

Frequently Asked Questions about the UFORE model (www.ufore.org)

What is UFORE?

UFORE, which stands for Urban Forest Effects, is a science-based, peer-reviewed computer model designed to calculate urban forest ecosystem services and values based on field data inputs and available data sets from external sources (e.g., weather and pollution data sets). UFORE can calculate urban forest structure and several ecosystem services and values for any area of any size.

UFORE is a compilation of three programs:

- 1) Field plot selector -- allows users to easily locate field plots on maps using GIS.
- 2) Data collection program -- a field data collection program for use on a personal digital assistant (PDA) running Windows CE.
- 3) UFORE application – an interface that allows the user to operate the two programs cited above, collect and enter field data (either through the PDA or on paper forms), have data analyzed, and generate and export standard graphs and tables. A user's manual is also available through the help menu.

Why was UFORE developed?

UFORE was developed in the 1990s to standardize a protocol for collecting and analyzing data in urban areas. The need for this tool became apparent following the first urban ecosystem assessment studies in Oakland, Chicago, and other U.S. cities.

What does UFORE calculate?

- Urban forest structure by strata (e.g., land-use types), including species composition, tree density, diameter distribution, tree health, leaf and tree biomass, and species diversity.
- Amount of pollution removed (hourly) by the urban forest, and associated percent improvement in air quality. Pollution removal is calculated for carbon monoxide, nitrogen dioxide, ozone, particulate matter (< 10 microns), and sulfur dioxide.
- Volatile organic compounds (VOC) emissions from the urban forest (hourly) and the relative impact of tree species on net ozone and carbon monoxide formation throughout the year.
- Total carbon stored and net annual carbon sequestration by the urban forest.
- Tree effects on building energy use and consequent emissions from power plants.
- Compensatory value of the forest, air pollution removal value, and carbon storage and sequestration values.
- Potential impact of infestations by gypsy moth, Asian longhorned beetle, Dutch elm disease, and emerald ash borer.
- Changes in streamflow (hourly) due to urban trees and impervious surfaces.
- Changes in water quality (hourly) due to urban trees and impervious surfaces, including total nitrogen, nitrate and nitrite, total Kjeldahl nitrogen, total phosphorus, dissolved phosphorus, total suspended solids, dissolved solids, lead, copper, zinc, cadmium, chromium, nickel, biological dissolved oxygen, chemical dissolved oxygen, alkalinity, and oil and grease.



Who uses UFORE?

UFORE has a diverse group of users, from scientists and university students who want to study the effects of urban forests on the environment, to local city planners who are exploring the use of trees on pollution mitigation and mapping underserved areas of their communities where trees would be the most useful, to managers who want to know and better manage their resource, to public groups that want to understand the values of urban forests and bolster support for urban tree planting and urban forestry programs.

Why should I use UFORE?

UFORE provides necessary information on the urban forest resource and its ecosystem services to improve urban forest management and garner support for urban forestry programs. Data on urban forest structure and health can aid in establishing appropriate budget levels and workload allocation, while information on tree cover can help define areas where new tree plantings would be more beneficial. Pest information can help detect existing vulnerabilities to insects and pathogens that could devastate the urban forest. The ecosystem service results can be used to determine the value of the resource and support integrating urban forest programs in larger regulatory efforts to improve environmental quality.

How can UFORE be used in regulatory efforts to improve environmental quality?

Results from UFORE also can help determine the effect of trees on aspects of the environment that are regulated by the U.S. Environmental Protection Agency. As the Clean Air and Clean Water Acts impose regulations that affect urban areas, the regulations affect urban development, funding, and management at local and state levels. As trees affect the environment, the ability to quantify these effects could lead to the incorporation of urban vegetation management strategies (and potential funding) to help meet these environmental regulations. Urban trees can be incorporated as an emerging measure with State Implementation Plans to meet clean air regulations

(www.fs.fed.us/ne/syracuse/Emerging%20Measures%20Summary.pdf).

Urban trees also could be used to potentially meet clean water regulations associated with Total Maximum Daily Loads (www.epa.gov/owow/tmdl/intro.html) and storm water programs (www.epa.gov/region6/water/npdes/sw/ms4/).

How have UFORE results helped communities?

Numerous communities, both nationally and internationally, have used UFORE to assess ecosystem services and aid in improved urban forest management. One of the best examples of how UFORE results have helped a community comes from New Jersey. There, based in part on UFORE results, Conectiv Electric Utility negotiated to have a \$1 million air pollution fine donated to the New Jersey Tree Foundation for a massive Urban Air-shed Reforestation project in the Camden area. Trained volunteers are planting 3-inch caliper shade trees in the communities most affected by the air pollution (www.na.fs.fed.us/urban/states2003/nj/nj.htm).

How does UFORE work?

UFORE uses locally collected field data along with readily available external data sources (e.g., weather and pollution data) to quantify basic tree functions and ecosystem services. However, some basic field measurements that are used to quantify urban forest structure must be collected on the ground (e.g., species, diameter, crown height and width, crown condition) from randomly located plots. Data from the plots are then statistically extrapolated upward to estimate totals and standard errors for the entire study area or strata (e.g., land-use types) within the study area.

Is field data collection necessary?

Yes. Field data are necessary to accurately quantify the urban forest structure. Quantifying carbon, VOC emissions, energy effects, and other services require data on individual trees for accurate estimates. Quantifying ecosystem services only with aerial data would provide only coarse estimates of these services. Using local field data along with local weather and pollution data sets provides a more accurate assessment of the local urban forest structure and services.

Is there any new functionality planned for UFORE?

Updates to the functionality of UFORE will be available via the Internet as UFORE will be continually developed and refined with new capabilities through time. There are three new modules in development.

- 1) UFORE-Hydro. This is a GIS-based program that estimates changes in streamflows and water quality based on changes in tree cover and impervious surface cover attributes within a watershed. The model is calibrated against actual streamflow data and is designed specifically to estimate vegetation effects.
- 2) UFORE-Species. This is a functional species selection program that was developed in cooperation with Horticipia (www.horticipia.com). From a database with information on thousands of trees, trees are rated for their relative ability for air pollution removal, VOC emissions, air quality improvement, carbon storage, air temperature reduction, shading, building energy conservation, and allergenicity. Users are asked to rate the importance of each of these functions to determine the best species given the users' ratings. The program rankings are based on relative tree functions at maturity and local hardiness zone to aid in tree selection in the area to maximum ecosystem services from trees and improve environmental quality in cities.
- 3) UFORE Growout. This program uses the output from UFORE to project future tree population totals, canopy cover, and carbon storage based on user inputs of estimated mortality rates. Populations can be projected over a 100-year period. The program also can be used to determine annual tree planting/establishment rates needed to sustain a specific tree canopy cover.



What cities have been analyzed using UFORE?

Atlanta, GA	Morgantown, WV
Baltimore, MD	Moorestown, NJ
Beijing, China	New York, NY
Boston, MA	Ningbo, China
Brooklyn, NY	Oakville, Ontario
Calgary, Alberta	Philadelphia, PA
Freehold, NJ	Porto Alegre, Brazil
Fuenlabrada, Spain	San Francisco, CA
Greenville-Spartanburg, SC	San Juan, PR
Houston, TX	Santiago, Chile
Hefei, China	Syracuse, NY
Jersey City, NJ	Toronto, Ontario
Kent, OH	Washington, DC
Minneapolis, MN	Wilmington, DE
	Woodbridge, NJ

Current cities being analyzed are:

Baton Rouge, LA
Fredericton, New Brunswick
Gainesville, FL
Scranton, PA
Shenzhen, China

How much does UFORE cost?

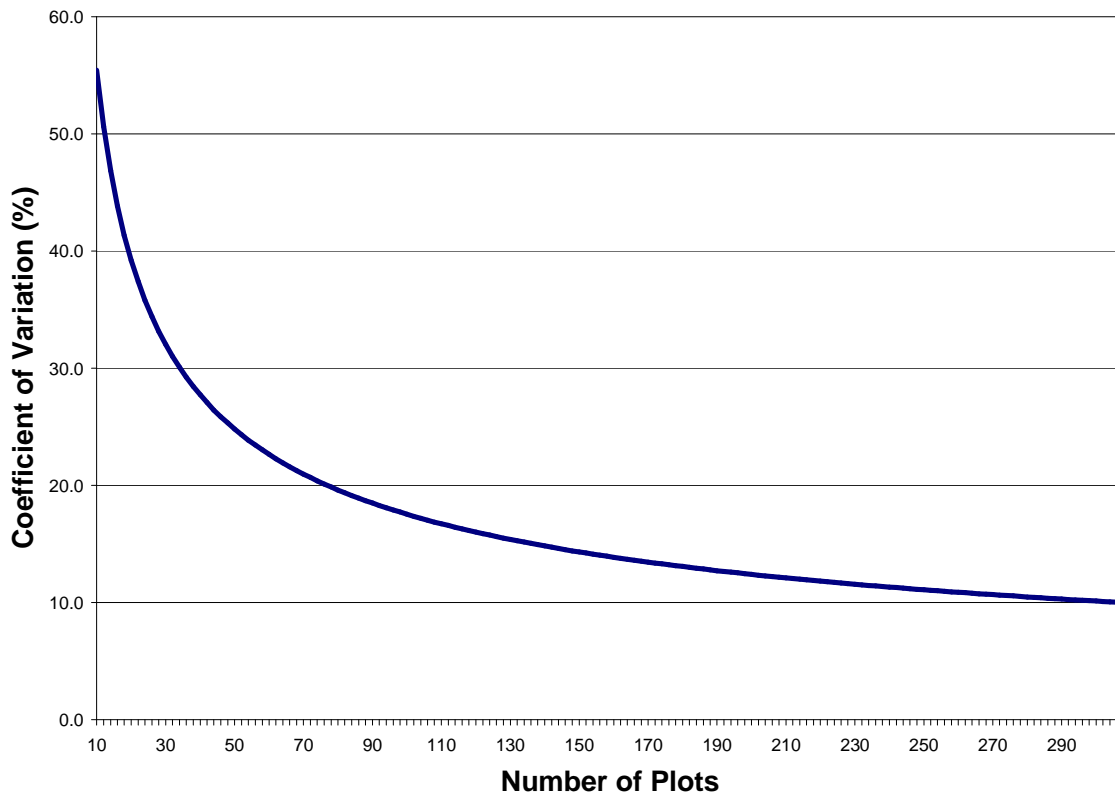
UFORE is a public-domain program distributed at no-cost.

What does the typical city analysis cost?

As a general rule, a two-person crew can collect data on 150 to 200 one-tenth acre plots during a 3-month summer season. The cost for the data collection would depend on how much the crew is paid and the local transportation cost to get to the plots. Other costs incurred by conducting an analysis relate to equipment and local office support costs for project setup, analysis, and reporting. Some costs are incurred for quality assurance measures (training and plot data checks).

How many field plots will I need to analyze my city?

The number of plots is up to the user. Increasing the number of plots and/or size of the plots will typically lead to lower variances and increased certainty in the results, but it also tends to increase the cost of the project. The following is a rough estimate of the coefficient of variation (standard error divided by total expressed as a percentage) of the total number of trees in a city based on the number of plots sampled.



What do I have to do to run a UFORE analysis?

Read the i-Tree Software Suite User's Manual found under the UFORE program help menu or at the Resource/Learning Center on the i-Tree website (www.itreetools.org) to determine the data collection and analysis procedures. The basic steps are:

- 1) Determine your study area
- 2) Distribute sample points for plot location
- 3) Collect the field data
- 4) Use UFORE to analyze the data
- 5) Use UFORE to generate tables and charts
- 6) Export data for local report generation

Training sessions and technical support are available. (see www.itreetools.org).

Can I use existing inventory data?

Existing inventory data can be used if the proper crown parameters are measured on each tree, along with information on species, diameter at breast height (4.5 feet), and crown condition (see i-Tree Software Suite User's Manual). Species codes must also be converted to UFORE species codes (see www.itreetools.org).



Can UFORE data be mapped?

Yes. Examples of types of GIS maps that can be produced using UFORE data are given within the UFORE program.

Does UFORE calculate cost-benefit ratios?

No. UFORE estimates dollar benefits of ecosystem services based on economic literature. To estimate the cost-benefit ratio, good estimates of management costs of the entire urban forest would be needed. These data are not yet available, but UFORE-Growout is being developed to project costs and benefits through time based on user inputs of costs.

Can UFORE be used for street trees and non-urban areas?

Yes. UFORE has been used to assess street trees and nonurban areas. If proper tree data are collected, UFORE can calculate leaf area and biomass, air pollution removal, VOC emissions, carbon storage and sequestration, and compensatory value on a per-tree basis. However, the STRATUM model is designed to analyze street tree populations and can be used to assess this resource.

As UFORE is designed to calculate tree effects based on an area sample, the model can be used for nonurban areas of any size. One limitation of using the model outside of urban areas is that some local input data sets (e.g., pollution and weather data) are more limited outside of urban areas.

Who developed UFORE?

UFORE was developed by a team of scientists and technicians from the Forest Service's Northeastern Research Station, Davey Resource Group, SUNY College of Environmental Science and Forestry, and Clemson University with support from these partner groups and Forest Service State and Private Forestry's Urban and Community Forestry and Northeastern Area programs.

Where can I obtain additional information about UFORE?

For additional information, visit www.itreetools.org, www.ufore.org, or www.fs.fed.us/ne/syracuse/Tools/UFORE.htm