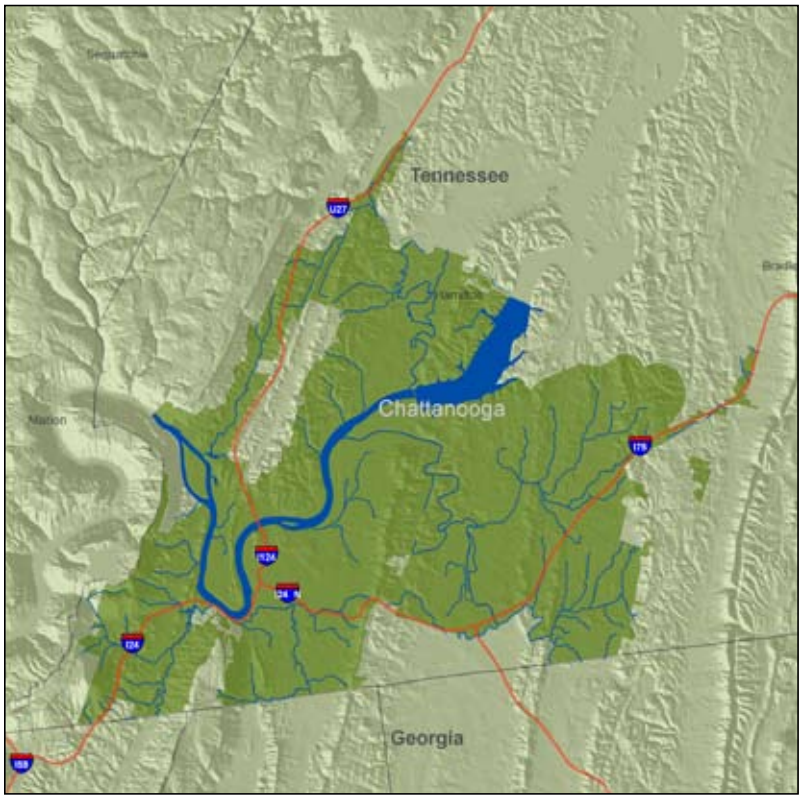
June 2010

Urban Ecosystem Analysis
City of Chattanooga, Tennessee

Calculating the Value of Nature

Report Contents



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Project Overview

The City of Chattanooga is on the verge of a development boom. The city has welcomed Volkswagen to build a new $1 billion assembly plant, which will attract parts-supplier businesses and thousands of employees to the Chattanooga area. Over the last 40 years, the city has transformed its image as the most polluted city in America in 1969, to a very livable and green city. The city recognizes that "A critical element related to healthy living and a clean environment lies in the Green Infrastructure of the community.[1]" Mayor Ron Littlefield was an early adopter of the US Mayors Climate Action Agreement as part of its commitment toward making Chattanooga more sustainable. In its Climate Action Plan, this commitment is summed up:

Coolidge Park represents the revival of the city on many levels, including its sustainability initiatives that recognize the urban forest as a vital ecological and economic asset.

To be truly sustainable, an industry must balance the interests of the economy, the environment and the community. Government and industry must explore initiatives to support growth in ways that will conserve tomorrow's resources while building business.[2]

The magnitude of anticipated land development has prompted city leaders to take a closer look at how these changes will impact their community—including potential negative impacts to their natural assets. City leaders will have to proactively determine the best way to balance development with preservation. This study specifically addresses the ecosystem services--air and water quality, carbon offsets, and stormwater management that Chattanooga's urban forest, open space, and other natural resources provide to the community.

Trees are important indicators of the health of a community's urban ecosystem. When trees are large and healthy, the ecological systems that support them are also healthy. Healthy trees provide valuable environmental benefits through the biological functions of their roots and leaves. These can be measured in terms of ecosystem services including reducing stormwater runoff, increasing carbon storage, and improving air and water quality. The greater the tree cover and the less the impervious surface in a community, the more ecosystem services are produced.

American Forests assesses the health and benefits of urban ecosystems through a process called Urban Ecosystem Analysis (UEA). The City of Chattanooga commissioned American Forests to conduct an Urban Ecosystem Analysis, with five project objectives: 1) Benchmark the city's current canopy cover and their associated ecosystem and economic benefits by land use category; 2) Inform city staff, community leaders, and the general public of this community asset; 3) Train city staff in using CITYgreen tools to model scenarios to make better informed decisions about future development; 4) Guide future tree planting to maintain water quality; and 5) Establish a comprehensive approach to maintaining this community asset by adopting tree canopy goals by land use category. The data, findings, and tools included in this study will be used by planners, foresters, and elected officials in determining the best balance between development and conservation.

American Forests classified 2008 National Agricultural Imagery Program (NAIP) imagery[3] to determine current land cover for the city overall and stratified by land use categories including: Central Business District, Commercial Mixed Use, Parks and Open Space, Industrial, Urban Residential, Suburban Residential, and Right of Way. This study included several newly annexed areas but did not include all proposed annexation as of 2010. In addition, American Forests examined the ecosystem benefits of ten sub-watershed stream buffers to document how water quality is affected by land use. Data from this project gives the City of Chattanooga's staff the ability to conduct their own assessments for on-going planning decisions. From a broader perspective, the urban ecosystem analysis offers the entire community a role in developing and maintaining its tree canopy and improving environmental quality.

Major Findings Summary

An analysis of 2008 high resolution NAIP data found that overall the city had a robust tree canopy, higher than many US urban cities east of the Mississippi that American Forests has quantified. However, there are areas, such as the Central Business District (CBD) where canopy cover is less than recommended. The city is currently increasing canopy cover in the CBD through its Take Root Program. American Forests recommends that the city take a pro-active approach in preserving existing green infrastructure to offset the ecosystem impacts that the expected development boom will incur.

Major findings include:

- Of Chattanooga's 92,543 acres of total landcover, the city had 47,588 (51.4%) acres of tree canopy. This includes 2,312 acres (2.5%) that had impervious paving underneath the canopy which prevents stormwater infiltration. The city had 16,200 acres (17.5%) open space with grass and scattered trees, 22,541 acres (24.4%) impervious surface, 773 (0.8%) acres bare soil, and 5,441 (5.9%) acres of water (Table 1).
- As of 2008, Chattanooga's 51.4% tree canopy cover provided 421 million cubic feet of stormwater detention services, valued at $1.26 billion, removed 4.5 million lbs. of air pollutants at a value of $12.9 million per year, stored 2 million tons of carbon in trees' biomass, and sequestered 15,943 tons of carbon annually (Table 2).
- When viewed by land use, the city's land use categories all have robust tree canopy percentages: Urban Residential at 58.4%, Suburban Residential at 66.4%, Industrial at 42.7%, and Parks and Open Space at 72.3%, with the exception of the most urbanized areas of the city—Commercial and Mixed Use at 26.6% and the Central Business District at 13.2%.
- The combined network of stream buffers (with a 50 ft. buffer zone) within the city's ten sub-watersheds has 1,698 acres (67.2%) of tree canopy. This network provides 14.4 million cubic feet of stormwater management, valued at $43 million and is a vital asset for filtering water before it enters area streams and the Tennessee River.

Tree Canopy and Other Lancover Ecosystem Benefits by Land Use

American Forests acquired 2008 National Agriculture Imagery Program (NAIP) satellite imagery dataset to provide a current snapshot of Chattanooga's landcover at a scale suitable to be further analyzed by the local community. Using these data, small areas of landcover within the city including its ten sub-watershed stream buffers and seven land use categories can be accurately measured and related ecosystem services quantified. The imagery was classified into six landcover categories: trees; trees with an impervious understory; open space/grass/scattered trees; impervious surfaces; bare soil; and water. Landcover was also stratified into seven land use classes: Urban Residential, Suburban Residential, Central

Table 1. Landcover Values by Landuse Category

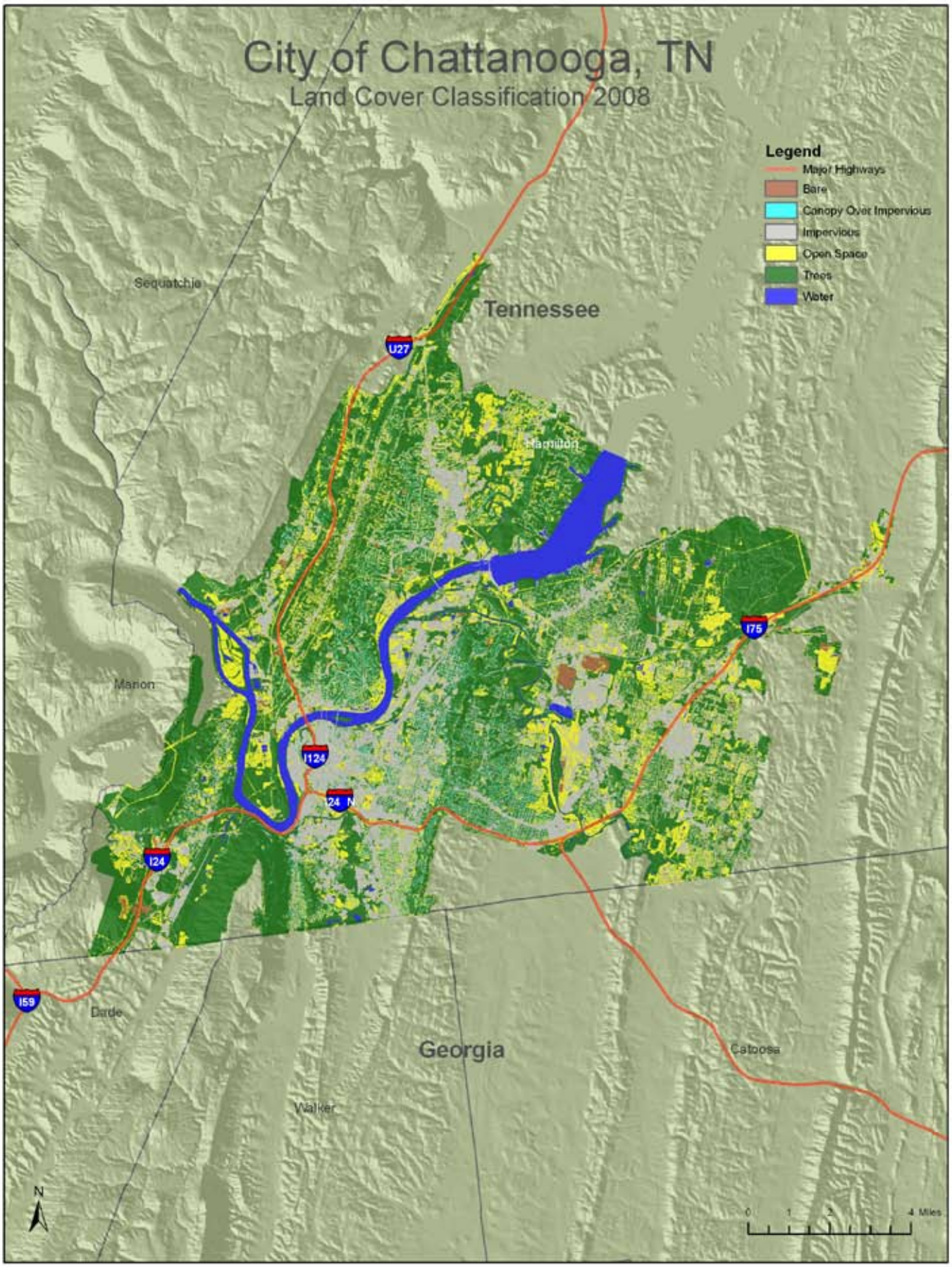
Landuse		Tree Canopy				Impervious		Open Space		Bare		Water	
	Total Land Acres	Total Canopy Acres	%	Impervious Understory Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
City of Chattanooga	92,543	47,588	51.4%	2,312	2.5%	22,541	24.4%	16,200	17.5%	773	0.8%	5,441	5.9%
Central Business District	1,599	211	13.2%	33	2.1%	1,207	75.5%	175	10.9%	5	0.3%	1	0.1%
Commercial Mixed Use	5,564	1,480	26.6%	71	1.3%	3,066	55.1%	966	17.4%	39	0.7%	13	0.2%
Parks and Open Space	11,756.30	8,504	72.3%	712	6.1%	712	6.1%	2,420	20.6%	37	0.3%	83	0.7%
Industrial	16,029	6,840	42.7%	84	0.5%	5,341	33.3%	3,094	19.3%	508	3.2%	247	1.5%
Urban Residential	5,149	3,010	58.4%	342	6.6%	1,261	24.5%	864	16.8%	8	0.2%	7	0.1%
Suburban Residential	34,920	23,186	66.4%	960	2.7%	4,592	13.1%	6,872	19.7%	165	0.5%	106	0.3%
Right of Way-total	17,531	4,363	24.9%	744	4.2%	6,357	36.3%	1,814	10.3%	11	0.1%	4,985	28.4%
50 ft. Stream Buffers	2,527	1,698	67.2%	27	1.1%	265	10.5%	336	13.3%	3	0.1%	25	1.0%

Data taken from 1-meter NAIP Imagery collected in 2008. AF downloaded data from NAIP website.

Table 2. Ecosystem Services By Land Use

	Area	2008 Tree Canopy	2008 Tree Canopy	Air Pollution Removal	Air Pollution Removal Value	Carbon Stored	Carbon Sequestered	Stormwater Value*	Stormwater Value @ $3 per cu. ft
	acres	acres	%	lbs./ yr	$	tons	tons	cu. ft.	$
City of Chattanooga	92,543	47,588	51.4%	4,538,976	$12,850,381	2,047,779	15,943	420,869,922	$1,262,609,766
Central Business District	1,599	211	13.2%	20,073	56,829	9,056	71	1,200,056	$3,600,168
Commercial Mixed Use	5,564	1,480	26.6%	141,173	399,677	63,691	496	13,444,804	$40,334,412
Parks and Open Space	11,756	8,504	72.3%	811,112	2,296,354	365,937	2,849	73,154,466	$219,463,398
Industrial	16,029	6,840	42.7%	652,397	1,847,012	294,332	2,291	60,104,331	$180,312,992
Urban Residential	5,149	3,010	58.4%	287,069	812,727	129,513	1,008	20,135,883	$60,407,648
Suburban Residential	34,920	23,186	66.4%	2,211,496	6,261,010	997,726	7,768	200,116,185	$600,348,554
Right of Way	17,531	4,363	24.9%	416,168	1,178,221	187,756	1,462	38,679,837	116,039,512
50 ft. Stream Buffers Total	2,527	1,698	67.2%	161,930	458,444	73,056	569	14,390,521	$43,171,563

**Stormwater analysis uses a 2yr, 24 hour storm event. The value of managing stormwater is based on current local construction costs of $3.00 per cubic foot (source: City of Chattanooga).*


City of Chattanooga, TN
Land Cover Classification 2008
Legend
Major Highways
Bare
Canopy Over Impervious
Impervious
Open Space
Trees
Water
Sequatchie
Tennessee
U27
Hamilton
I75
Marion
I124
24 N
I24
I59
Dade
Georgia
Catoosa
Walker
N
0 1 2 4 Miles

Business District, Commercial and Mixed Use, Industrial, Parks and Open Space, and Rights of Way (ROW).

An Urban Ecosystem Analysis was conducted on each land use category's landcover[4]. Table 1 details the acreage and percent landcover in relation to the total land area of the city. Chattanooga's urban forest contributes to its multiple ecosystem benefits (Table 2). Just as Chattanooga enjoys adequate water supply where other cities may struggle to provide this basic and costly resource, Chattanooga is also fortunate to have a robust tree canopy that provides important ecosystem benefits that are translated into additional economic value. Nevertheless, the Chattanooga Green Committee cautions that these resources are not to be squandered. "Although Chattanooga is situated along the Tennessee River and we currently find adequate aquifers and recharge areas in place, our community must not have a false sense of abundance." So too, it is important to preserve the existing tree canopy to make the best use of its natural ecosystem services and save on the costs of man-made infrastructure.

Stormwater Ecosystem Services

There is a direct relationship between natural vegetative buffers that line streams and water quality. The greater the tree canopy and other green infrastructure the less stormwater runs off the land and the fewer pollutants enter the streams. This decreases the costs of providing clean water. Also, shading from tree canopy aids in maintaining thermal water quality standards.

Trees reduce the volume of stormwater runoff by capturing some rain on their leaves and branches, which then evaporates back into the atmosphere. Other water is absorbed by the tree roots or infiltrates into the soil rather than running off the land. As a result less runoff must be managed by manmade infrastructure. In 2008, Chattanooga had a 51% tree canopy, which managed 1.26 billion cubic feet of stormwater, valued at $3.79 billion using a $3 per cubic foot value based on local costs (source: City of Chattanooga).

Two landmark attributes of the Chattanooga area are its ridges and riparian areas. Chattanooga's Climate Action Plan recognizes the need to address stormwater, tree cover, hillsides and sensitive areas… to preserve the 100-year flood zone and riparian zones in their natural state to minimize flood damage and to provide critical habitat and natural buffers for filtering water pollutants.[6]

In addition to the individual land use areas detailed in this report, American Forests analyzed ten stream buffer areas within the city including: Chattanooga Creek, Citico Creek, Friar Branch, Lookout Creek, Mackey Branch, Mountain Creek, N.Chicamauga Creek, S. Chicamauga Creek, Tennessee River (unnamed tributaries only), and Wolftever Creek. The combined 50 foot stream buffer area has 1,698 acres (67%) of tree canopy. This network currently provides 14.3 million cubic feet of stormwater management, valued at $43 million (Table 2). An analysis of each stream buffer used a 25 ft and a 50 ft. vegetative buffer to detail the ecosystem benefits provided by each[7]. Table 4 provides an example of this analysis from the Citico Creek subwatershed. In the ten stream buffer areas, tree canopy ranged from 44% to more than 60%. Though these high canopy percentages appear robust and healthy, some of the canopy is comprised of privet and other exotic and invasive species. To maximize the ecosystem benefits of its stream buffers, the city should replace these with non-invasive species over time.

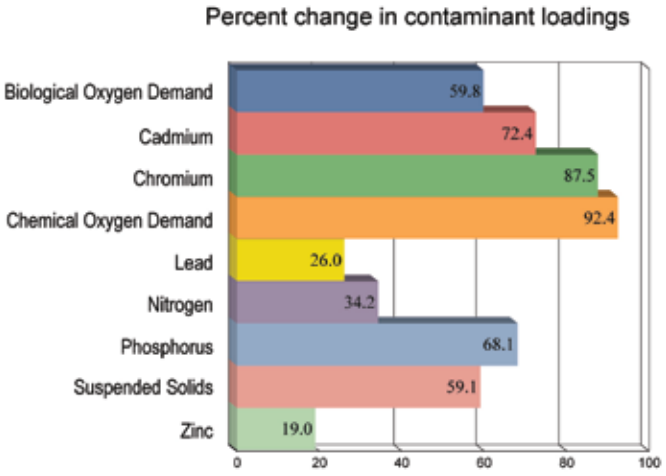
A community's pervious land cover serves as its green infrastructure; its protection and enhancement provides direct benefits to the taxpayer and improved environmental quality including slowing stormwater runoff, improving water and air quality, protecting soil from erosion, and storing atmospheric carbon. Green infrastructure includes vegetation and their complex interactions with soil, air, and water systems. As defined in this project, green infrastructure includes tree canopy, open space, and water. American Forests used CITYgreen software to analyze the environmental and dollar value of each benefit. For more details and formulas used in each assessment visit: http://www.americanforests.org/resources/urbanforests/naturevalue.php

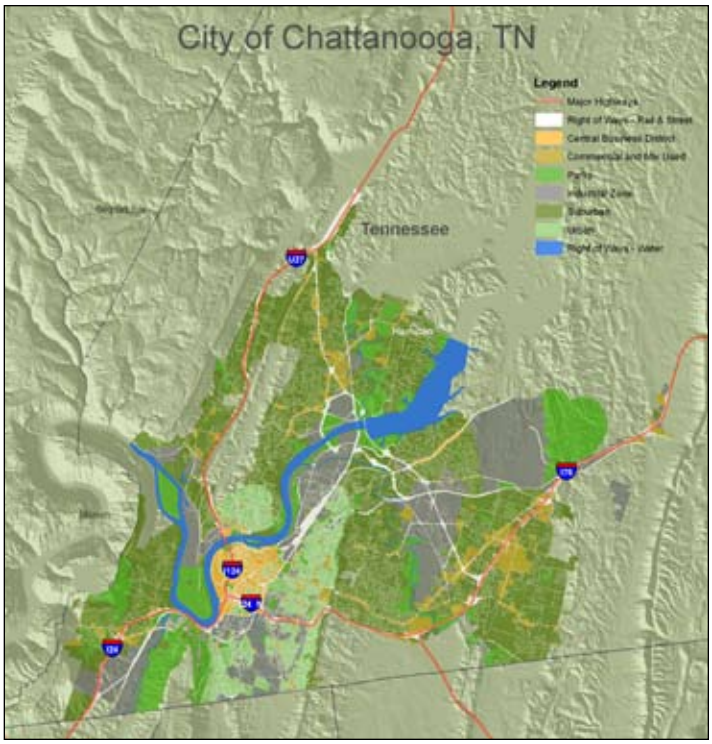
The city recently established a new stormwater management fee that gives credit for having existing and planting new tree canopy on a site. CITYgreen software includes modeling capabilities to determine the stormwater benefits of increasing tree canopy on a site.

Water Quality Ecosystem Services

Tree roots also absorb water pollutants; the impact of the following nine contaminants can be calculated from the stormwater runoff changes provided by the tree canopy: Biological Oxygen Demand, Cadmium, Chromium, Copper, Lead, Nitrogen, Phosphorus, Suspended Solids, and Zinc. Citywide, water pollution, as measured in percent change in pollutant loading, would worsen by between 19% for Zinc and 92% for Chemical Oxygen Demand if trees were removed from the land (Graph 1).

Graph 1. City of Chattanooga Water Pollutants As Measured In Percent Change in Pollutant Loading[8]





Air Quality Ecosystem Services

Air quality is of particular concern in the Chattanooga area because while the city reached attainment for the 8-hour ozone standard adopted in 1997, the Environmental Protection Agency (EPA) adopted a more stringent 75 parts per billion standard which Chattanooga does not currently meet[9]. Sunlight and hot weather can cause ground-level ozone—known as a summertime air pollutant—to form in harmful concentrations in the air.

The air quality ecosystem services that trees provide are advantageous for Chattanooga. Tree canopy cools the air by evaporating water and by direct shading of buildings and pavement. This lowers the ambient temperature in cities (known as urban heat islands), reducing ground level ozone production and related smog conditions. While trees also emit hydrocarbons that contribute to smog ozone, research shows that because of trees cooling effects, they provide a net benefit in reducing air pollution.[10] Chattanooga's Climate Action Plan—Interim Report 2008 recommends that the city, "Maintain healthy urban forests [and] promote tree planting to increase shading and to absorb CO2"[11]

Table 3. Air Pollutant Removal Provided by Chattanooga's Urban Forest

Air Pollutant	Lbs. Removed/yr.	Dollar value/yr
Carbon Monoxide	127,261	$62,456
Ozone	1,951,335	$6,894,167
Nitrogen Dioxide	509,044	$1,798,478
Particulate Matter	1,611,973	$3,802,398
Sulfur Dioxide	339,363	$292,881
Totals	4,538,976	$12,850,381

Dollar values are based on 2009 dollars

The ecological value of air quality ecosystem services is based on the UFORE model developed by the U.S. Forest Service. The dollar value is calculated based on externality costs to society (such as public health-related respiratory costs) due to the additional air pollution. Externality values are established by State Public Service Commissions. Chattanooga's urban forest removes 4.5 million lbs. of air pollutants annually, valued at almost $13 million per year (Table 3).

Carbon Storage and Sequestration Benefits

Trees have a direct impact on the carbon footprint—the amount of atmospheric carbon a community produces that contributes to global warming. Trees provide a carbon sink by storing and sequestering atmospheric carbon in their wood. Both the total storage and the rate at which carbon is stored (known as sequestration) can be measured. Chattanooga's tree canopy stores 2 million tons of carbon and sequesters nearly 16,000 tons of carbon annually. Planting new trees and maintaining existing trees provide opportunities for the public and private sector to reduce their community's carbon footprint.

Table 4. Ecosystem Benefits of Stream Buffers[12]

Citico Creek Subwatershed	25 ft. buffer	50 ft. buffer
Total Acres	53.9	97.3
Tree Canopy Acres	35.5	60.6
Tree Canopy Percentage	66%	62%
Air Quality (lbs. removed/yr.)	3,389	5,781
Air Quality (dollar value/yr.)	$9,594	$16,366
Carbon Stored (tons)	1,529	2,608
Carbone Sequestered (tons/yr)	12	20
Stormwater runoff (cu. ft. avoided storage)	195,450	340,664
Stormwater runoff savings	$586,351	$1,021,993

Modeling Ecosystem Benefits

Modeling demonstrates the benefits of changing landcover percentages for a given area. For example, as discussed under stormwater management, American Forests ran an Urban Ecosystem Analyses for each sub-watershed's stream buffers under two modeling scenarios, using 25 ft. and 50 ft. vegetative buffers. A side-by-side modeling comparison of the Citico Creek Subwatershed shows the additional ecosystem benefits provided by the additional buffer area (Table 4). Likewise, if net tree canopy is decreased due to unmitigated development, modeling this change will reveal the increase in stormwater runoff and decrease in air and water quality and carbon benefits. Modeling can also be used as an incentive to encourage commercial property owners to maintain their existing trees and plant more trees to reduce their stormwater fees.

Recommendations

Tree Cover Goals by Land Use

- Due to the impending dramatic land development that will occur with Volkswagen and associated businesses and staffing coming to Chattanooga, American Forests recommends that the city maintain the current tree canopy percentages in each land use category so that there is no net loss over time.

Citywide	51%	Urban Residential	58%
Central Business District	15%	Suburban Residential	66%
Commercial Mixed Use	27%	Right of Way	9%
Parks and Open Space	72%	Stream Buffers (total)	67%
Industrial	43%		

- To increase tree canopy to 15% in the Central Business District the city has already implemented "Take Root", a program to plant 1,500 trees in the downtown area funded by local donations. To date, the program has planted 1,049 trees toward meeting this goal.
- Recognizing that tree canopy will be lost due to their development and in support of the company's core commitment to environmental sustainability, Volkswagen has committed $200,000 toward tree planting to mitigate tree loss. The city should direct reforestation efforts to vegetative buffers so as to derive the most value from protecting water entering the Tennessee River and its tributaries.
- Along with preserving the overall size of the urban forest it is also important to improve the health of the existing urban forest to maximize its potential to provide ecosystem services. Replace privet and other exotic tree species with non-invasive species, especially along the stream buffers.

Integrate Urban Forests into New Development

- In keeping with the city's commitment toward sustainability, use innovative development techniques and Best Management Practices (BMPs) such as:
  - Low-Impact Development (LID) - LID is a comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrologic regime of urban and developing watersheds. http://www.lowimpactdevelopment.org/
  - Replace impervious pavement under the current 3% of the city's tree canopy with pervious pavement to provide better growing conditions, tree growth and longevity, and less stress and resulting disease and costly maintenance.
  - Adopt LEED-Neighborhood Development standards, sponsored by the US Green Building Council. This is a third-party verification standard that a development's location and design meet accepted high levels of environmentally responsible, sustainable development. http://bit.ly/2cD0DW

Example of stream buffers along Citico Creek.

Use the Digital Data to Better Integrate Green Infrastructure into City Initiatives such as: Land Planning, Urban Forestry, Stormwater Management, and Public Outreach

- Share the green data layer and CITYgreen software provided with this project with other city departments concerned with related ecosystem services. For example, Chattanooga's stormwater staff can include urban ecosystem analysis into the revision of their stormwater management plan to better understand how streams are influenced by land use and then target reforestation efforts.
- Use CITYgreen to model the positive impacts that BMP's like green roofs and rain gardens have on stormwater runoff and water quality. Use CITYgreen to model the positive economic impacts tree canopy has on reducing stormwater fees for new and existing commercial development.
- Use CITYgreen to model the impacts of changing tree canopy, impervious surfaces, and other land covers under different development scenarios.
- Use analysis findings in popular media to educate the public about the importance of their role in increasing the urban forest and the positive impact planting on private property will make.
- Incorporate CITYgreen schools program into public schools to increase awareness of environmental issues by teaching practical applications of GIS, math, science and geography. Curriculum is available through American Forests.

About the Urban Ecosystem Analysis

American Forests' Urban Ecosystem Analysis is based on the assessment of "ecological structures"—unique combinations of land use and land cover patterns. Each combination performs ecological functions differently and is therefore assigned a different value. For example, a site with heavy tree canopy provides more stormwater reduction benefits than one with lighter tree canopy and more impervious surface.

Data Used

American Forests acquired National Agriculture Imagery Program (NAIP) 1-meter pixel resolution, 4-band, multi-spectral satellite imagery in 2008. American Forests conducted a knowledge-based classification of this imagery to divide the land cover into six land cover categories: trees, trees with impervious understory, open space with scattered trees and grass, urban, bare soil, and water.

Analysis Formulas

Urban Ecosystem Analyses were conducted using CITYgreen software. CITYgreen for ArcGIS used the raster data land cover classification from the high-resolution imagery for the analysis. The following formulas are incorporated into CITYgreen software.

TR-55 for Stormwater Runoff: The stormwater runoff calculations incorporate volume of runoff formulas from the Urban Hydrology of Small Watersheds model (TR-55) http://www.hydrocad.net/tr-55.htm developed by the U.S. Natural Resources Conservation Service (NRCS), formerly known as the U.S. 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. For greater accuracy, a stormwater analysis was conducted for each Planning District and then values were added together to provide stormwater runoff for the entire city. The City of Chattanooga staff provided a local average $3 per cubic foot dollar value for the CITYgreen stormwater calculations.

L-THIA for Water Quality: Using values from the U.S. Environmental Protection Agency (EPA) and Purdue University's Long-Term Hydrological Impact Assessment (L-THIA) https://engineering.purdue.edu/mapserve/LTHIA7/ spreadsheet water quality model, The Natural Resources Conservation Service (NRCS) developed the CITYgreen water quality model. This model estimates the change in the concentration of the pollutants in runoff during a typical storm event given the change in the land cover from existing trees to a no tree condition. This model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD). Pollutant values are shown as a percentage of change.

UFORE Model for Air Pollution: 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 55 U.S. 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 as a result of air pollutants' detrimental effects on human health.

Acknowledgements for this Study

We gratefully acknowledge the support of the Lyndhurst Foundation and the City of Chattanooga in conducting this study.

For More Information

American Forests, founded in 1875, is the oldest national nonprofit citizen conservation organization. Its three centers–Global ReLeaf, Urban Ecosystem Center, and Forest Policy Center–mobilize people to improve the environment by planting and caring for trees.

American Forests' CITYgreen software provides individuals, organizations, and agencies with a powerful tool to evaluate development and restoration strategies and impacts on urban ecosystems. American Forests offers regional training, teacher workshops, and technical support for CITYgreen and is a certified ESRI developer and reseller of ArcGIS products.

Footnotes

1 Chattanooga's Climate Action Plan—Interim Report June 2008 page 35. http://www.chattanooga.gov/Chatt_Green_Interim_Report.pdf
2 Chattanooga's Climate Action Plan—Interim Report June 2008, page 49
3 American Forests acquired National Agriculture Imagery Program (NAIP) 1-meter pixel resolution data taken from, 4-band, multi-spectral satellite imagery collected in 2008.
4 Note that findings from NAIP imagery can not be compared to findings from previous UEA's using Landsat data because the imagery is at a different resolution.
5 Chattanooga's Climate Action Plan—Interim Report June 2008, page 39
6 Chattanooga's Climate Action Plan—Interim Report June 2008, page 36
7 The data findings for these analyses reside with the City Urban Forestry Department; contact Gene Hyde for this information.
8 Percent change in pollutant loading is measured using existing tree canopy cover compared to no tree canopy
9 Chattanooga's Climate Action Plan—Interim Report June 2008, page 33
10 Urban smog control: A new role for trees? http://bit.ly/dz4zCq http://findarticles.com/p/articles/mi_m1200/is_n1_v138/ai_9177813/pg_2/?tag=content;col1
11 Chattanooga's Climate Action Plan—Interim Report June 2008, page 8
12 The ecosystem benefit results for each stream buffer included with this project resides with Chattanooga's Urban Forester. Contact Gene Hyde for more information.

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