OHIO AND MICHIGAN URBAN TREE CANOPY ASSESSMENTS AND WEB PORTAL

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Abstract

In September 2008, the Department of Natural Resources (DNR) from Ohio and Michigan jointly submitted a grant application to the U.S. Forest Service State & Private Forestry called the Urban Tree Canopy (UTC) Assessment and Implementation Project which was selected for funding in 2009. Using the latest remote sensing and geoprocessing models and methodologies, six (6) cities and one county received UTC assessments covering a combined 750 square miles. The UTC process involved collecting, acquiring and analyzing various aerial imagery, LiDAR, and GIS base layers, performing object-based image classification (Feature Analyst v.5) and vector editing, customizing geoprocessing models in ModelBuilder and Python, ecosystem services analysis (i-Tree and CITYgreen software), suitability modeling (CommunityViz), and final reporting. Eastern Michigan University (EMU) used the process to develop a curriculum for GIS-based natural resource assessment techniques. EMU faculty and students made the products accessible online using Esri's ArcGIS Server API for Microsoft Silverlight (http://www.midwestutc.org/). Cities, counties, non-profits and others are using the UTC data to set canopy cover goals and educate the public on the benefits of urban trees.

Introduction

The urban forest is the collection of all trees and shrubs found in every neighborhood, town, and city. Simply put, urban tree canopy is the portion of city trees that consists of leaves, stems, and branches. However, when used in the context of urban tree canopy assessments, the term refers to the quantity of surface area covered by the leaves, stems, and branches of city trees when viewed from above. It includes trees of all shapes, sizes, and species, their canopies above and the ground below. The urban forest exists along public streets, in parks, in private yards, and everywhere in between. Collectively, this natural resource makes up what is called Green Infrastructure, and is providing environmental, social, and economic benefits to over 80% (225 million) of the US population living in urban areas. Rigorous new research uses tools like Geographic Information Systems (GIS) and remote sensing to better assess the urban forest and helps demonstrate how this resource assists in solving many of our social, economic, and ecological issues, both locally and nationally.

For urban forestry programs to be effective and sustainable, it is necessary to understand the nature of a community's urban forest resource, specifically its size, species distribution, land use, and land cover. Urban forest managers are now able to adapt new technologies in remote sensing and geographic information systems (GIS) to create an effective means of identifying some of these components. This aerial analysis is called an urban tree canopy (UTC) assessment and it represents a new direction in enhanced monitoring and management of the urban forest, on public as well as private land.

In 2009 the Michigan and Ohio Departments of Natural Resources (DNR) collaborated with six municipalities, AMEC Environment & Infrastructure, and Eastern Michigan University to conduct a multi-faceted project focused on characterizing local UTC. The project was funded by the USDA Forest Service and the website www.MidwestUTC.org was developed to host the project results and data and to provide relevant educational resources for urban forest managers, educators and citizens alike.

The map here shows the extent of the project's study areas.

What is a UTC Assessment?

An urban tree canopy (UTC) assessment is a technical and scientific process that quantifies the amount of surface area (when viewed from above) covered by the leaves, branches, and stems of the trees in a given area. Of all the methods for measuring and characterizing a city's urban forest, a UTC assessment is the fastest and least expensive way of achieving meaningful results.

The goal of the UTC assessment is to help policy makers understand how much tree canopy their city currently has, as well as how much they could potentially have, given the makeup of their community. Knowing the extent of a city's tree canopy allows for the education of both city officials and the general public regarding the state of their urban forest, and encourages their interest in seeing it expanded and nurtured. Comparisons can also be made to other regional cities of similar size, in order to determine how a city's urban forest ranks relative to its peers. This helps managers set tree canopy goals, and develop plans that will economically and efficiently meet these goals.

Ohio and Michigan's UTC Assessment Process

An assortment of geographic information system (GIS) layers such as municipal boundaries, land use, and infrastructure data were submitted by each of the six cities to AMEC. These data, integrated with aerial imagery provided by the U.S.D.A. Farm Services Agency, provided AMEC with the information needed to perform a UTC analysis. These analyses identified tree canopy size and composition for each city, and showed locations where the urban forest could potentially be expanded within the project areas.

All UTC assessments use a combination of geographic information science (GIS) technology and image interpretation techniques, and begin with the collection and analysis of at least four types of data:

- High-resolution aerial or satellite imagery
- Supporting GIS layers (which generally include some infrastructure and natural features)
- Land cover classification data
- Geographic municipal, planning, and land use boundaries for assessment and reporting

The imagery is analyzed in combination with the GIS layers and land cover data in order to determine which areas of the city are currently covered by tree canopies, which areas are not currently covered by tree canopies but have the potential for planting new trees, and which areas are covered by impervious surfaces (and therefore lack the potential for planting new trees); these categorized areas are then measured, and, using the municipal geographic boundaries, the percentage of land area each category occupies within the total city is assessed, as well as the percentage of land each category occupies within the city's different land use zoning types (such as commercial, residential, and industrial) or land divisions (such as parcels).

Geographic Boundaries Assessed

	Adrian	Ann Arbor	Cincinnati	Cleveland Metroparks	Hudson	University Heights
Total City Area	X	X	X			X
Citywide Land Use	X	X			X	
Ecosites				X		
Reservations				X		
Watersheds		X			X	
Creeksheds						
US Census Blocks	X	X			X	X
Residential Subdivisions						X
Land Parcels	X				X	X
Neighborhoods			X			
Parks			X			
Public Right-of-Way						X

* The table above lists the geographic boundaries in each city for which UTC was assessed. The results can be found in each city's report.

As seen in the table above, each project had some identical assessment boundaries; however each project also included custom geospatial analysis, ecosystem analysis, or tool development to assist in urban forest planning, education, and implementation. Two examples are provided:

- AMEC developed a process to prioritize vacant (plantable) street trees in Adrian and Ann Arbor using CommunityViz software. Weights could be applied to various GIS criteria under scenarios to calculate Suitability Scores from 0-100 for each tree feature point to guide where and why the City should plant trees for environmental and economic factors.
- AMEC provided Ann Arbor with a Tree Canopy Calculator spreadsheet tool to assist in UTC goal setting. The plug-and-play tool allows a user to see the effects of tree size and tree planting on canopy goals citywide and by land use types.

Once the assessment has been performed, the results are summarized in reports that are then given to city managers. These results provide an informed starting point for local policy makers to develop new forestry management plans, or to revise existing plans.

The following software, tools, and extensions were used in the OH/MI UTC Assessment Project:

- Esri ArcGIS for geoprocessing, database management, cartography and web mapping
  - Desktop (Advanced, aka ArcInfo)
  - ModelBuilder and Python scripts
  - Server (API for Microsoft Silverlight)
- CommunityViz (Placeways) suitability model wizard to prioritize tree planting locations and 3D visualization
- Feature Analyst (Textron Systems / Overwatch Systems) for object-based image analysis (OBIA) to perform land cover classification
- i-Tree Suite of Tools (U.S. Forest Service), specifically i-Eco and i-Hydro, for assessing the structure, value and function (ecosystem services) of the urban forest
- CITYgreen (American Forests) for modeling current and future ecosystem services

Ecosystem Services (Benefits) Analysis

In addition to the GIS products provided in the UTC assessments, several projects included an analysis of urban forest ecosystem services. These are the direct and indirect benefits provided by urban trees that are often unaccounted for. Examples include stormwater runoff abatement, carbon storage and sequestration, absorption of air pollutants, and energy conservation from summer shade and winter wind block, to name a few. Models and inventory or assessment data make it possible to assess current ecosystem services and future benefits under forecasted land cover scenarios.

Using Cincinnati and Hudson's land cover data, CITYgreen modeling provided reports of the current and future urban forest value in economic and environmental terms. In Cleveland, Ian Hanou (then of AMEC) provided i-Tree Eco training to Cleveland Metroparks and assisted in working with the U.S. Forest Service in the analysis and reporting of the Eco project results. And lastly, after completing Cincinnati and Hamilton County's land cover classification and UTC Assessment, AMEC utilized the US Forest Service i-Tree Hydro model to assess the impact of impervious surface area, invasive honeysuckle understory, and other green infrastructure on stormwater runoff, streamflow, and water quality in the Lick Run watershed.

Results and Deliverables

The tables below offer a high-level summary of the multi-state UTC assessment results and product deliverables.

Summary of Results

	Adrian	Ann Arbor	Cincinnati	Cleveland Metroparks	Hudson	University Heights
Total UTC (%)	24.1	32.9	38.8	40.9	40.4	21.8
Total Possible UTC (%)	62.1	43.3	Not Reported	32.4	51	31.2
Total UTC (Acres)	1,341	6,015	19,754	61,597	6,684	255
Total Possible UTC (Acres)	3,462	7,911	Not Reported	48,802	8,442	364
Study Area Size (Acres)	5,571	18,264	50,913	150,514	16,548	1,168
Study Area Size (Sq. Miles)	8.7	28.5	79.6	235.2	25.9	1.8

*** The table above lists the primary results of each city's UTC assessment, as well as the size of each study area.**

Project Deliverables

	Adrian	Ann Arbor	Cincinnati	Cleveland Metroparks	Hudson	University Heights
GIS Layers	X	X	X	X	X	X
Aerial Imagery	X	X	X	X	X	X
UTC Calculator		X				
UTC Spreadsheet	X	X	X	X	X	X
CITYgreen Analysis			X			
i-Tree Eco Analysis				X		
UTC Results Report	X	X	X	X	X	X
PowerPoint Presentation		X			X	X
Revisions to 2000 UTC Analysis			X			
GIS Priority Tree Planting Database	X	X				

* The table above lists the products provided by AMEC to each city upon completion of their UTC assessment.

The Next Steps

The reports generated from these analyses allow municipal governments to better understand how their urban trees are benefitting the area, in terms of both economic savings and ecosystem services. This information informs planning decisions that city officials make regarding their urban forestry programs. However, the ultimate goal of this project is to provide the urban forester with tools and a proven and easily replicable template they can use, in the hope that the results of these studies will provide the rationale for other local governments to perform their own urban tree canopy analyses.

For more information, visit www.MidwestUTC.org.