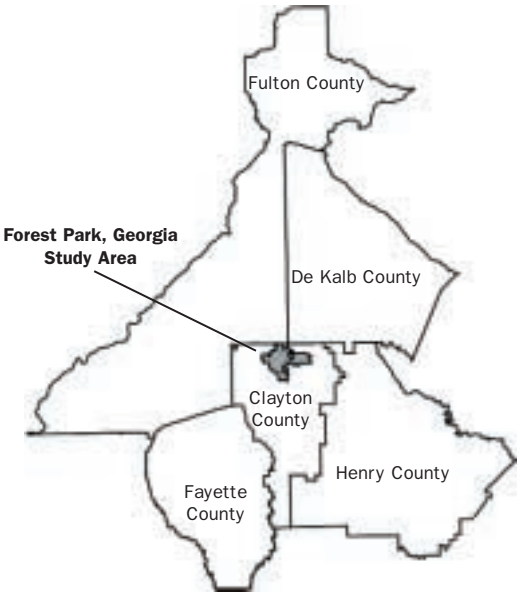
*July 2000*

# Urban Ecosystem Analysis Forest Park, Georgia

*Calculating the Value of Nature*

## Report Contents






125 YEARS 1875-2000

AMERICAN FORESTS®

PEOPLE CARING FOR TREES & FORESTS SINCE 1875

# Urban Ecosystem Analysis
# The City of Forest Park

## Project Overview

AMERICAN FORESTS conducted an Urban Ecosystem Analysis of Forest Park, Georgia to determine how the landscape has changed over time. The analysis assessed the loss of tree canopy and its associated values using data from satellite images spanning a 22-year period from 1974 to 1996. The analysis covered 6,088 acres of land. A more detailed study of the area was also conducted to determine the economic value of these changes.

The analysis used Geographic Information Systems (GIS) technology to measure the structure of the landscape, with emphasis on tree cover. Regional changes in the landscape were analyzed using satellite images. A more detailed look at the urban forest's economic value was conducted using low-level digital imagery (April 2000) and AMERICAN FORESTS' CITYgreen® software. CITYgreen is a desktop GIS software used by local government agencies and engineering groups for decision support.

## Major Findings

***Urban Forest Canopy Cover: From a vegetation perspective, the ecology of Forest Park has changed since 1974. Forests have declined and urban development has expanded.***

■ From an analysis of satellite imagery, average tree canopy density declined from 22% in 1974 to 17% in 1996.

■ In 1974, areas with heavy tree canopy (50% or greater tree cover) covered 21% of the area (1,288 acres). Developed areas (with tree cover of less than 20%) covered 71% of the land (4,325 acres).

■ By 1996, areas with low tree canopy (less than 20% ) became even more prevalent, expanding to 83% of the land area, an increase of 17% (5,043 acres). Heavy tree canopy declined by 26% (950 acres), representing just 26% of the land area studied.

***There are economic implications of tree loss for stormwater management and clean air in Forest Park.***

■ From 1974 to 1996, tree loss in Forest Park resulted in a 28% increase in runoff—an estimated 2.2 million cubic feet of water (based on an average maximum, two year, 24-hour storm event). Using the City's cost estimate of $2.00/cubic foot to build stormwater systems, this vegetation loss is equivalent in value to a $4.5 million system.

■ The total stormwater retention capacity of this urban forest cover in 1996 is valued at an estimated $11.3 million, down from 1974's value of $15.8 million, based on the avoided cost of having to manage this stormwater.

■ Lost tree canopy would have removed about 37,000 pounds of the pollutants: sulfur dioxide ($SO_2$), carbon monoxide (CO), ozone ($O_3$), and particulate matter 10 microns or less (PM10) from the atmosphere annually, at a value of approximately $95,000 per year.

■ Forest Park's direct residential summer energy savings, as a result of trees shading homes, is estimated at $339,000 annually. The area's recent drought is exacerbated by the region's urban heat island. A dome of hot air within the Atlanta area diverts rainfall to the east and west. Tree cover can help cool urban areas and reverse this trend.

***Maintaining and restoring tree cover is a cost-effective way to improve urban infrastructure.***

■ The natural landscape should be recognized for its economic, as well as its ecological, value. Tree cover is a good measure of the ecological health of the landscape.

■ Increasing the average tree cover to 40% in the area would provide sizeable benefits.

■ Strategically planting trees in urban and suburban areas would improve the effectiveness of tree cover for energy savings, air and water quality, as well as wildlife habitat.

**Table 1. Forest Park's Vegetation Change and Associated Benefits***

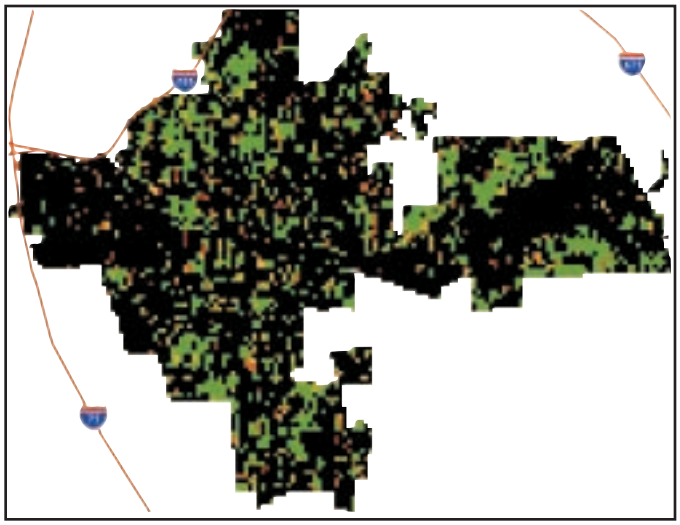
| | 1974 | 1996 | Loss/Gain 1974-1996 |
|---|---|---|---|
| Acres with more than 50% tree cover | 1,288 (21%) | 950 (16%) | -26% |
| Acres with 20%-49% tree cover | 475 (8%) | 96 (2%) | -80% |
| Acres with less than 20% tree cover | 4,325 (71%) | 5,043 (83%) | 17% |
| Stormwater Management Value | $16 million | $11 million | $5 million total** $325,000 annually*** |
| Air Pollution Removal Value (annually) | $334,000 | $239,000 | $95,000 |
| Energy Savings (annually) | | | $339,000**** |

* Numbers may not add to 100% due to rounding.
** Represents a one time savings, and does not include additional savings from annual maintenance.
*** 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).
**** One and two story residential summer energy savings from direct shading of trees.

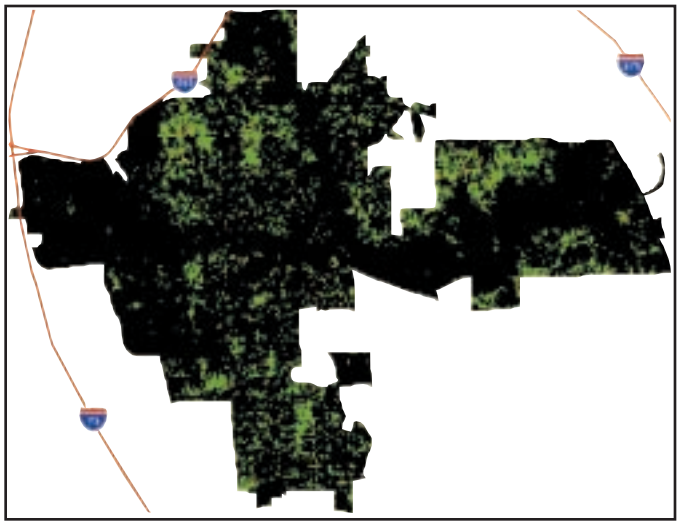
# Regional Analysis

**Key to satellite images:**

| < 20% | 20-29% | 30-39% | 40-49% | ≥ 50% |
|---|---|---|---|---|



*Landsat MSS 1974 80 Meter Pixel Resolution*



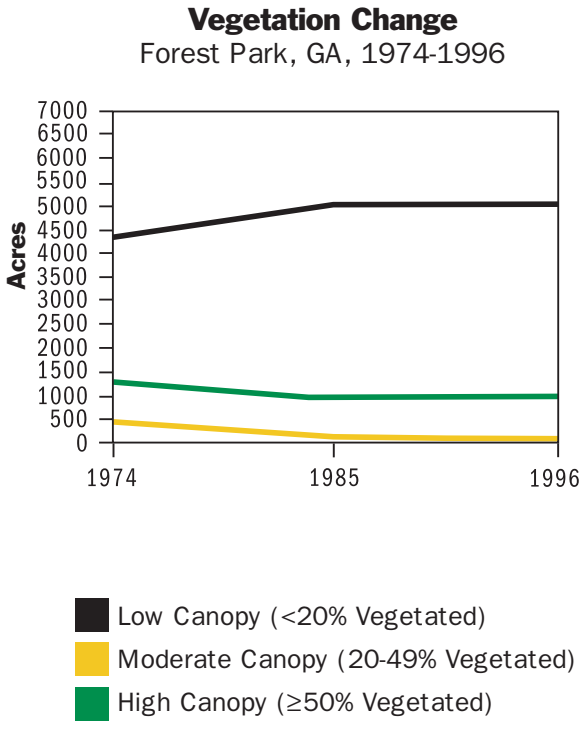
*Landsat TM 1996 30 Meter Pixel Resolution*

## Forest Park Area Satellite Images

Classified satellite images show the change in land cover in Forest Park over a recent 22-year period. Heavy tree canopy cover (≥50%) is indicated in green while low tree canopy cover (<20%) and impervious surfaces associated with urban areas are in black. The GIS analysis measures nine categories of tree cover. Canopy categories are displayed in five groupings to accommodate the limitations of printing the images at this scale.

## Graphing Change

The changes in vegetation depicted in the satellite images (above) are represented by a line graph (right). The chart shows the change in vegetation cover over a 22-year period for three categories. Dense, natural forest cover is represented by a green line and indicates areas with 50% or greater tree canopy. Developed areas are represented by a black line and indicate areas where tree canopy is low—less than 20%. The yellow line represents land where the tree cover is between 20% and 49%.

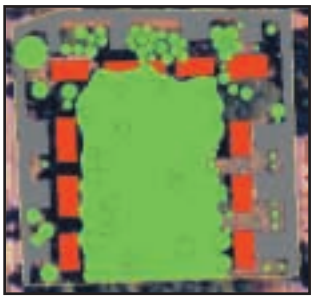


# Local Level Analysis

Using canopy cover classes identified from the satellite image, point samples were selected and low-level aerial imagery was used along with CITYgreen software to calculate the value of the local ecology.

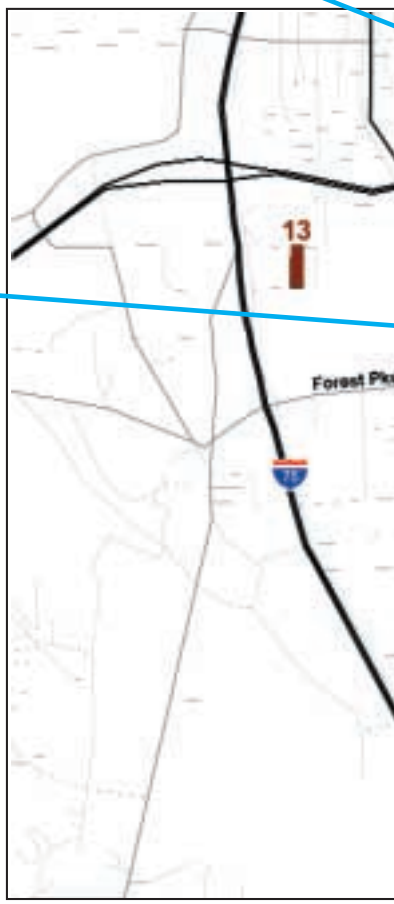
Fourteen sites were selected within Forest Park and analyzed for their ecological value. Sites were selected to represent different land uses (residential, commercial/industrial, and open space). Within each category the sites were also divided into four canopy classes by density (0-19%, 20-29%, 30-39%, 40-49%). A 50% or greater density is considered a natural forest condition. The values of all sites within a class were averaged together for analysis. The resulting average benefits from the sites within each class were multiplied by the total land area of each class. Four of the study sites, representing different land uses and canopy classes are illustrated at right.

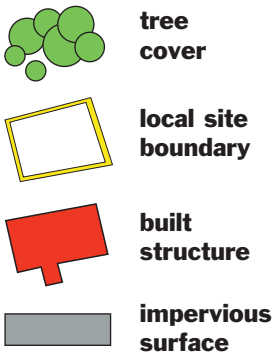
Aerial imagery of study sites provide information about trees, grass, and impervious surfaces. Tree inventory data were collected in the field while other data sources provided data on soil types, rainfall patterns, and land-use configurations. CITYgreen software was used to calculate ecosystem benefits for each sample site. The results were then extrapolated to the entire project area based on the total area for each percentage canopy/landuse category.



**48% tree cover**

**32% tree cover**




## How to Use CITYgreen To Analyze Local Data

AMERICAN FORESTS uses CITYgreen software to conduct a detailed analysis of the structure of the landscape and to calculate the dollar benefits of trees. This analytical technique incorporates research and engineering formulas to place a dollar value on the work trees do. With CITYgreen it is possible to determine how various canopy cover classes affect stormwater movement, air quality, and energy conservation.

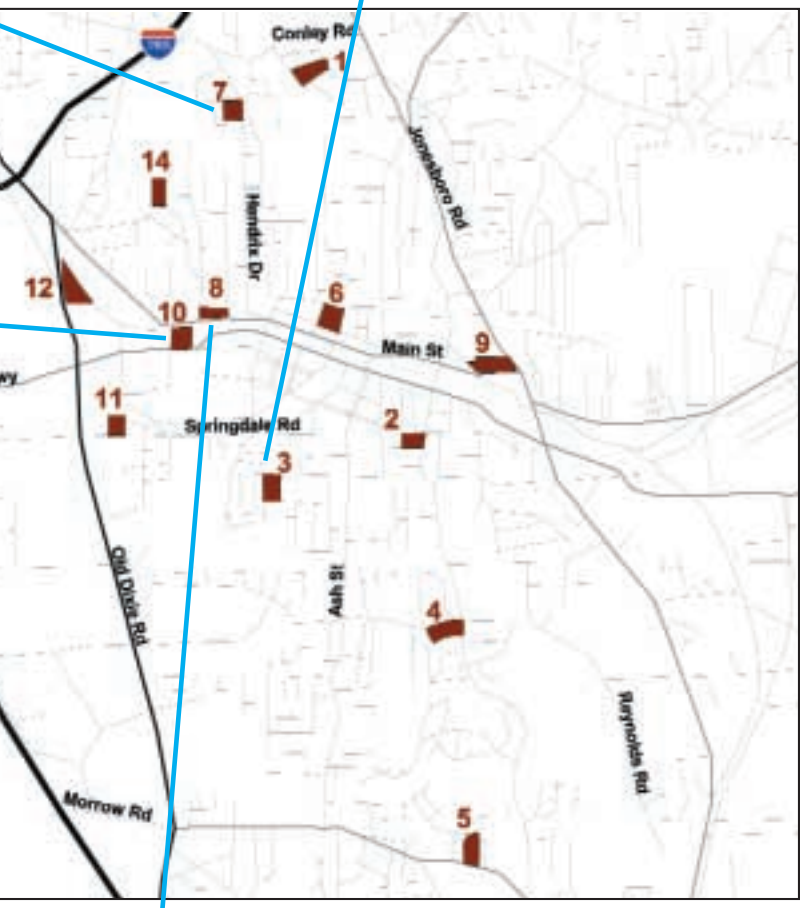
## Stormwater Runoff

Trees and soil function together to reduce stormwater runoff. Trees reduce stormwater flow by intercepting rainwater on leaves, branches, and trunks. Some of the intercepted water evaporates into the atmosphere and some soaks into the ground, reducing peak flows and thus reducing the total amount of runoff that must be managed in urban areas. Trees also slow storm flow, reducing the volume of water that must be managed at once. The TR-55 model, developed by the Natural Resources Conservation Service, provides a quantitative measure of stormwater movement called an "event model" (see page 8).

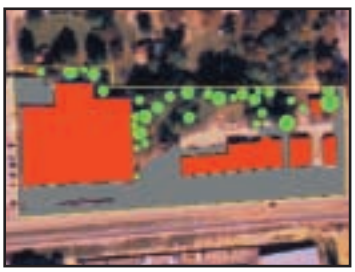
Communities that employ non-structural stormwater management strategies can reduce the cost of constructing stormwater control infrastructure. The value of trees for stormwater management has been calculated based on avoided costs of handling stormwater runoff. Local costs are multiplied by the total volume of avoided storage to determine dollars saved by trees.

In Forest Park, the existing tree canopy reduces the need for stormwater management by 5.7 million cubic feet. Using a $2 per cubic foot stormwater management cost, trees currently save the city $11.3 million.

**16% tree cover**




*Fourteen sample sites were chosen throughout the city of Forest Park to represent a range of neighborhoods and canopy conditions. Four of the fourteen sites are shown in detail here, illustrating canopy coverage from10-45%.*



**8% tree cover**

## Air Quality

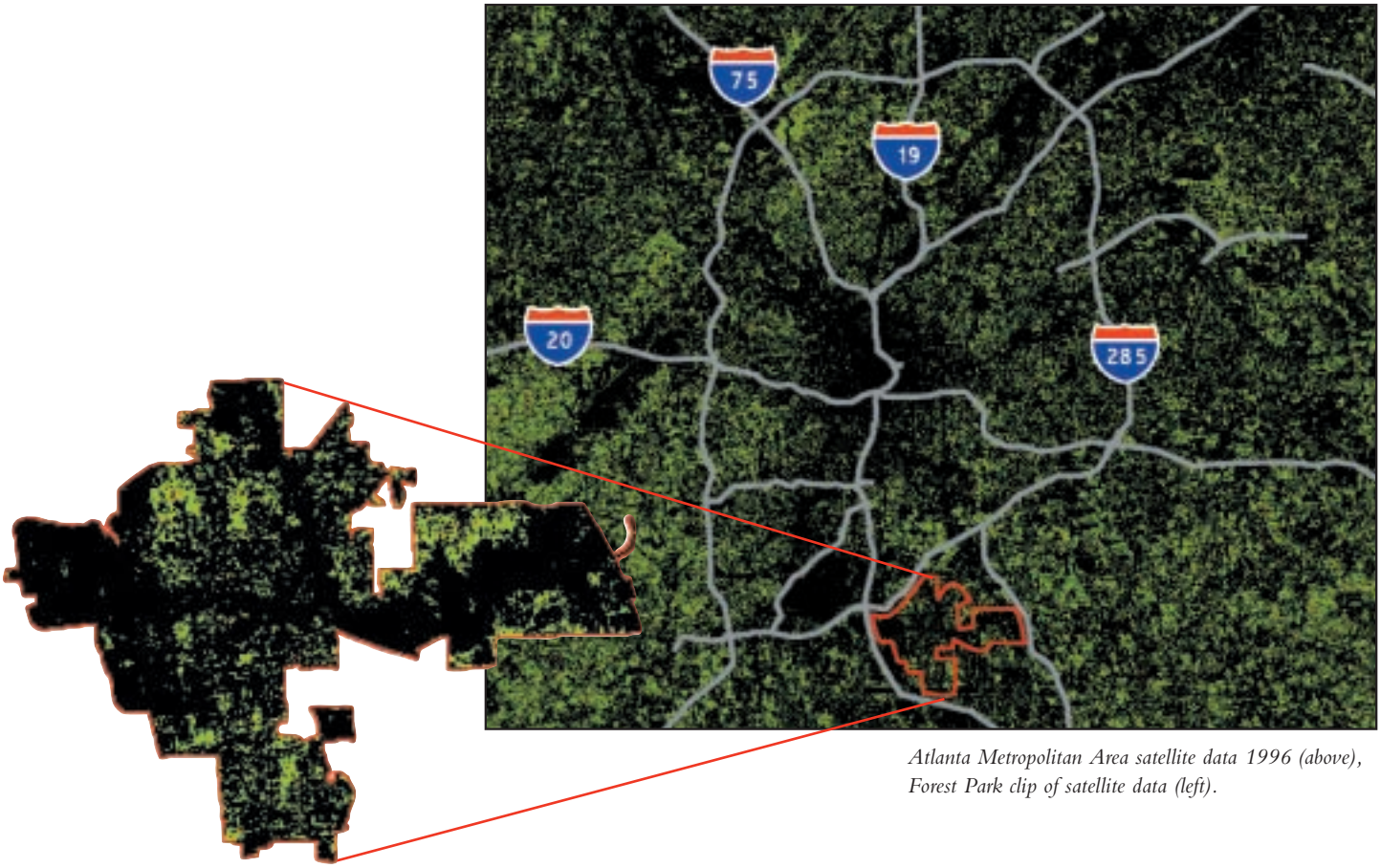
Trees provide air quality benefits by removing pollutants such as nitrogen dioxide, carbon monoxide, sulfur dioxide, ozone, and particulate matter less than 10 microns in size. To calculate the dollar value for these pollutants (see page 8), economists multiply the number of tons of pollutants removed by "externality costs," or costs to society not reflected in marketplace activity, as established by state public service commissions. This figure represents costs that society would have paid, in areas such as health care, if trees did not remove these pollutants. In Forest Park, the existing tree canopy removes 98,000 pounds of pollutants, valued at $239,000 annually. Tree cover as it existed in 1974 would have removed 135,000 pounds of pollutants at a value of $339,000.

## Energy Use

The City of Forest Park experiences a long, hot summer, which is exacerbated by the region's urban heat island and exhibited by the recent drought. Residents spend approximately $400 per home on air conditioning per year. AMERICAN FORESTS' analysis suggests that the existing tree canopy in residential sample sites saves an average of $71 per home. (Note: Because USDA Forest Service research has thus far only modeled savings to residential-size buildings, values were not calculated for residential homes greater than two stories, commercial or open space sites.)

To estimate the city-wide energy conservation savings of trees, the average savings of $71/home was projected across the city's 4,800 single-family detached residences in Forest Park. Assuming that 100% of residences have air conditioning (McPherson et al, 1993), the estimated annual residential savings is approximately $339,000.

# Using Regional Data for Local Analysis




*Atlanta Metropolitan Area satellite data 1996 (above), Forest Park clip of satellite data (left).*

A regional level image contains a great deal of data that can be used by individual local governments. A city or county can obtain a sub-set of the regional data by cutting its boundaries from the regional view. With this information, a local government can determine tree canopy cover. This coarse image can be divided or stratified into various tree cover density classes. These classes form the basis for a more detailed analysis.

Forest Park's image was clipped from a larger regional image of the ten county Atlanta Metropolitan area. The regional analysis shows general trends; the more detailed local analysis is used for planning.

In a separate study, AMERICAN FORESTS analyzed tree canopy cover and ecological change in the City of Atlanta (777,385 acres). The findings show that Forest Park experienced a slower rate of decline in tree canopy than that of Atlanta, however had much lower tree canopy cover to begin with. This perspective allows regional and local planners to consider how the region and the city affect one another.

In Atlanta in 1974, areas with heavy tree canopy coverage (with 50% or greater tree cover) covered 47% of the area. Developed areas and farmland (with tree cover of less than 20%) comprised 44% of the land. By 1996 areas with low tree cover became dominant, expanding to over 71% of the area and heavily-forested areas declined to 26% of the area.

**Table 2. Atlanta and Forest Park Tree Coverage Comparison**

| Average Tree Canopy Cover | 1974% | 1996% | % Loss |
|---|---|---|---|
| City of Atlanta | 43% | 26% | 17% |
| City of Forest Park | 22% | 17% | 5% |

# What's Next for Forest Park?

## Recommendations

The Urban Ecosystem Analysis uses CITYgreen to measure tree cover as an indicator of environmental quality and to guide land-use planning and growth management. When urban trees are large and healthy, the ecological system that supports them is also healthy. Healthy trees require healthy soils, adequate water, and clean air. This report brings together the expertise of ecologists, scientists, and engineers with computer mapping technology to evaluate the environment in Forest Park and chart a course of action for future improvement. We encourage the city of Forest Park to incorporate this data into the local planning process.

***1. Use the findings of this study to address public policy issues for land-use planning and growth management.***

■ Consider the financial value of natural resources during the public policy decision-making process. Urban ecosystems provide concrete financial benefits to municipalities. Investment in resource management should capture these benefits.

■ Incorporate a natural resource data layer into the local planning and zoning process. Before decisions are made that change the landscape, consider the benefits of conserving and increasing tree canopy cover.

***2. Consider the dollar values associated with trees when making land-use decisions.***

■ Use CITYgreen software as a decision support tool to increase community participation.

■ Implement innovative land-use planning techniques and engineering guidelines to save existing trees and plant new ones.

■ Use trees as a valuable and essential element of the urban environment.

***3. Increase and conserve tree canopy cover in urban areas.***

■ Develop measurable urban tree canopy goals. Recommended goals for Forest Park based on urban forest canopy cover patterns in U.S. cities:

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

***4. Use additional GIS applications for land-use planning techniques.***

■ Use CITYgreen software as a tool to incorporate trees into land-use planning by collecting data on tree cover and quantifying the value of the trees. Use the findings in the decision making process.

***5. Develop best practices to increase tree cover in new developments.***

■ Develop standards for tree protection.

***6. Use CITYgreen to conduct additional local analyses.***

■ Increase the number of study sites to obtain more accurate results and to use for specific planning projects.

■ Update the local analysis every five years to track future trends in forest canopy and associated benefits.

# About the Urban Ecosystem Analysis

## Ecostructure Classification

AMERICAN FORESTS' Urban Ecosystem Analysis is based on the assessment of ecostructures, unique combinations of land use and land cover present in a city. Each ecostructure performs ecological functions differently and thus provides different values. For example, a site with a heavy tree canopy provides more stormwater reduction benefits than one with a light tree canopy.

In this study, the regional analysis provided an overview of tree cover change in Forest Park. Using land use and tree cover percentage categories to model the area's ecostructures, sample study sites were selected to further examine the effects of different tree canopy cover percentages on air quality, energy and stormwater management.

## Data Used in this Study

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. For the local analysis, AMERICAN FORESTS used geo-rectified .tif images (digital aerial photos) at a one foot resolution. Field data was collected by Connie Head, Technical Forestry Services, in May 2000.

AMERICAN FORESTS developed CITYgreen software to help communities analyze the value of local trees and vegetation as part of urban infrastructure. CITYgreen is an application of ArcView for Windows, a Geographic Information Systems (GIS) software developed by ESRI.

## Analysis Formulas

***TR-55 for Stormwater Runoff:*** The stormwater runoff calculations incorporate formulas from the Urban Hydrology of Small Watersheds model, (TR-55) developed by the US 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.

***UFORE Model for Air Pollution:*** CITYgreen uses formulas from a model developed by David Nowak, PhD, of the US Forest Service. The model estimates how many pounds of ozone, sulfur dioxide, nitrogen dioxide, PM10 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 indirect costs to society, such as rising health care expenditures.

## Acknowledgments

We gratefully acknowledge the support of the city of Forest Park; the Natural Resources Conservation Service; the USDA Forest Service; ESRI for GIS software; Emerge for aerial photography and ERDAS for remote sensing software.

## For More Information

AMERICAN FORESTS, founded in 1875, is the oldest national nonprofit citizen conservation organization. Its three centers–Global ReLeaf, Urban Forestry, and Forest Policy–mobilize people to improve the environment by planting and caring for trees. Global ReLeaf 2000 is AMERICAN FORESTS' campaign to plant 20 million trees for the new millennium.

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 workshops and technical support for CITYgreen and is a certified ESRI developer and reseller of ArcView products.

For further information contact:

AMERICAN FORESTS P.O. Box 2000 Washington DC 20013
Phone: 202/955-4500; Fax: 202/955-4588
E-mail: cgreen@amfor.org
Web: www.americanforests.org
Click on "Trees, Cities & Sprawl"

125 YEARS 1875-2000
AMERICAN FORESTS®
PEOPLE CARING FOR TREES & FORESTS SINCE 1875

GLOBAL RELEAF 2000