low impact areas, cemeteries, parks and historic sites. Many of trees growing along the streets were in poor condition and had less than ideal diameter distributions.

Methodology:

Two University of Georgia forestry students assisted a consulting urban forester inventory the trees on Washington's main streets and city properties. Measuring equipment was borrowed from the Georgia Forestry Commission. The data was downloaded and stored at the City's Electric Department.

The following data was collected: location, species, diameter, height, condition, hazards, life cycle, management recommendations, pruning recommendations, mulching recommendations, damage, rooting area, utilities, number of stems and GPS Coordinates.

Cost of Study:

Item	Cost
Data Collection	$5,000
Travel	$1,000
Supplies	$1,000
Equipment	$1,000
Overhead	$960
Total	$8,960

Time to Conduct Study:

The project took six months to complete.

City of Powder Springs, Georgia

Publication Title:

Inventory for Planning, Preservation and Protection of Trees
Urban & Community Forestry Grant # 01-22

Publication Date:

2001

Partners:

City of Powder Springs
Local Citizens
Local Schools,
Keep Powder Springs Beautiful Committee
Downtown Development Authority
Powder Springs Development Authority
Friends of the Trails
Ford Board Committee
Planning and Zoning Committee

Project Overview:

An inventory was needed to develop a management plan of the city's trees. This inventory was conducted along primary and secondary arterial roads. The tree data was used by the consulting architectural firm of Post, Buckley, Shuh and Jernigan in the development of the city's master plan. The city limits of Powder Springs encompasses approximately 25 square miles.

Methodology:

The inventory was designed by the city's consulting arborist who also trained volunteers to collect the data.

Cost of Study:

Item	**Cost**
Inventory Design (Consultant)	$3,300
Data Collection	$3,278
Supplies	$350
Transportation	$50
Total	$6,978

Time to Conduct Study:

The project took four months to complete.

Analysis and Comparison of Tree Inventories

While these tree inventories were conducted for many different reasons and by different procedures, there are some striking similarities. In most cities, the majority of the trees were of only two or three species. These species were mostly dogwoods, crape myrtles and oaks. This can prove to be devastating if the city experiences an insect or disease outbreak that attacks those particular species.

The average age of the trees is increasing and the average condition of the trees is decreasing. As these trees decline and die, they are being replaced with smaller, flowering trees that do not produce the large canopies of the trees being removed. These actions will change the aesthetics and character of the city.

The majority of the cities have large number of vacant planting spaces and significant numbers of living and dead trees that need to be removed. When adding the current planting spaces to the planting spaces that will be created when those trees are removed, cities have numerous areas where trees can be planted.

The value of the urban forests within these cities is very significant, even when compared to other municipal assets. The trees are a part of the urban infrastructure and city leaders need to adequately fund the management of them.

While most cities were very efficient with the grant funds that they received, very few contributed any cash to the inventory project. Urban forestry consultants and volunteers inventoried the majority of the trees. City employees aided the projects with support and administration.

Most of the cities have not updated the inventory since they were completed. Data for some cities could not be obtained. The information gathered during these studies can prove to be very beneficial to the efficient management of the urban forest if it is updated and reviewed periodically.

Notes:

Section

2

CITYgreen® Analyses and Tree Canopy Studies

CITYgreen® analyses and Tree Canopy Studies map the urban ecology and measure the economic benefits of trees and green space.

CITYgreen® is a Geographic Information System (GIS) application for land-use planning and policy-making and is marketed by American Forests. It is an application for *Arcview*® for Windows, the most widely-used desktop GIS software. The software conducts complex statistical analyses of ecosystem services and creates easy-to-understand maps and reports. CITYgreen® calculates dollar benefits based on your specific site conditions.

CITYgreen® analyzes**:**

- Stormwater Runoff
- Air Quality
- Summer Energy Savings
- Carbon Storage and Avoidance
- Tree Growth

With CITYgreen®, you can take advantage of natural systems to produce the maximum economic benefits for your growing community. CITYgreen® uses the most up-to-date scientific research to calculate the dollar value of trees and vegetation.

CITYgreen® creates:

- Broad regional studies or detailed small site assessments
- Ecological maps revealing the value of resources
- Models for future growth
- Colorful, easy-to-understand presentations
- Automatic reports that summarize key findings

Tree Canopy can also be measured using aerial photographs and satellite imagery. The amount of cover can be measured manually by using dot grids and planimeters, or with the use of computer programs.

City of Alpharetta

Publication Title:

Alpharetta Tree Cover / Storm Water Study
Urban & Community Forestry Grant # 97-23

Publication Date:

August 2001

Partners:

City of Alpharetta
Engineering Department, City Arborist, Environmental Services
Alpharetta Clean and Beautiful
Dudley Hartel, Consulting Urban Forester

Project Overview:

A study of Windward, a residential and commercial development, was conducted to determine the effect of tree cover on stormwater runoff characteristics. The Windward community is a 3,300 acre mixed use development located east of Georgia 400 in Alpharetta. Windward was selected for this study because of the fast pace of development during the past 10 years.

Major Findings:

When evaluating the stormwater benefits provided by trees, it is apparent that young trees provide very few significant benefits during the first 15 years of establishment. While other environmental benefits may accrue from young trees, stormwater benefits are only derived from crown size and density. Taking species characteristics into account, most species do not begin to provide stormwater benefits until 15 years after establishment.

Recommended activities to improve future quantification of tree resource for preservation and tree planting in Alpharetta:

- maintain growth data for commonly planted tree species; include measurements important for crown density
- based on measurements and observations of growth, make changes to "Recommended Tree Species" lists used with ordinances or education
- encourage development design that retains groups of mature trees in otherwise "buildable" areas,
- when tree planting is necessary (required), encourage groups of trees that will create overlapping and therefore denser crowns,
- encourage developers and homeowners to use tree planting sites to their

fullest advantage (i.e. discourage the planting of small flowering trees where the site will support large maturing trees like oaks)

Methodology:

GIS data for the location map was taken from the Atlanta Regional Commission CD-ROM provided to the City of Alpharetta. The City of Alpharetta provided an AutoCAD drawing file of the Windward development. Layers of interest for this study were extracted and converted to *Arcview*® shapefiles for the study.

The watershed boundary was digitized from a map provided by the City of Alpharetta. This was accomplished by scanning the map, registering it with the base map infrastructure and then digitizing from the screen within *Arcview*®. Sampling locations used by Environmental Services for water quality testing were digitized from a map provided.

Pre-development (1972) aerial photography was obtained from the University of Georgia Science Library. Black and white photographs at a 1:20,000 scale were scanned at 300 DPI as TIF images for use with *Arcview*®.

The images were registered to the Windward infrastructure drawing provided by the City of Alpharetta. The primary infrastructures used were streets and streams within the development area. The software program, *The Geographic Transformer Version 3.07* (Blue Marble Geographics), was used for all image registration.

Post-development (i.e. current, 1997) aerial photography was purchased from Georgia Aerial Surveys, Inc. of Smyrna, Georgia. Black and white photography at a scale of 1:7920 was scanned at 300 DPI. Pre-development and post-development land cover was digitized within *Arcview*® using the CITYgreen® extension and methodology. The resulting land cover percentages were entered into the CITYgreen® Off-Site program which is an implementation of TR-55 (NRCS).

Tree canopy was then digitized from 1999 DOQQ's and subtracted from the pervious component to determine the grass landcover for these two areas. Various custom tools have been used to complete this tree canopy study. The primary set of "tools" was obtained from the Oregon Department of Forestry. Their *Arcview*® extension, Xtools™ provides GIS functionality and analysis.

Cost of Study:

Item	**Cost**
Consultant	$12,500
Software	$1,800
Water Monitoring and Testing	$16,510
Maps	$3,000
Labor	$2,675
Total	$36,485

City of Griffin

Publication Title:

Stormwater Characteristics of a Griffin Watershed
Urban & Community Forestry Grant # 96-21

Publication Date:

September 25, 1997

Partners:

City of Griffin
Dudley Hartel, Consulting Urban Forester

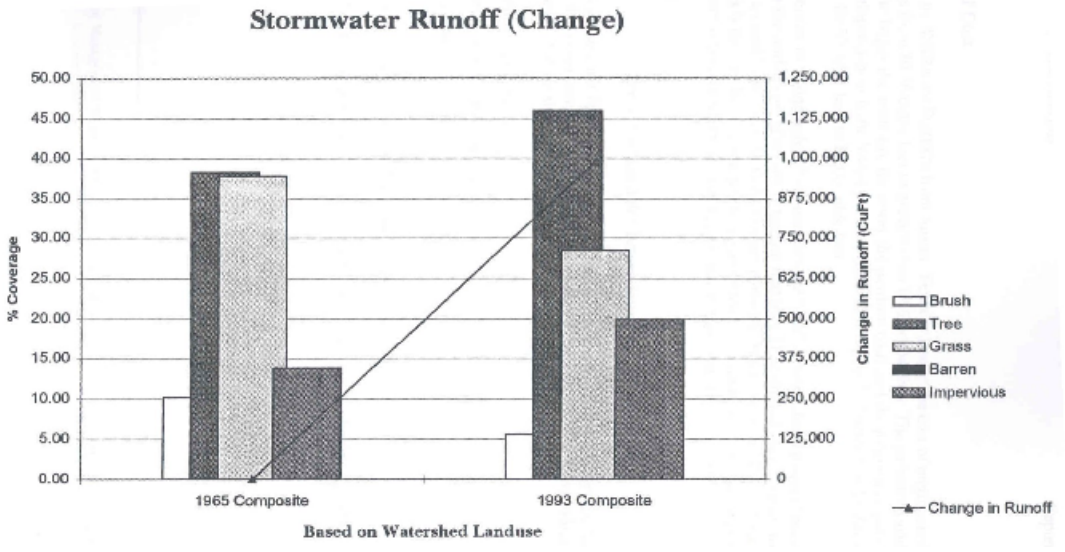
Project Overview:

A study of a 1778 acre watershed was conducted to determine the effect of tree cover changes from 1965 through 1993 on stormwater runoff characteristics.

Major Findings:

In older, residential neighborhoods, tree growth and replacement were significant contributors to the reduction of stormwater runoff. This reduction, within these stable landuses, significantly reduced the overall watershed increases from industrial and residential development.

The study supports the use of a "ground cover" based index for the establishment of a fee structure for stormwater management and treatment in the future. A "ground cover" indexed fee provides additional incentive to property



owners and developers to retain and manage tree cover and other vegetation that significantly reduces stormwater runoff.

The study further indicates the importance of long-term programs for the management of the public and private urban forest within Griffin. By expanding and maintaining a healthy urban forest, the City can compensate for continued development within the watershed that typically has an adverse effect on stormwater runoff and characteristics.

Methodology:

The land use was delineated based on similarity of the ratios among impervious surfaces, tree canopy, grass and other vegetation. These were the primary TR-55 parameters that affect stormwater runoff.

Aerial photography from NRCS on a scale of 1:20,000 was scanned at 300 DPI from black and white contact prints. The availability of the photography determined the selection of the base year, 1995. This base year also met the requirement that significant development and other landscape changes be represented over the study timeline.

The base year was compared to 1993 photography obtained for BEI Aerial Mapping. These photographs were at a scale of 1:22,800 and scanned at 300 DPI. GIS layers for streets, water bodies and political boundaries were obtained from the McIntosh Trail Regional Development Center. A 25-year, 24-hour storm event or 6.75 inches of rain was used.

Cost of Study:

Item	**Cost**
Consultant	$12,000
Aerial Photos and Maps	$8,000
Software	$2,500
Labor	$4,000
GPS Unit	$1,000
Total	$27,500

Time to Conduct Study:

This study was completed in 24 months.

City of Athens, Georgia

Publication Title:

Development Design and Stormwater Characteristics,
Community Forest and Change Analysis
Urban & Community Forestry Grants # 96-50, 00-1

Publication Date:

September 24, 1997, August 17, 2001

Partners:

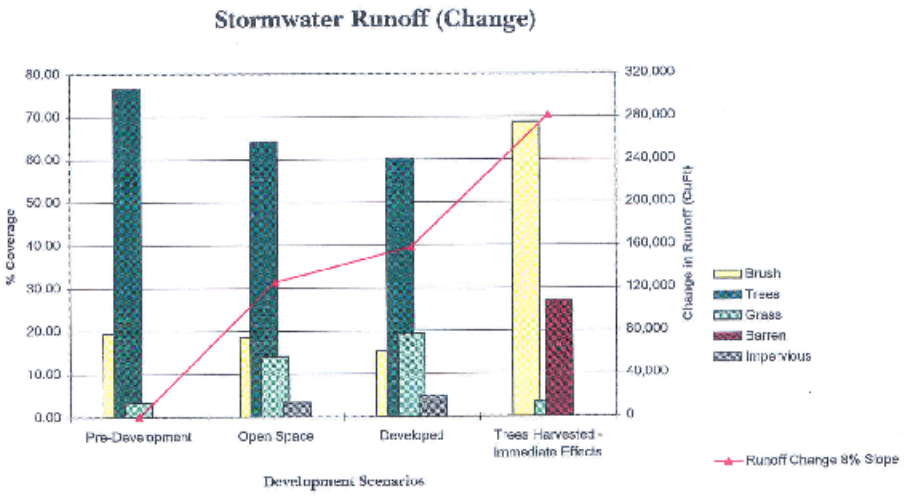
The University of Georgia Research Foundation, Inc.
Athens-Clarke County Urban Tree Advisory Committee
USDA – Forest Service – Southeastern Forest Experiment Station
Unified Government of Athens-Clarke County – Landscape Management Division
Northeast Georgia Regional Development Center
Dudley Hartel, Consulting Urban Forester
Kimberly Patton, ASLA – Rick Raymond and Associates
Natural Resource Technologies
Bob Barker and Associates

Project Overview:

The first project was a study of residential and commercial developments was conducted to determine the effect of tree cover on stormwater characteristics. The second project was a study of changes in tree composition, distribution and condition over a 20 year period.

Major Findings:

When tree and other vegetation were retained on developed sites, stormwater runoff volume was reduced. The volume of this reduction was dependent upon the percentage of the development that was affected by the design



changes and construction practices that favor retention of vegetation. There were other benefits, including: reduced erosion, reduced transport of sediments, reduced transport of pollutants, stormwater time of concentration increased, increased infiltration, evaporation and filtering and reduction in peak flow.

The amount of major forest cover types increased from 23 percent in 1980 to 56 percent in 2000. In the urban residential settings, many areas were classed as scattered, light pine or pine-hardwood.

Methodology:

For the first project, four study areas were selected for the analysis. Study sites ranged in size from 6.8 acres to 123 acres. Several development scenarios were analyzed for each study area, including: pre-development conditions, immediate effects of harvesting existing trees, development under current zoning and open space design characteristics.

Predevelopment scenarios were estimated from on-site inspections and aerial photographs. Harvesting scenarios were developed based on density of timber and knowledge of local logging practices. The developed scenario was based on planning and zoning documents. Ms. Patton developed the open space design for three residential sites. A 25-year, 24-hour storm event (6.75) was used.

For the second project, aerial photography was purchased from the years 1980, 1990 and 2000. The amount of cover by class was determined for each set of photographs. The cover types and amounts were compared and changes were noted.

Cost of Study:

Item	**1996**	**2000**
Research Labor	$7,800	$9,600
Supplies	$2,545	$23,300
Overhead	$1,230	$2,832
Total	$11,575	$35,632

Time to Conduct Study:

Each project in this study was completed in 12 months.

City of Macon, Georgia

Publication Title:

Urban & Community Forestry Grant # 97-37, 98-34, 99-30

Publication Date:

August 27, 1998, July 30, 1999, August 15, 2000

Partners:

City of Macon
Bibb County
Trees for Macon
Keep Macon Bibb Beautiful Commission
Pacific Meridian Resources

Project Overview:

The city and county combined to assemble and analyze data to demonstrate changes in land cover and tree canopy and to estimate the stormwater benefit derived from the trees.

Major Findings:

The City of Macon has seen considerable growth and development during the past decade. This growth has had a significant impact on Macon and Bibb County's urban forest lands, resulting in a net loss of approximately 4,000 acres of vegetation from 1985 to 1997, including almost 500 acres of forest land.

The average tree health rating was midway between fair and good. Trees having the best health were found in areas that had been newly developed. Trees in highly developed areas with large amounts of impervious surfaces had the lowest health rating.

The existing tree canopy saved homeowners from $16 to $69 in summer cooling costs in residential areas, with an average of about $38 per home. The greatest savings were found in the study site with the highest tree canopy percentage, although high tree canopy percentages did not always correlate to significant energy savings.

The trees in all study sites produced approximately $1,200 in annual pollution removal benefits. The existing tree in all the sites also store over 235 tons of carbon, sequestering about 1300 pounds of carbon per year. The estimated value of the sequestered carbon for all study areas is approximately $616 per year. Sites that had the most biomass had the greatest air quality benefits.

The existing tree canopy of all the study sites reduced the volume of stormwater runoff by an average of 23 percent when compared to areas with no tree cover. Similarly, the peak flow rates were also reduced by an average of 29 percent for all sites when compared to land with no trees. Sites having the very little vegetation and large amounts of impervious surfaces had the highest runoff volumes and peak flow rates.

Projecting the results across the total area of Macon and Bibb County indicates that the existing urban forest lands in Macon save the city and its residents over $2.7 million annually, an average of $256 per acre for commercial and residential areas. Tree in the commercial and residential areas of Bibb County produce almost $7.5 million per year in savings, an average of almost $300 per acre. Based on the acres of vegetation lost from 1993 to 1997, the City of Macon lost over $9,000 in urban forest benefits during this period. The savings lost by Bibb County totaled approximately $105,000 from the loss of almost 650 acres of vegetation during the study period. The findings for Bibb County include the total area of Macon.

Methodology:

Current and historical satellite images were use to determine the land cover and tree canopy. SPOT multi-spectral data was available for 1986 to 1997. A Normalized Difference Vegetation Index (NDVI) was prepared for the images used by CITYgreen. Data from 1986, 1991 and 1997 were used. The major land cover types used were deciduous forest, evergreen forest, mixed forest, impervious surfaces, other vegetation and water.

Cost of Study:

Item	**1997**	**1998**	**1999**
Satellite Imagery	$7,300	$2,200	$5,000
Analysis	$5,000	$1,500	$12,500
Presentation of Data	$ 850	$1,500	$2,500
Total	$13,150	$5,200	$20,000

Time to Conduct Study:

The project was completed in eight months each year.

City of Forest Park, Georgia

Publication Title:

Urban Ecosystem Analysis – Forest Park, Georgia
Calculating the Value of Nature
Urban & Community Forestry Grant # 99-13

Publication Date:

July 2000

Partners:

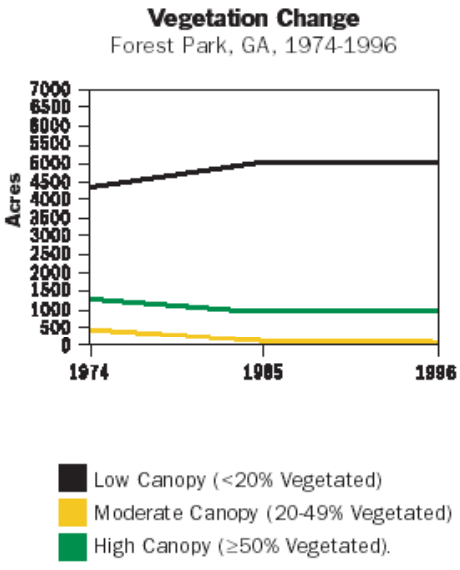
American Forests
City of Forest Park

Project Overview:

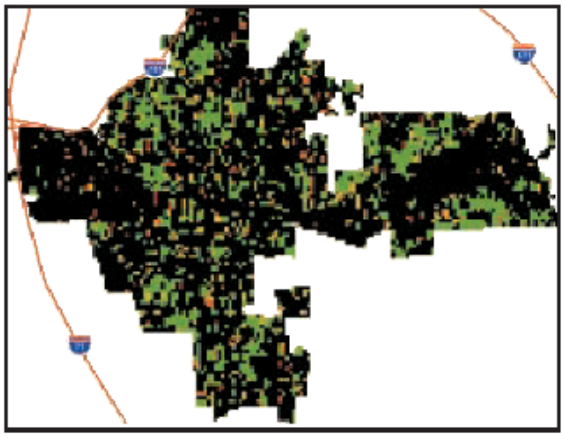
The City of Forest Park is less than five miles from Hartsfield – Atlanta International Airport. This proximity to the airport has made Forest Park a major freight terminal. The high traffic load and freight facilities has made this area a large heat island and increased the air and noise pollution. The study area consisted of 6,088 acres and for a period from 1974 to 1996.

Major Findings:

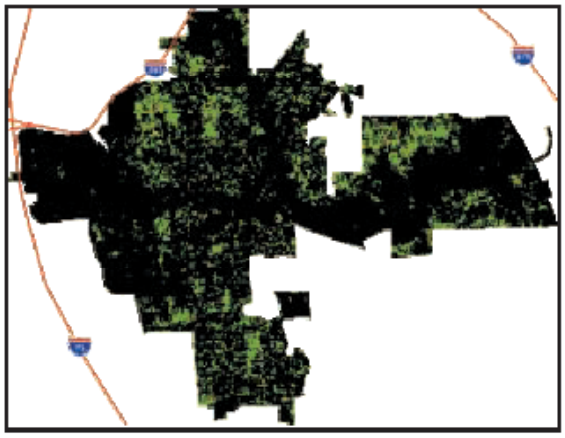
The average tree canopy density declined from 22% in 1974 to 17% in 1996. In 1974, areas with heavy canopy covered 21% of the area and developed areas covered 71%. In 1996, areas with low tree canopy became more prevalent, expanding to 83% of the land area or an increase of 17%. Heavy tree canopy declined by 26% to only 26% of the total land area.



From 1974 to 1996, tree loss resulted in a 28% increase in runoff and would require a stormwater system equivalent in value to a $4.5 million system.
The stormwater retention capacity was reduced from $15.8 million in 1974 to $11.3 million in 1996. The loss of tree canopy reduced the amount of pollutants that could have been removed by 37,000 pounds. The residential summer energy saving is estimated to be $339,000 annually.



Landsat MSS 1974 80 Meter Pixel Resolution



Landsat TM 1996 30 Meter Pixel Resolution

Methodology:

Satellite data from 1974 and 1996 were used in this study. These images were selected because of their atmospheric clarity and time of year. Landsat satellite TM (30 meter pixel) and MSS (80 meter pixel) images were used as the source of land cover data. This data was refined using a subpixel classification technique so that nine vegetation categories were obtained. Geo-rectified .tif images (aerial photographs) on a 2 foot resolution were used for the local analysis.

US National Resources Conservation Service (NCRS) Technical Release 55 (TR-55) formulas were used to calculate stormwater runoff. The Urban Forest Effects (UFORE) model was used to estimate the amount of ozone, sulfur dioxide, nitrogen dioxide, PM 10 and carbon monoxide. The CITYgreen avoided carbon module calculated the amount of energy savings, which was multiplied by Energy Information Administration (EIA) data for state-level fuel sources used in electricity production.

Cost of Study:

Item	**Cost**
Ecosystem Analysis (American Forest)	$30,000
Management Strategy (consultant)	$14,880
Overhead	$6,120
Total	$51,000

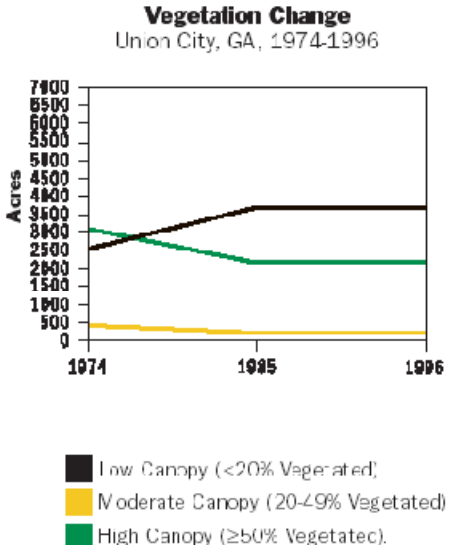
Time to Conduct Study:

The project took nine months to complete.

City of Union City, Georgia

Publication Title:

Urban Ecosystem Analysis – Union City, Georgia
Calculating the Value of Nature
Urban & Community Forestry Grant # 99-54



Publication Date:

July 2000

Partners:

City of Union City
Bron Cleveland Associates, Inc.
American Forests

Project Overview:

The City of Union City was located 15 miles from downtown Atlanta and adjacent to Interstate 85. Union City was challenged with rapid encroachment of development and was looking to develop a strategy that will embrace smart growth and preserve green spaces and forest resources. Large commercial areas and strip malls have created air and noise pollution. Protecting and expanding the existing urban forest is necessary for Union City to remain a pleasant place to live, work and visit.

Major Findings:

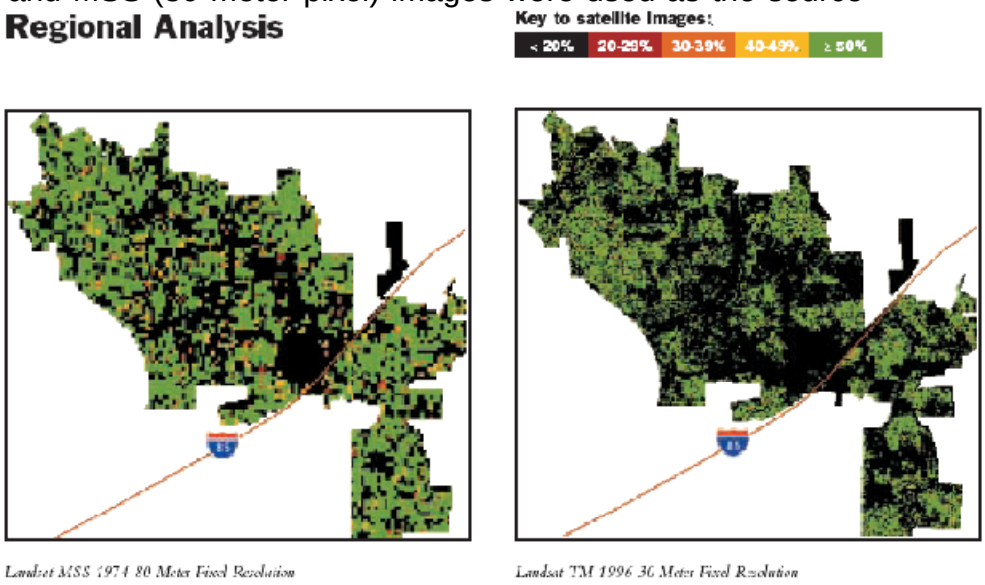
In 1974, areas with heavy tree canopy covered 51% of the area and developed areas covered 42%. By 1996, areas with low canopy became more prevalent, expanding to 61% and the heavy tree canopy declined by 30% to 36% of the study area.

From 1974 to 1996, tree loss in Union City resulted in a 29% increase in runoff or an estimated 2.8 million cubic feet of water. Using a cost estimate of $2.00 per cubic foot to build a stormwater system, this vegetation loss is equivalent in value to a $5.6 million system.

The total stormwater retention capacity of this urban forest cover in 1996 is valued at an estimated $13.7 million, down from 1974's value of $19.3 million, based on the avoided cost of having to mange the stormwater. The lost tree canopy would have removed about 56,000 pounds of pollutants. Union City's direct residential summer energy savings, as a result of trees shading homes, is estimated at $75,000 annually.

Methodology:

Satellite data from 1974 and 1996 were used in this study. These images were selected because of their atmospheric clarity and time of year. Landsat satellite TM (30 meter pixel) and MSS (80 meter pixel) images were used as the source of land cover data. This data was refined using a subpixel classification technique so that nine vegetation categories were obtained. Geo-rectified .tif images (aerial photographs) on a 2 foot resolution were used for the local analysis.



US National Resources Conservation Service (NCRS) Technical Release 55 (TR-55) formulas were used to calculate stormwater runoff. The Urban Forest Effects (UFORE) model was used to estimate the amount of ozone, sulfur dioxide, nitrogen dioxide, PM 10 and carbon monoxide. The CITYgreen avoided carbon module calculated the amount of energy savings, which was multiplied by Energy Information Administration (EIA) data for state-level fuel sources used in electricity production.

Cost of Study:

Item	Cost
Ecosystem Analysis (American Forests)	$30,000
Ordinance Revision (Consultant)	$12,240
Overhead and Administration	$5,760
Total	$48,000

Time to Conduct Study:

The project took six months to complete.

City of Denver and the Northern Front Range, Colorado

Publication Title:

Regional Ecosystem Analysis for Metropolitan Denver and Cities of the Northern Front Range, Colorado

Publication Date:

April 2001

Partners:

USDA – Forest Service
The Northern Front Range Ecosystem Analysis Advisors
ESRI for GIS Software
ERDAS for remote sensing software

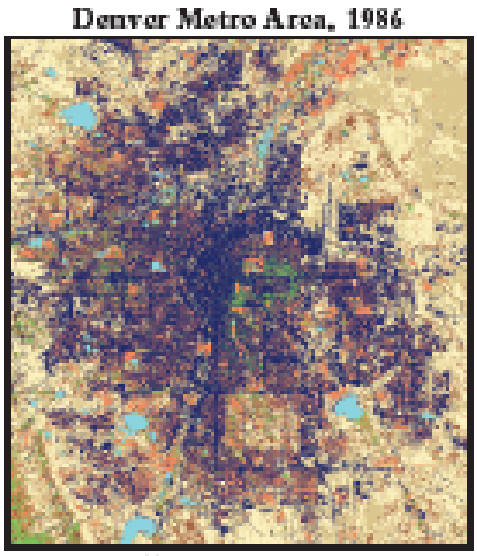
Project Overview:

The project area extended from the Denver metropolitan area on the south to Fort Collins on the north and determined how the landscape changed from 1986 to 1998. The study was done on three levels. A regional study (2.24 million acres) investigated the land use changes from 1986 to 1998.

Major Findings:

In 1986, impervious surfaces within the Denver metro area represented the largest percentage of land cover, 30% or 126, 559 acres. Grassland comprised 25%, non-irrigated cropland 19%, irrigated cropland 13%, wetlands 8% and forest land 4%.

By 1998, impervious areas had increased 31% and represented 39% of the area. Forest canopy increased 45% but still only represented 6% of the total land area. Grassland increased 12%, while wetlands decreased by 59% and irrigated



cropland by 22%.

In urban Denver, the current urban forest provides the equivalent value of a $21 million stormwater facility.

Table 3. Current Tree Canopy Benefits for Northern Front Range Study Cities[1]

	Urban Denver[4]	Boulder	Louisville	Ft. Collins	Greeley	Total
Acres	214,509	14,421	4,906	26,318	18,159	278,313
Stormwater Management one-time Value[2] (cubic ft.)	24,548,093	6,401,131	857,308	11,735,090	6,623,096	50,164,718
(U.S. Dollars)	$21,111,360	$5,504,972	$1,249,829	$10,092,178	$5,695,863	$43,654,202
Stormwater Management annually[3] (U.S. Dollars)	$1,533,717	$399,930	$90,799	$733,186	$413,798	$3,171,430
Air pollution Removal Value annually (lbs.)	1,095,725	258,401	41,672	333,349	430,735	2,159,882
(U.S. Dollars)	$2,600,401	$613,142	$308,769	$790,775	$1,031,338	$5,344,426
Total Carbon Stored (tons)	545,800	52,635	16,597	92,403	161,343	868,778
Carbon Sequestered annually (tons)	9,029	1,187	371	740	3,635	14,962

1. Numbers may not add to 100% due to rounding. Energy and avoided carbon values could not be calculated per city due to small sample size.
2. Represents a one-time savings, and does not include additional savings from annual maintenance.
3. Annual benefits are calculated on a stormwater management facility's construction costs, plus the cost of the loan or bond to finance construction (assuming a 6% interest rate for a 30 year lifespan of the facility).
4. Urban Denver includes Denver, Aurora, Lakewood, and Wheat Ridge.

Methodology:

Satellite data from 1986 and 1998 were used in this study. These images were selected because of their atmospheric clarity and time of year. Landsat satellite TM (30 meter pixel) and MSS (80 meter pixel) images were used as the source of land cover data. This data was refined using a subpixel classification technique so that nine vegetation categories were obtained. Geo-rectified .tif images (aerial photographs) on a 2 foot resolution were used for the local analysis.

US National Resources Conservation Service (NCRS) Technical Release 55 (TR-55) formulas were used to calculate stormwater runoff. The Urban Forest Effects (UFORE) model was used to estimate the amount of ozone, sulfur dioxide, nitrogen dioxide, PM 10 and carbon monoxide. The CITYgreen avoided carbon module calculated the amount of energy savings, which was multiplied by Energy Information Administration (EIA) data for state-level fuel sources used in electricity production.

City of Atlanta, Georgia

Publication Title:

Urban Ecosystem Analysis – Atlanta Metro Area – Calculating the Value of Nature
Urban & Community Forestry Grant # 94-3

Publication Date:

August 2001

Partners:

The Turner Foundation
Environmental Protection Agency
Department of Energy
Georgia Power
Trees Atlanta
ESRI for GIS software
ERDAS for remote sensing software

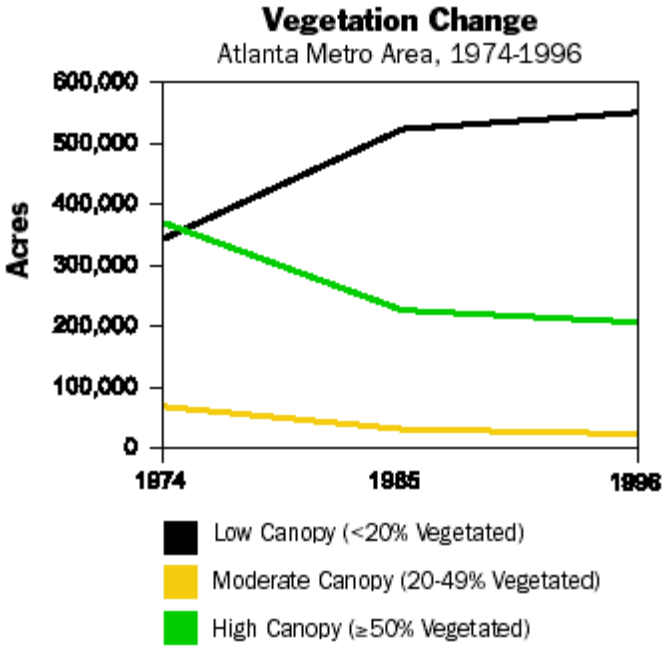
Project Overview:

The study area centered on the City of Atlanta and covered 775,000 acres.

Major Findings:

The area covered with heavy tree cover was reduced from 50% in 1974 to 25% in 1996. The area covered with low tree cover was increased from 44% in 1974 to 71% in 1996. The average tree cover was reduced from 45% to 29%.

The amount of stormwater runoff increased by 33% or an estimated 591 million cubic feet of water. The cost to build a system to handle this water was $1.18 billion. In 1996, the stormwater retention

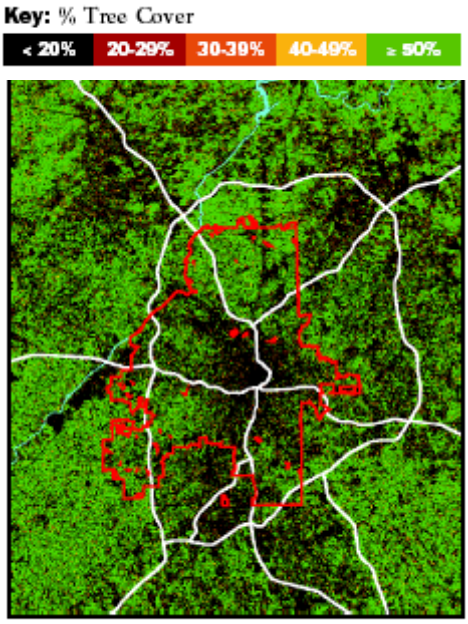


capacity of the trees was worth $2.36 billion, which was $85.9 million less than the capacity in 1974. The urban forest was also capable of removing 11 million pounds of pollutants annually for a value of $28 million. The shade from the trees reduces the residential summer energy costs by $2.8 million annually and reduces the emission by 658,000 tons per year.

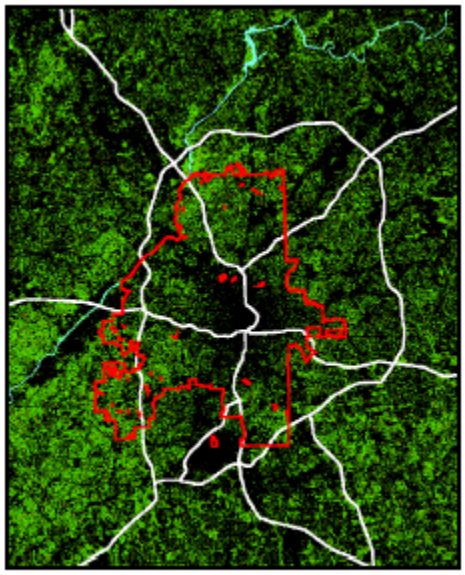
Methodology:

Satellite data from 1974, 1986 and 1996 were used in this study. These images were selected because of their atmospheric clarity and time of year. Landsat satellite TM (30 meter pixel) and MSS (80 meter pixel) images were used as the source of land cover data. This data was refined using a subpixel classification technique so that nine vegetation categories were obtained. Geo-rectified .tif images (aerial photographs) on a 2 foot resolution were used for the local analysis.

US National Resources Conservation Service (NCRS) Technical Release 55 (TR-55) formulas were used to calculate stormwater runoff. The Urban Forest Effects (UFORE) model was used to estimate the amount of ozone, sulfur dioxide, nitrogen dioxide, PM 10 and carbon monoxide. The CITYgreen avoided carbon module calculated the amount of energy savings, which was multiplied by Energy Information Administration (EIA) data for state-level fuel sources used in electricity production.



Landsat MSS 1974 80 Meter Pixel Resolution


Landsat TM 1996 30 Meter Pixel Resolution

Cost of Study:

Item	Cost
Equipment	$9,350
Data Collection	$11,400
Supplies	$1,000
Total	$21,750

Time to Conduct Study:

This project took 11 months to complete.

City of Portland, Oregon

Publication Title:

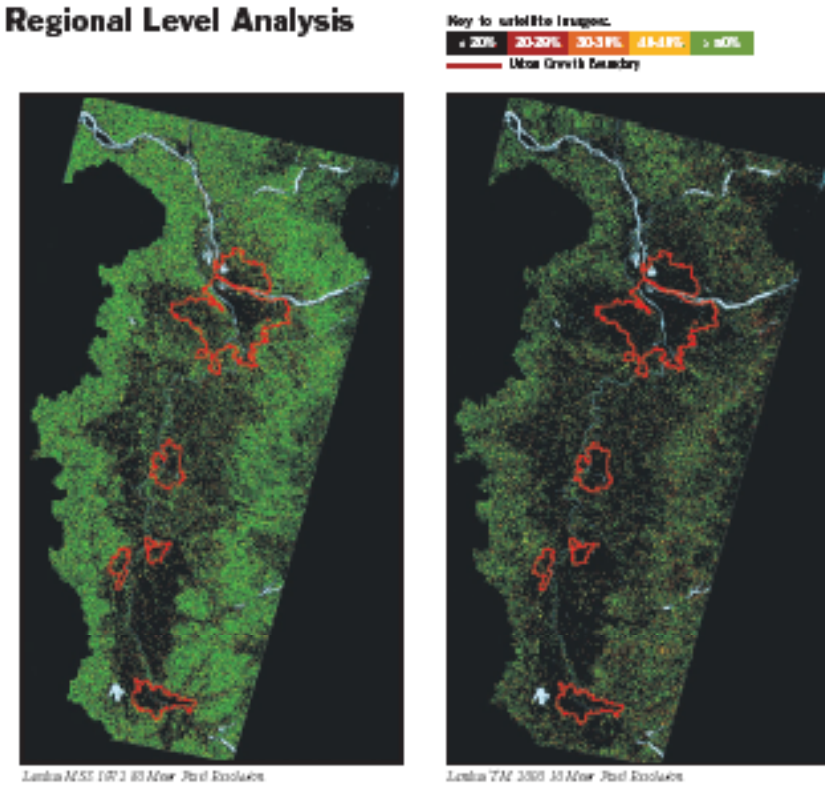
Regional Ecosystem Analysis for the Willamette/Lower Columbia Region of Northwestern Oregon and Southwestern Washington State – Calculating the Value of Nature

Publication Date:

October 2001

Partners:

USDA – Forest Service
Washington State Department of Natural Resources
Oregon Department of Forestry
Cities of Albany, Beaverton, Corvallis, Eugene, Portland, Salem, Tualatin, Vancouver and Wilsonville
ESRI for the GIS software
ERDAS for remote sensing software



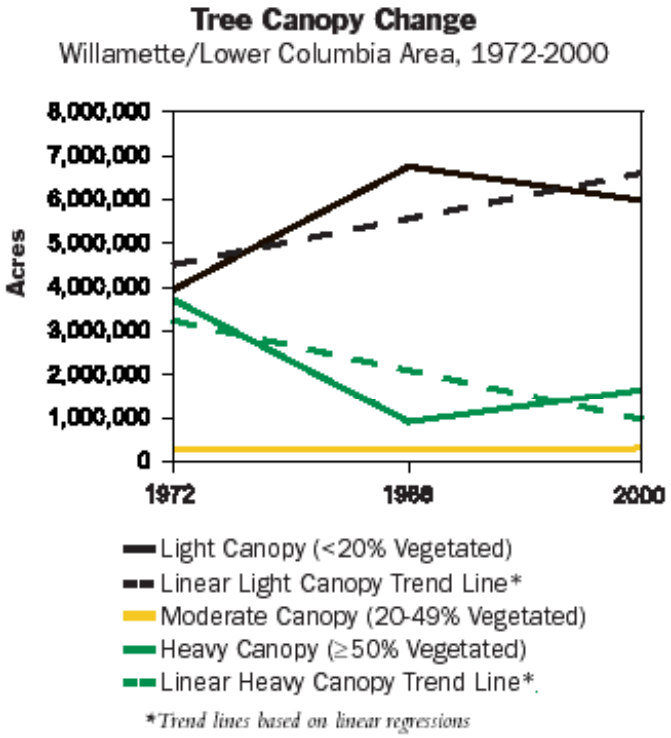
Project Overview:

This project encompassed 7 million acres from Vancouver, Washington to Eugene, Oregon. The study analyzed data from 1972 to 2000. This area is composed of abundant fist, lush forests and fertile agricultural lands. Over 80% of the population of Oregon lives in this area and the population is growing.

Major Findings:

The tree cover was 46% in 1972, but was 24% in 2000. The area with light canopy (less than 20%) increased by 51%, while the areas with heavy tree canopy declined by 56%. The average tree cover in the urban area decreased from 21% to 12%. The vast majority (75%) of the region is relatively open. Of the remaining land, 21% is densely forested and 4% middle density. The trees that were lost would have removed 138 million pounds of pollutants per year

(valued at $322 million), stored 58 million tons of carbon and intercepted 963 million cubic feet of stormwater (valued at $2.4 million).



Methodology:

Landsat satellite TM (30 meter pixel) and MSS (80 meter pixel) images were used for the regional analysis of land cover data. This data was divided into nine vegetation categories by American Forests. Digital aerial photographs that were geo-rectified into .tif images were used for local analysis. Field data as collected by American Forests with the assistance of urban forestry staff and volunteers from the participating cities.

US National Resources Conservation Service (NCRS) Technical Release 55 (TR-55) formulas were used to calculate stormwater runoff. The Urban Forest Effects (UFORE) model was used to estimate the amount of ozone, sulfur dioxide, nitrogen dioxide, PM 10 and carbon monoxide. The CITYgreen avoided carbon module calculated the amount of energy savings, which was multiplied by Energy Information Administration (EIA) data for state-level fuel sources used in electricity production.

City of Washington, DC

Publication Title:

Regional Ecosystem Analysis for the Washington DC Metropolitan Area – An Assessment of Existing Conditions and a Resource for Local Action

Publication Date:

February 2002

Partners:

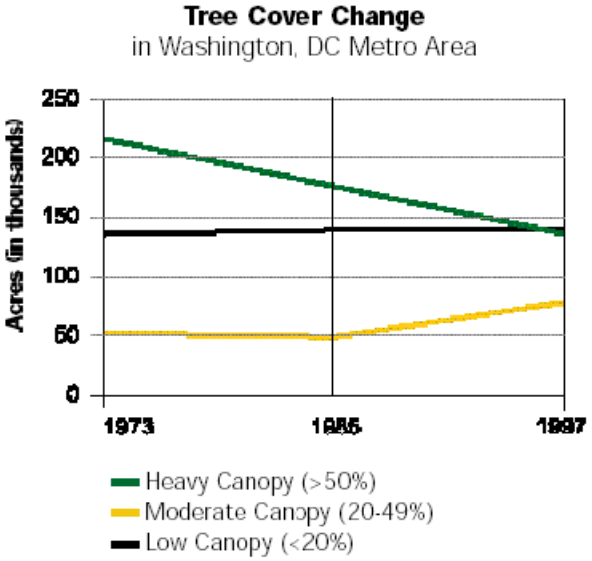
USDA – Forest Service
The Casey Trees Endowment Fund
The National Capital Planning Commission
ESRI – GIS software
ERDAS – Remote sensing software

Project Overview:

The project area covered 636 square miles of the Washington DC metropolitan area and built a green infrastructure data layer for use in planning and development. This study addressed the lack of understanding of the ecological and economic value of trees and the absence of a means to use that information in GIS systems.

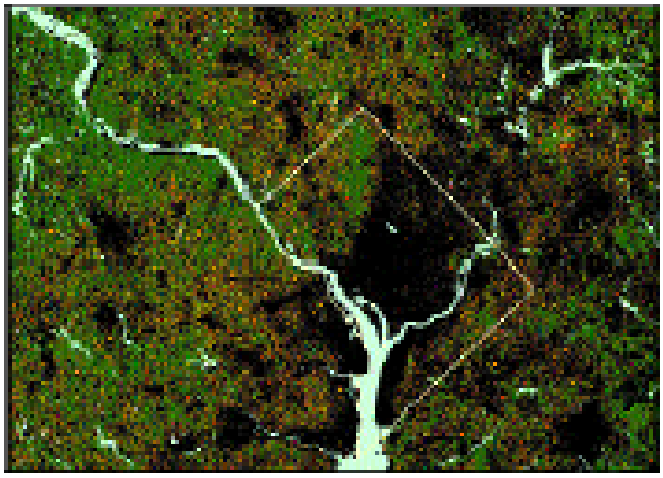
Major Findings:

The tree canopy of the subject area ranged from nine percent in Friendship Village, an urbanized area, to 72% in Mantua. The overall percentage of cover by type is displayed to the right.



The total stormwater retention capacity of the trees in the subject area was determined to be 949 million cubic feet and valued at $4.7 billion (based up $5 per cubic foot). These trees also were determined to be able of removing 20 million pounds of pollutants for a benefit of $49.8 million annually.

Using 1972, 1985 and 1997 satellite images, it was determined that the heavy tree cover (green area) declined 30 percent and the low canopy area (black area) increased by more than 20 percent.



Methodology:

Landsat satellite TM (30 meter pixel) and MSS (80 meter pixel) images were used as the source for land cover data. For the local ecosystem analysis, high resolution (4 meter pixel) multispectral satellite imagery was used. One meter panchromatic imagery was used to ground truth the data. This data was acquired during the growing season and classified into nine vegetation categories. A green infrastructure data layer was created to determine the amount of areas covered in trees, grass, parking lots, buildings and roads. The data was inputted into CITYgreen version 5.0. US National Resources Conservation Service (NCRS) Technical Release 55 (TR-55) formulas were used to calculate stormwater runoff. The Urban Forest Effects (UFORE) model was used to estimate the amount of ozone, sulfur dioxide, nitrogen dioxide, PM 10 and carbon monoxide.

City of Charlottesville, VA and Harrisburg, PA

Publication Title:

Regional Ecosystem Analysis Chesapeake Bay Watershed —
Charlottesville, VA and Harrisburg , PA Areas
Calculating the Value of Nature

Publication Date:

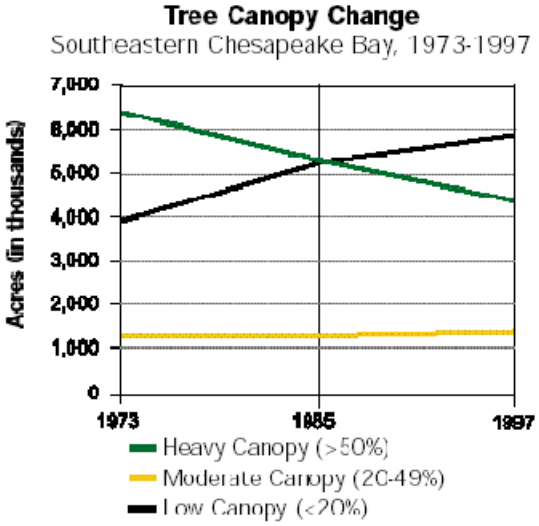
February 2002

Partners:

USDA Forest Service Chesapeake Bay Project -
Harrisburg, Charlottesville, and Original Chesapeake Bay Study Areas
ESRI – GIS Software
ERDAS – remote sensing software
American Forests -

Project Overview:

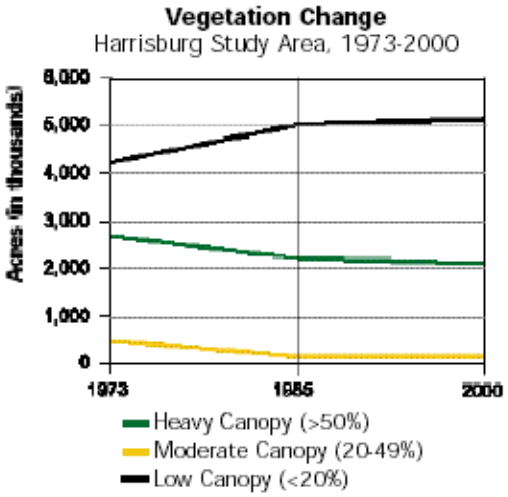
A Regional Ecosystem Analysis (REA) was conducted in the Chesapeake Bay Region in 1999. This original study covered 11.4 million acres and determined that a significant amount of the tree canopy was lost. The average canopy declined from 51% in 1973 to 39% in 1997. The 2002 study covered the areas of Charlottesville, VA (5.3 million acres) and Harrisburg, PA (7.5 million acres).



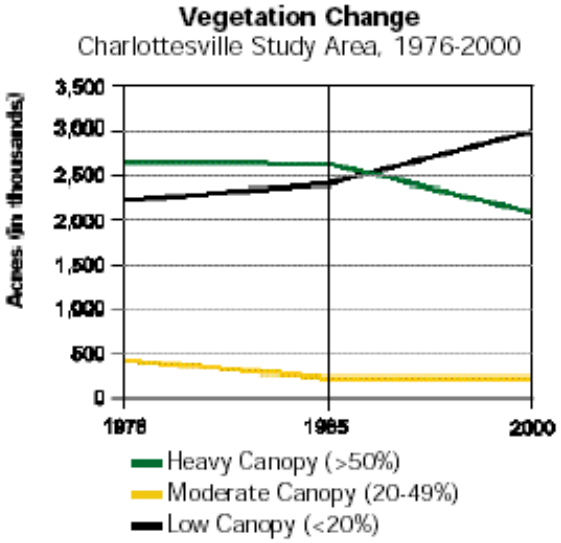
Major Findings:

The forest covers of these two cities have changed dramatically since the 1970's.

This loss of tree canopy had economic implications for these two cities. Storm water runoff increased by 19% or 3 billion cubic feet of water in Charlottesville. This additional runoff cost $6 billion dollars for the construction of retention ponds and other engineering systems. The lost trees would have removed approximately 88.6



million pounds of pollutants from the air at a value of $218 million per year. In Harrisburg, there was an 8% (or 1 billion cubic feet of water) increase in storm water runoff. The $2 billion increase for storm water management is added to the annual $248 million loss of removing air pollutants.



Methodology:

For regional analysis, Landsat satellite TM (30 meter pixel) and MSS (80 meter pixel) images were used as the source of land cover data. AMERICAN FORESTS used a subpixel classification technique and divided land cover into nine vegetation categories. Tree benefits were calculated using CITYgreen® software on a full pixel landcover classification of the satellite images.

The stormwater runoff calculations incorporate formulas from the Urban Hydrology of Small Watersheds model, (TR-55) developed by the USDA Natural Resources Conservation Service (NRCS), formerly known as the US Soil Conservation Service. Don Woodward, P.E., a hydrologic engineer with NRCS, customized the formulas to determine the benefits of trees and other urban vegetation with respect to stormwater management.

CITYgreen® uses formulas from a model developed by David Nowak, PhD, of the USDA Forest Service. The model estimates how many pounds of ozone, sulfur dioxide, nitrogen dioxide, and carbon monoxide are deposited in tree canopies as well as the amount of carbon sequestered. The urban forest effects (UFORE) model is based on data collected in 50 US cities. Dollar values for air pollutants are based on averaging the externality costs set by the State Public Service Commission in each state. Externality costs are the indirect costs to society, such as rising health care expenditures.

Analysis and Comparison of Canopy Studies

The cities in Georgia have seen similar changes as cities in other parts of the country. These cities have seen significant losses of trees and forested areas. Losses of heavily wooded areas ranged from 5% to over 20%.

The losses of these trees have contributed to major increases in water runoff, decreases in air and water quality and major decreases savings to homeowners. The water runoff increased ranged from 25% to 30% for most cities. This increase in runoff increased the cities' stormwater management expenses. The cost to mange this water was approximately $2.00 per cubic foot of water.

American Forests makes several recommendations concerning forest canopies. First, they recommend that the cities and other municipalities take the information from these studies to their local governments. The value and benefits of these trees should provide concrete evidence to the municipal officials to maintain healthy urban ecosystems.

The dollar values associated with the trees should be considered with making land decisions. The use of CITYgreen® and other demonstration aids should be used as support tools to increase community participation. New and existing trees should be used as essential elements of the urban environment and engineering systems.

The tree canopy within urban areas should be increased and conserved. The recommended goals should be as the following

- 40% overall tree canopy
- 50% tree canopy in suburban residential areas
- 25% tree canopy in urban residential areas
- 15% tree canopy in the central business districts.

Many tools are available for land-use planning and developments. These tools include GIS applications, best management practices and CITYgreen®. These tools should be developed and used to convince builders, developers, planners, land managers as well as city governments about the value of the urban forests. These entities should also use these tools to plan developments that best incorporated trees into the overall infrastructure.

Notes:

Appendix 1

Project Contacts

Community: Acworth
Grant: 95-02
Ali Bring
City of Acworth
4375 Senator Russell Square
Acworth, GA 30101
404-974-3112

Community: Alpharetta
Grant: 96-01
Kristina Eicher
City of Alpharetta
11875 Haynes Bridge Road
Alpharetta, GA 30201
770-410-5760

Community: Ashburn
Grant: 94-06
Constance Head
City of Ashburn
P. O. Box 766
Ashburn, GA 31714
706-335-7070

Community: Athens-Clarke County
Grant: 96-51
David Myers
University of Georgia
Research Foundation
622A Boyd Graduate Studies Research Center
Athens, GA 30602
706-542-4109

Community: Athens-Clarke County
Grant: 00-01
Robinson Barker
Athens-Clarke County Urban Tree Advisory Committee
155 Sandstone Drive
Athens, GA 30605
706-354-0359

Community: Athens-Clarke County
Grant: 94-07
Roger Cauthen
Athens-Clarke County
350 Pound Street
Athens, GA 30601
706-613-3565

Community: Atlanta
Grant: 94-03
American Forests
P. O. Box 2000
Washington, DC 20013
202-955-4500

Community: Avondale Estates
Grant: 94-11
Phyllis Flowers
City of Avondale Estates
21 North Avondale Plaza
Avondale Estates, GA 30002
404-294-5400

Community: Baxley
Grant: 01-03
Jeffrey Baxley
City of Baxley
P. O. Box 290
Baxley, GA 31515
912-367-8300

Community: Chatham County
Grant: 95-16
Dennis Goldburgh
Chatham County Engineering Dept.
P. O. Box 8161
Savannah, GA 31412
912-652-7817

Community: Covington
Grant: 98-21
Ray Geiger
City of Covington
2116 Stalling Street
Covington, GA 30015
770-385-2020

Community: Darien
Grant: 98-62
Susan Johnston
City of Darien
P. O. Box 452
Darien, GA 31305
912-437-2844

Community: Duluth
Grant: 97-13
Phil McLemore
City of Duluth
3578 W. Lawrenceville
Duluth, GA 30136
770-476-1790

Community: Forest Park
Grant: 99-13
William Werner
City of Forest Park
745 Forest Parkway
Forest Park, GA 30297
404-366-472

Community: Griffin
Grant: 96-21
Brant Keller
City of Griffin
P. O. Box T
Griffin, GA 30224
770-229-6603

Community: Hartwell
Grant: 95-43
Bob Pease
City of Hartwell
P. O. Box 309
Hartwell, GA 30643
706-376-4756

Community: Macon
Grant: 94-41
Ben Hamrick
Macon-Bibb County Parks
and Recreation Department
P. O. Box 247
Macon, GA 31202-0247

Community: Macon
Grant: 95-53
Ben Hamrick
Macon-Bibb County Parks
and Recreation Department
P. O. Box 247
Macon, GA 31202-0247

Community: Macon
Grant: 97-27
Michael Huffman
Macon-Bibb County Parks
and Recreation Department
P. O. Box 247
Macon, GA 31202-0247
478-751-7693

Community: Metter
Grant: 96-34
Wanda Leverett
City of Metter
Roundtree Street
Metter, GA 30439
912-685-2527

Community: Milledgeville
Grant: 98-37
Charles Osborne
City of Milledgeville
P. O. Box 1900
Milledgeville, GA 31061
478-445-6386

Community: Newborn
Grant: 99-34
Sally Chamberlain
Town of Newborn
P. O. Box 247
Newborn, GA 30056
770-786-8360

Community: Oxford
Grant: 98-41
Linda Jensen
Oxford Tree Board
110 West Clark Street
Oxford, GA 30054
770-787-9869

Community: Powder Springs
Grant: 00-22
Rosalyn Nealy
City of Powder Springs
P. O. Box 46
Powder Springs, GA 30127
770-943-1666

Community: Rhine
Grant: 99-41
Jane Lann
City of Rhine
P. O. Box 87
Rhine, GA 31077
229-386-3712

Community: Savannah
Grant: 95-68
Barry Smith
City of Savannah
P. O. Box 1027
Savannah, GA 31402
912-651-6610

Community: Thomaston
Grant: 01-33
Kerry Waldron
City of Thomaston
P. O. Box 672
Thomaston, GA 30286
706-647-4242

Community: Union City
Grant: 99-54
Sonya Carter
City of Union City
5047 Union Street
Union City, GA 30291
770-964-2288

Community: Valdosta
Grant: 95-82
Eric Hahn
City of Valdosta
P. O. Box 1746
Valdosta, GA 31603
912-333-1807

Community: Valdosta
Grant: 95-82
Frank Jenner
City of Valdosta
P. O. Box 1746
Valdosta, GA 31603
912-251-2304

Community: Washington
Grant: 00-39
Mike Hardy
Washington Tree Board
P. O. Box 9
Washington, GA 30673
706-678-3277

Appendix

2

Urban and Community Forestry Contacts

American Forests
P. O. Box 2000
Washington, DC 20013
202-955-4500
www.americanforests.org

American Society of Consulting Arborists
15245 Shady Grove Road, Suite 130
Rockville, MD 20850
301-947-0483
www.asca-consultants.org

Georgia Arborists Association
C/o Arborguard Tree Specialists
P. O. Box 461
Avondale Estates, GA 30002
404-299-5555

Georgia Forestry Commission
P. O. Box 819
Macon, GA 31202-0819
800-GA-TREES
www.gfc.state.ga.us

Georgia Municipal Association
201 Pryor Street, SW
Atlanta, GA 30303
404-688-0472
www.gmanet.com

Georgia State Board of Registration for Foresters
Joint Secretary, Examining Boards Div.
Office of the Secretary of State
166 Pryor Street, SW
Atlanta, GA 30303

Georgia Urban Forest Council, Inc.
P. O. Box 961
Macon, GA 31202
800-994-GUFC
gufc@comcast.net
www.gufc.org

International Society of Arboriculture
P. O. Box 3129
Champaign, IL 61826-3129
217-355-9411
www.isa-arbor.com

Treelink
www.treelink.org

National Arbor Day Foundation
100 Arbor Avenue
Nebraska City, NE 68410
402-474-5655
www.arborday.org

National Arborist Association
Route 101, P. O. Box 1094
Amherst, NH 03031-1094
603-673-3311
www.natlarb.com

National Association of State Foresters
Hall of the States
444 North Capitol Street, NW
Suite 540
Washington, DC 20003
202-624-5977
www.stateforesters.org

National Tree Trust
1120 G Street, NW
Suite 770
Washington, DC 20005
800-846-8733
www.nationaltreetrust.org

National Urban & Community Forestry Advisory Council
USDA Forest Service
20628 Diane Drive
Sonora, CA 95370
209-536-9201
www.treelink.org/nucfac/index.htm

Society of American Foresters
5400 Grosvenor Lane
Bethesda, MD 20814
301-897-8720
www.safnet.org

Society of Municipal Arborists
P.O. Box 641
Watkinsville, GA 30677
706-769-7412
UrbanForestry@prodigy.net
www.urban-forestry.com

University of Georgia Extension Forest Resources
www.forestry.uga.edu/efr

USDA Forest Service, Southern Region
Cooperative Forestry
1720 Peachtree Street, NW
Suite 811 N
Atlanta, GA 30309
www.urbanforestrysouth.org