



Urban Forests

Calculating Tree Benefits

Michael R. Binkley
The Davey Tree Expert Company



i-Tree is a
Cooperative
Initiative



Today's Purpose

- 🌳 Even better care and management of your Urban Forest
- 🌳 Justification for your Urban Forest program
 - \$ in; \$ out
 - Quantifiable tree benefit estimates
- 🌳 Calculate general Tree Benefits in ~ 1 hour
 - Does NOT require a degree in IT
 - Practical use



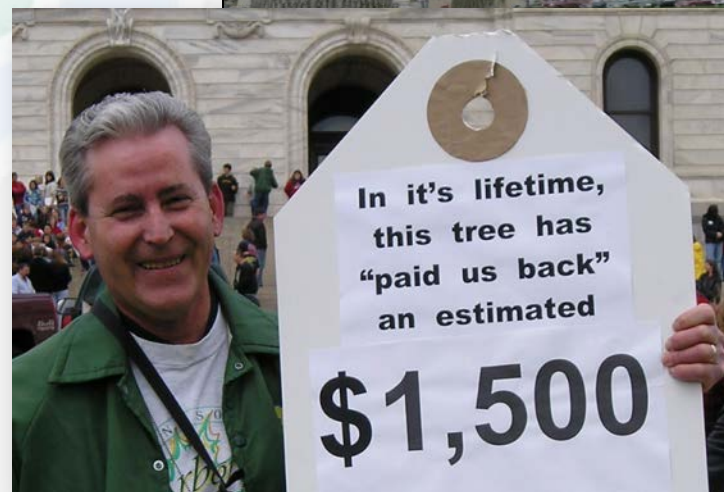
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Cooperative
Initiative



i-Tree: Demonstrating that Trees Pay Us Back!

Street Tree Benefits in Minneapolis:

- 🌳 \$6.8 million in energy savings
- 🌳 \$9.1 million in reduced storm water runoff
- 🌳 \$7.1 million increase in property value
- 🌳 \$1 million improvements to air quality



i-Tree: Demonstrating that Trees Pay Us Back!



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i-Tree: Demonstrating that Trees Pay Us Back!



i-Tree is...

Development, Dissemination, Support, & Refinement

- 🌳 Credible, USDA
FS peer-reviewed
tools
- 🌳 Public Domain
Software
- 🌳 Accessible
- 🌳 Technical Support

*“Putting USFS Urban Forest science
into the hands of users”*

The screenshot shows the i-Tree website homepage. At the top, there is a navigation bar with the i-Tree logo, the tagline "Tools for Assessing and Managing Community Forests", a "Get the Tools." button with a CD icon, a Google Custom Search box, and a USDA logo. Below the navigation bar is a large banner image of a tree-lined street. Underneath the banner is a horizontal menu with buttons for Home, About, Applications, Utilities, Resources, Support, and i-Tree News. The main content area is divided into three columns. The left column has a section titled "Listen & Learn: i-Tree Overview" featuring a small i-Tree logo and text about its technology for effective urban forest management, followed by a "Featured i-Tree Project" section highlighting the City of Milwaukee, WI, and an "i-Tree Ecosystem Analysis Milwaukee" image. The middle column is titled "What is i-Tree?" and contains a paragraph explaining that i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. The right column is titled "What's New?" and lists recent updates: "i-Tree: Measuring the Urban Forest in FLC NewsLink FLC article March 2009 >>", "i-PED - Pest Evaluation and Detection Protocol Learn more about i-PED>>", and "i-Tree April 2009 Newsletter now available April 2009 i-Tree Newsletter>>". At the bottom of the website, there is a footer with logos for i-Tree, i-Tree is a Cooperative Initiative, UAS, DAVEY, Arbor Day Foundation, SMA (Society of Municipal Arborists), ISA (International Society of Arboriculture), and Casey Trees.

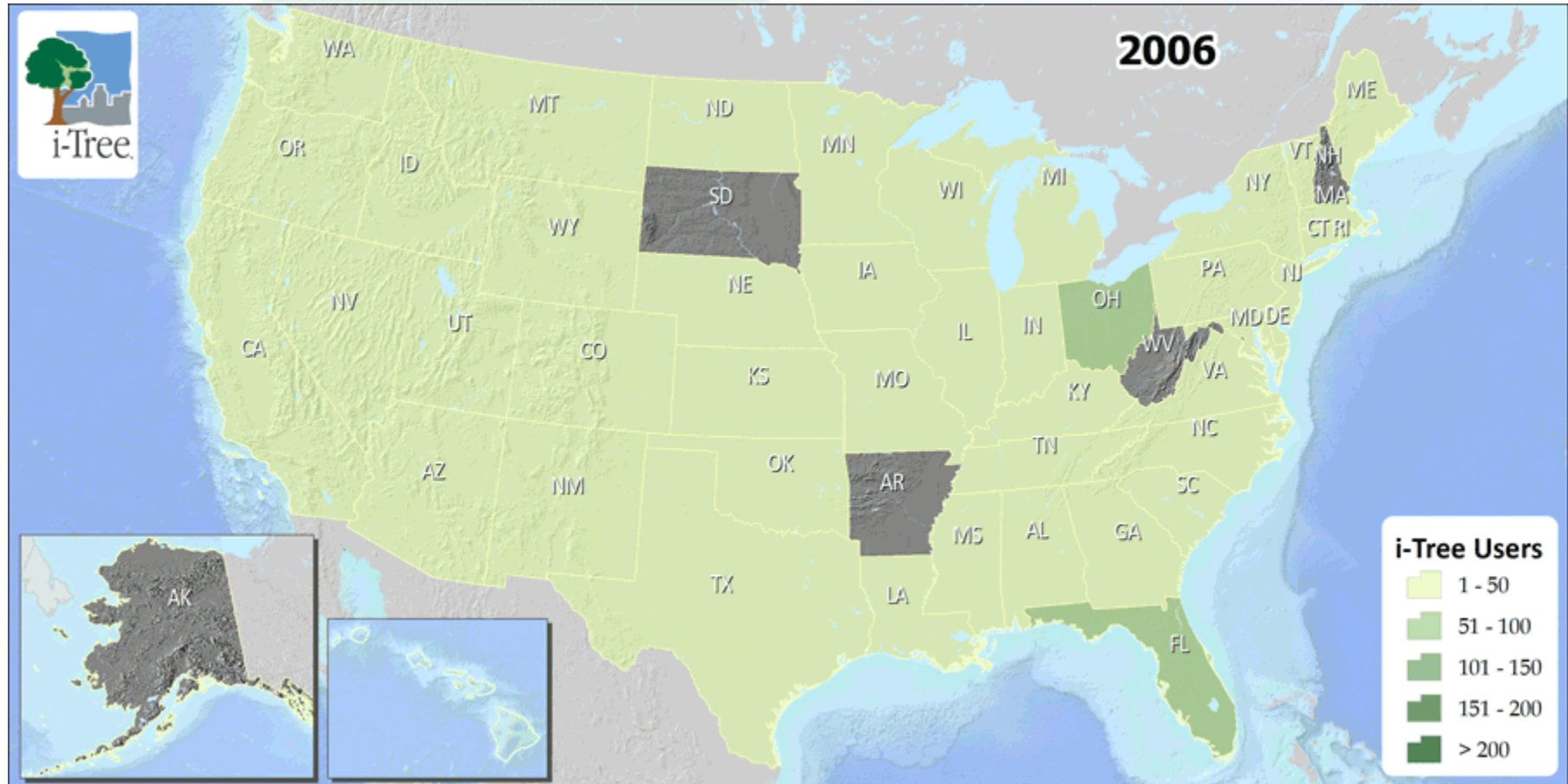


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i-Tree user base continues to grow...

at home,

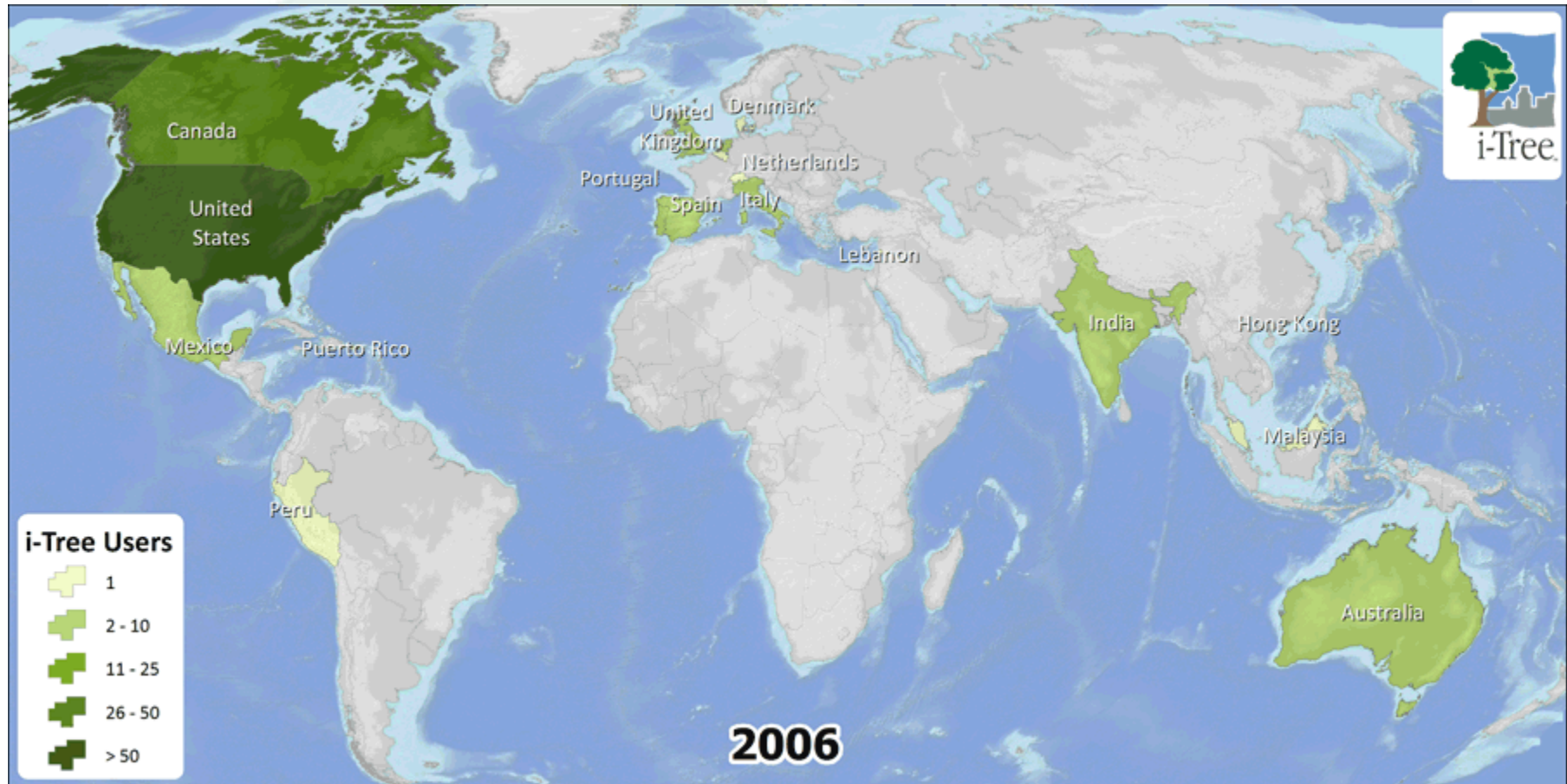


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i-Tree user base continues to grow...

and abroad.



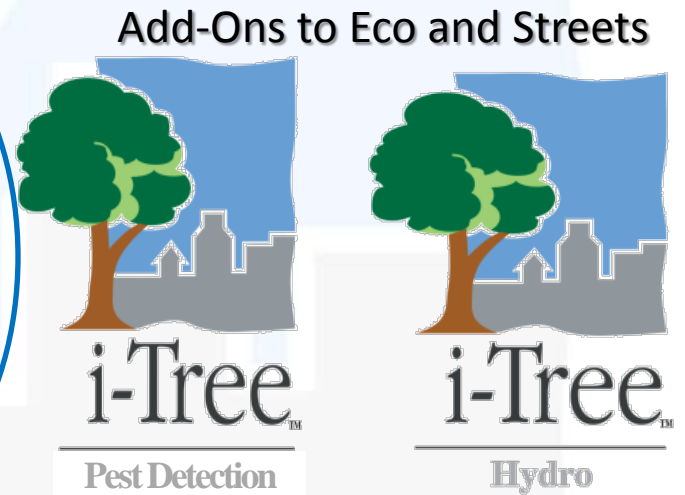
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v4: New Tools & Enhancements



<- Field Data ->



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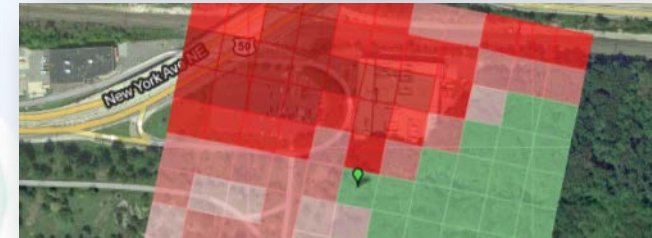


Remote Sensing Canopy Assessment Tools

- less
- Cost, Resolution, Time
- more
- Regional Value Aggregation lookups & calculations
 - i-Tree Design
 - Satellite Based
 - i-Tree Vue
 - Statistical Estimation via photo-interpretation
 - i-Tree Canopy
 - Hyperspectral classification, GIS analysis & photo-interpretation
 - UTC

Trees Affected	Population Standard Estimate Error	% of Species	% of
1	N/A (N/A)	100.00	1
1	N/A (N/A)	100.00	
1	N/A (N/A)	100.00	
2	N/A (N/A)	100.00	
1	N/A (N/A)	100.00	
7	N/A (N/A)	87.50	
1	N/A (N/A)	100.00	
1	N/A (N/A)	100.00	
6	N/A (N/A)	100.00	
5	N/A (N/A)	100.00	
1	N/A (N/A)	100.00	
1	N/A (N/A)	100.00	
1	N/A (N/A)	100.00	

i-Tree Streets Climate Zones





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i-Tree Design

- 🌳 (formerly the National Tree Benefit calculator)
- 🌳 One tree
- 🌳 Geared towards public use
- 🌳 Web accessible by all
- 🌳 Benefit values reported by species via look up tables & calculations
- 🌳 Energy values based on look up tables AND Google Map orientation of house and tree



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i-Tree

Tools for Assessing and Managing
Community Forests

Get the Tools.



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i-Tree Benefit Calculator

Understanding This Tool:

The Tree Benefit Calculator allows anyone to make a simple estimation of the benefits individual trees provide. This tool is based on calculations and methods used in i-Tree Streets and Eco assessment tools. With inputs of location, species and tree size, users will get an understanding of the environmental and economic value trees provide on an annual basis.

The Tree Benefit Calculator is intended to be simple and accessible. As such, this tool should be considered a starting point for understanding trees' value in the community, rather than a scientific accounting of precise values. For more detailed information on urban and community forest assessments, please explore the rest of the [i-Tree](#) website.

Thank you for choosing i-Tree to calculate the economic and ecological benefits of your tree.

To get started enter your address below:

3045 Woodcrest Dr, Fairlawn, OH 44333, USA

Submit



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i-Tree Benefit Calculator

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Get started with three easy steps:

1. Draw your house or building and locate your tree:

Use the drawing tool  to outline your house or building. Be sure to outline "conditioned" living area only; garages and other unheated or cooled spaces should not be included. Use the tree tool  to locate your tree; place the marker as close to the base (or center) of the tree as possible. Planting on the East and West sides of your house will save you money on your summer cooling bills.

You may find it easier to outline the building and place your tree by zooming in.

2. Indicate when your house or building was built:

post-1980

3. Enter your tree's information:

Maple, Red

If you're looking for a Willow Oak it's listed as "Oak, Willow". If your tree isn't listed, use the general "Other" listings.

14

Enter the diameter of the tree in inches; how wide is the trunk of your tree at about 4.5 feet above the ground?

Good

Finally, enter what type of condition best describes your tree.

[Calculate Benefits](#)

Map Satellite Hybrid

POWERED BY Google

Terms of Use

Lat: 41.1143451 Long: -81.6175228 Bearing: 122.5 Distance: 2.0m (6.5ft) Vertices: 13; Area: 219.6 m² (2364.0 ft²)

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[Calculate another tree](#)

Overall Benefit

Storm Water

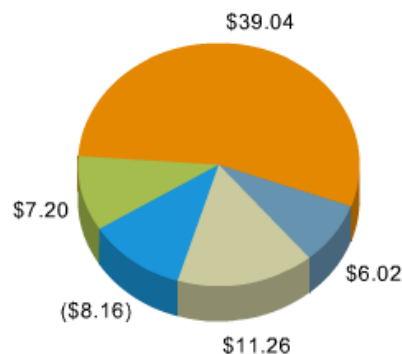
Energy

Air Quality

CO2

About Model

Stormwater Cooling Heating
Air Quality CO2



Breakdown of your tree's benefits

Click on one of the tabs above for more detail

This 14 inch Red maple provides overall benefits of: \$55 every year.

While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees' specific geography, climate, and interactions with humans and infrastructure is highly variable and makes precise calculations that much more difficult. Given these complexities, the results presented here should be considered initial approximations-a general accounting of the benefits produced by urban street-side plantings.

Benefits of trees do not account for the costs associated with trees' long-term care and maintenance.

If this tree is cared for and grows to 19 inches, it will provide \$89 in annual benefits.

Red maple
Acer rubrum

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Overall Benefit

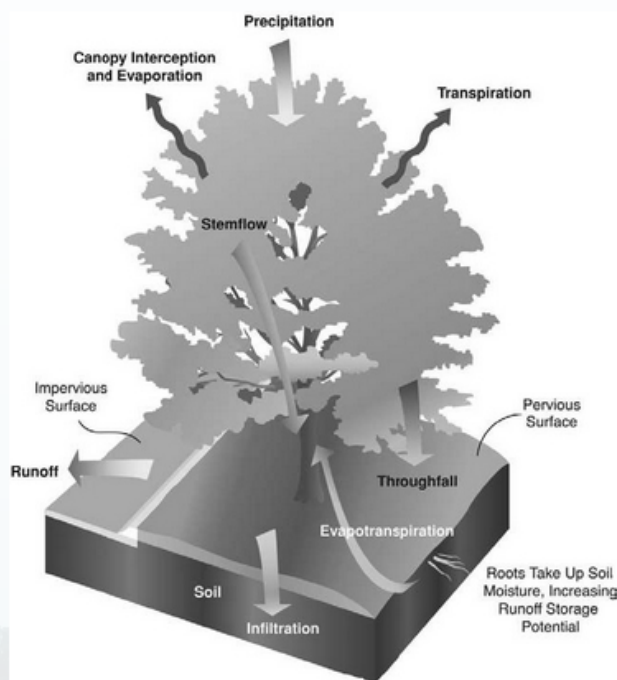
Storm Water

Energy

Air Quality

CO2

About Model



Your 14 inch Red maple will intercept 1,441 gallons of stormwater runoff this year.

Urban stormwater runoff (or "non-point source pollution") washes chemicals (oil, gasoline, salts, etc.) and litter from surfaces such as roadways and parking lots into streams, wetlands, rivers and oceans. The more impervious the surface (e.g., concrete, asphalt, rooftops), the more quickly pollutants are washed into our community waterways. Drinking water, aquatic life and the health of our entire ecosystem can be adversely effected by this process.

Trees act as mini-reservoirs, controlling runoff at the source. Trees reduce runoff by:

- Intercepting and holding rain on leaves, branches and bark
- Increasing infiltration and storage of rainwater through the tree's root system
- Reducing soil erosion by slowing rainfall before it strikes the soil

For more information visit: [The Center for Urban Forest Research](#)

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Overall Benefit

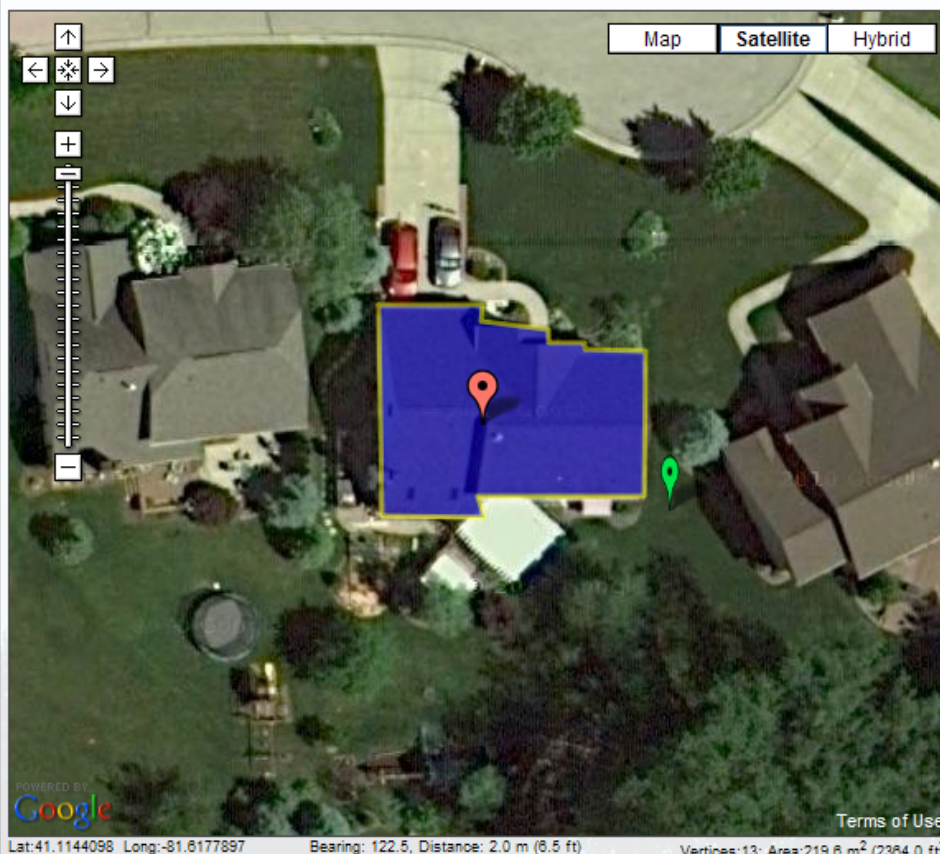
Storm Water

Energy

Air Quality

CO2

About Model



Your 14 inch Red maple will conserve 68 Kilowatt-hours of electricity and reduce consumption of oil or natural gas by -1 therm(s).

Trees modify climate and conserve building energy use in three principal ways (see figure at left):

- Shading reduces the amount of heat absorbed and stored by buildings.
- Evapotranspiration converts liquid water to water vapor and cools the air by using solar energy that would otherwise result in heating of the air.
- Tree canopies slow down winds thereby reducing the amount of heat lost from a home, especially where conductivity is high (e.g., glass windows).

Strategically placed trees can increase home energy efficiency. In summer, trees shading east and west walls keep buildings cooler. In winter, allowing the sun to strike the southern side of a building can warm interior spaces. If southern walls are shaded by dense evergreen trees there may be a resultant increase in winter heating costs.

For more information visit: [The Center for Urban Forest Research](#)

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Google[Terms of Use](#)

Lat:41.1144098 Long:-81.6177897

Bearing: 122.5, Distance: 2.0 m (6.5 ft)

Vertices:13; Area:219.6 m² (2384.0 ft²)



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Overall Benefit

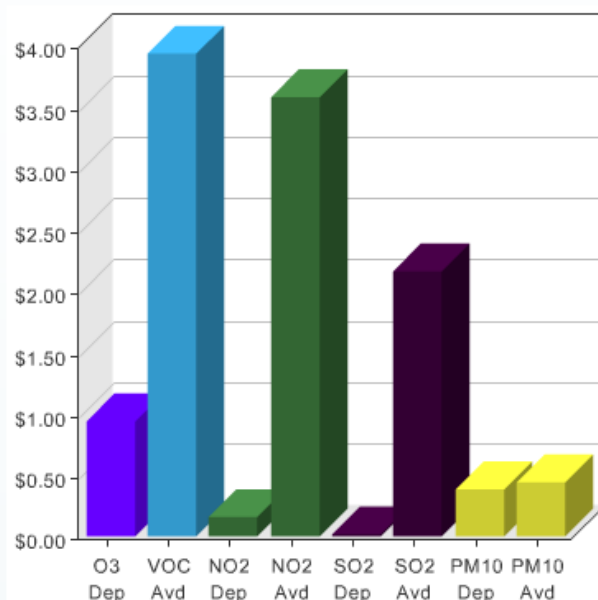
Storm Water

Energy

Air Quality

CO2

About Model



"Dep" stands for deposition. This is your tree absorbing or intercepting pollutants. "Avd" stands for avoided. This is your tree lessening the need for creation of these pollutants in the first place by reducing energy production needs.

Air quality benefits of your 14 inch Red maple are shown in the graph at left.

Air pollution is a serious health threat that causes asthma, coughing, headaches, respiratory and heart disease, and cancer. Over 150 million people live in areas where ozone levels violate federal air quality standards; more than 100 million people are impacted when dust and other particulate levels are considered "unhealthy." We now know that the urban forest can mitigate the health effects of pollution by:

- Absorbing pollutants like ozone, nitrogen dioxide and sulfur dioxide through leaves
- Intercepting particulate matter like dust, ash and smoke
- Releasing oxygen through photosynthesis
- Lowering air temperatures which reduces the production of ozone
- Reducing energy use and subsequent pollutant emissions from power plants

It should be noted that trees themselves emit biogenic volatile organic compounds (BVOCs) which can contribute to ground-level ozone production. This may negate the positive impact the tree has on ozone mitigation for some high emitting species (e.g. Willow Oak or Sweetgum). However, the sum total of the tree's environmental benefits always trumps this negative.

For more information visit: [The Center for Urban Forest Research](#)

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Overall Benefit

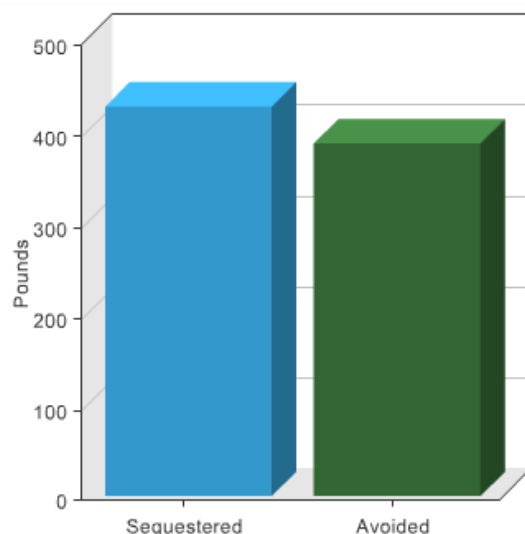
Storm Water

Energy

Air Quality

CO2

About Model



This year your 14 inch Red maple tree will reduce atmospheric carbon by 818 pounds.

How significant is this number? Most car owners of an "average" car (mid-sized sedan) drive 12,000 miles generating about 11,000 pounds of CO2 every year. A flight from New York to Los Angeles adds 1,400 pounds of CO2 per passenger. Trees can have an impact by reducing atmospheric carbon in two primary ways (see figure at left):

- They sequester ("lock up") CO2 in their roots, trunks, stems and leaves while they grow, and in wood products after they are harvested.
- Trees near buildings can reduce heating and air conditioning demands, thereby reducing emissions associated with power production.

Combating climate change will take a worldwide, multifaceted approach, but by planting a tree in a strategic location, driving fewer miles, or replacing business trips with conference calls, it's easy to see how we can each reduce our individual carbon "footprints."


For more information visit: [The Center for Urban Forest Research](#)


i-Tree Benefit Calculator - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.itreetools.org/benefits.php

Global Vari... Check if a p... Check whet... JavaScript S... ColorPicker... Google Map... Results for ... Hot Deals fr... i-Tree ...

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i-Tree Benefit Calculator

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[Calculate another tree](#)

Overall Benefit

Storm Water

Energy

Air Quality

CO2

About Model



The i-Tree Benefit Calculator allows you to calculate the approximate benefits individual trees provide. This tool is based on methods and models derived from i-Tree tools but designed to be accessible and require minimal inputs of location and tree information. As such, this tool relies on regional averages for climate, geographic and species growth information amongst other parameters. Therefore, this tool should be considered a starting point for understanding trees' value in the community rather than a scientific accounting of precise values. For more detailed information on urban and community forest assessments, please continue exploring the [i-Tree](#) website.

Credits:

- The National Tree Benefit Calculator was originally conceived and developed by [Casey Trees](#) and [Davey Tree Expert Co.](#)
- This tool is powered by i-Tree; the data generating the results comes from the i-Tree Tools: <http://www.itreetools.org/>
- Significant text and graphical content was originally published by the USDA Forest Service's Center for Urban Forest Research through their [Tree Guide](#) series of publications. We credit the authors of these publications.
- Facts about personal carbon production based on driving and flying courtesy of [Conservation International](#)
- For technical questions about this tool, contact [i-Tree support](#)



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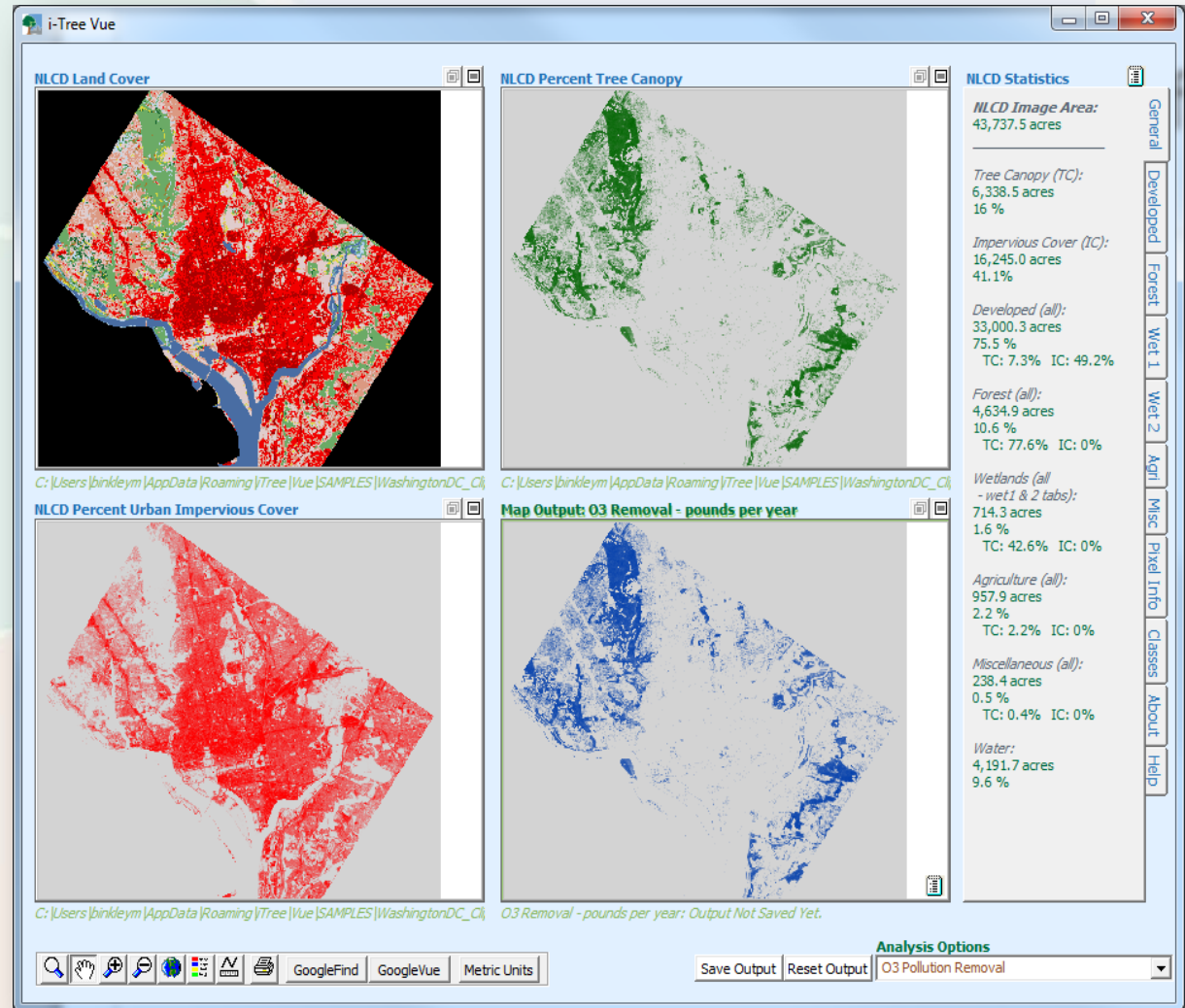
i-Tree Vue

- NASA Landsat
- + MRLC NLCD
- + USFS Research
- + i-Tree Development

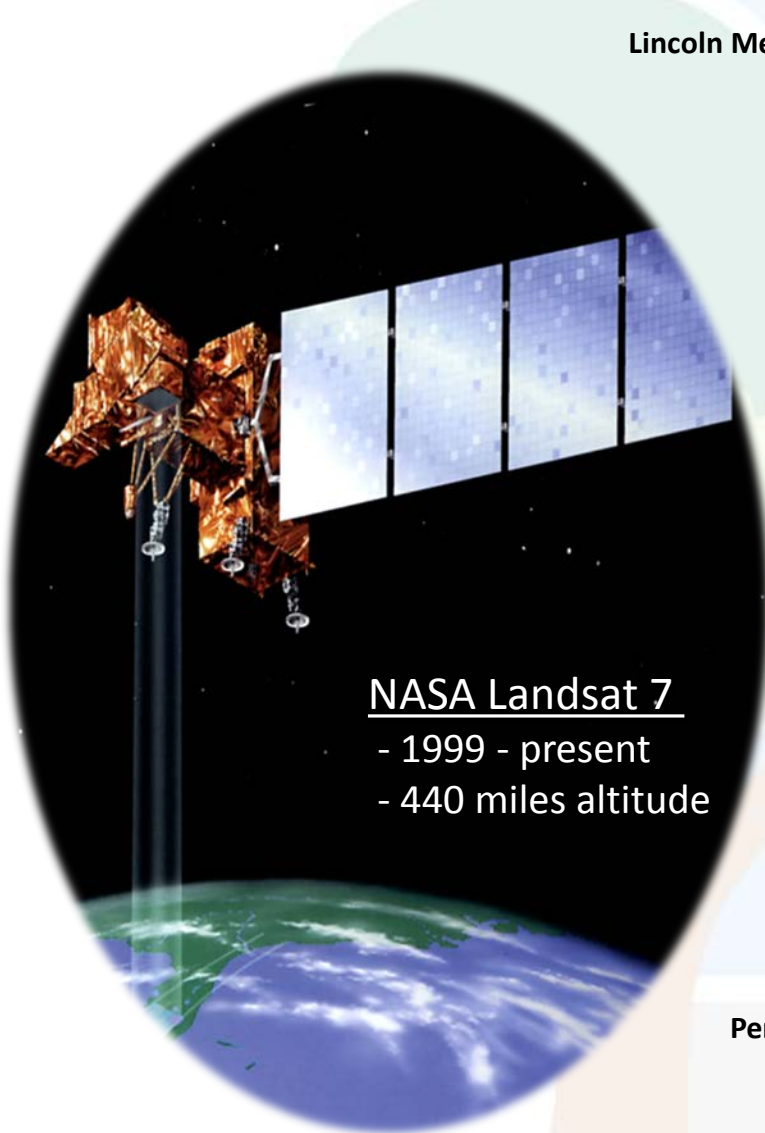
Urban Forest Benefit Estimates

Free, Fast, & Easy!

- ✓ Accessible to everyone
- ✓ 2 hours start to finish
- ✓ No training required



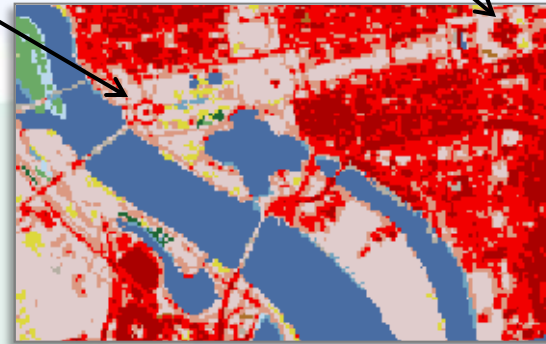
i-Tree Vue: Data Used to Estimate Tree Benefits



Lincoln Memorial

U.S Capitol

MRIC



Land Cover

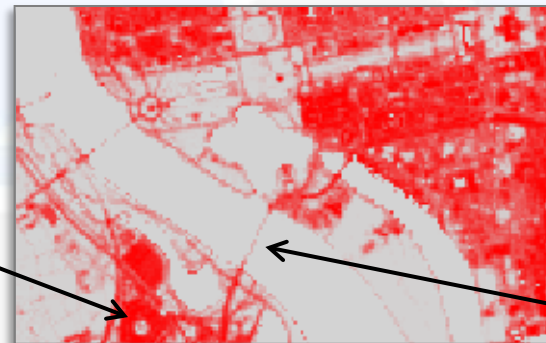
29 classes:

- Developed/Urban
- Forested
- Wetland
- Agriculture



Tree Canopy

0 – 100%



Impervious Cover

- Pavement
- Buildings

0 – 100%

Pentagon

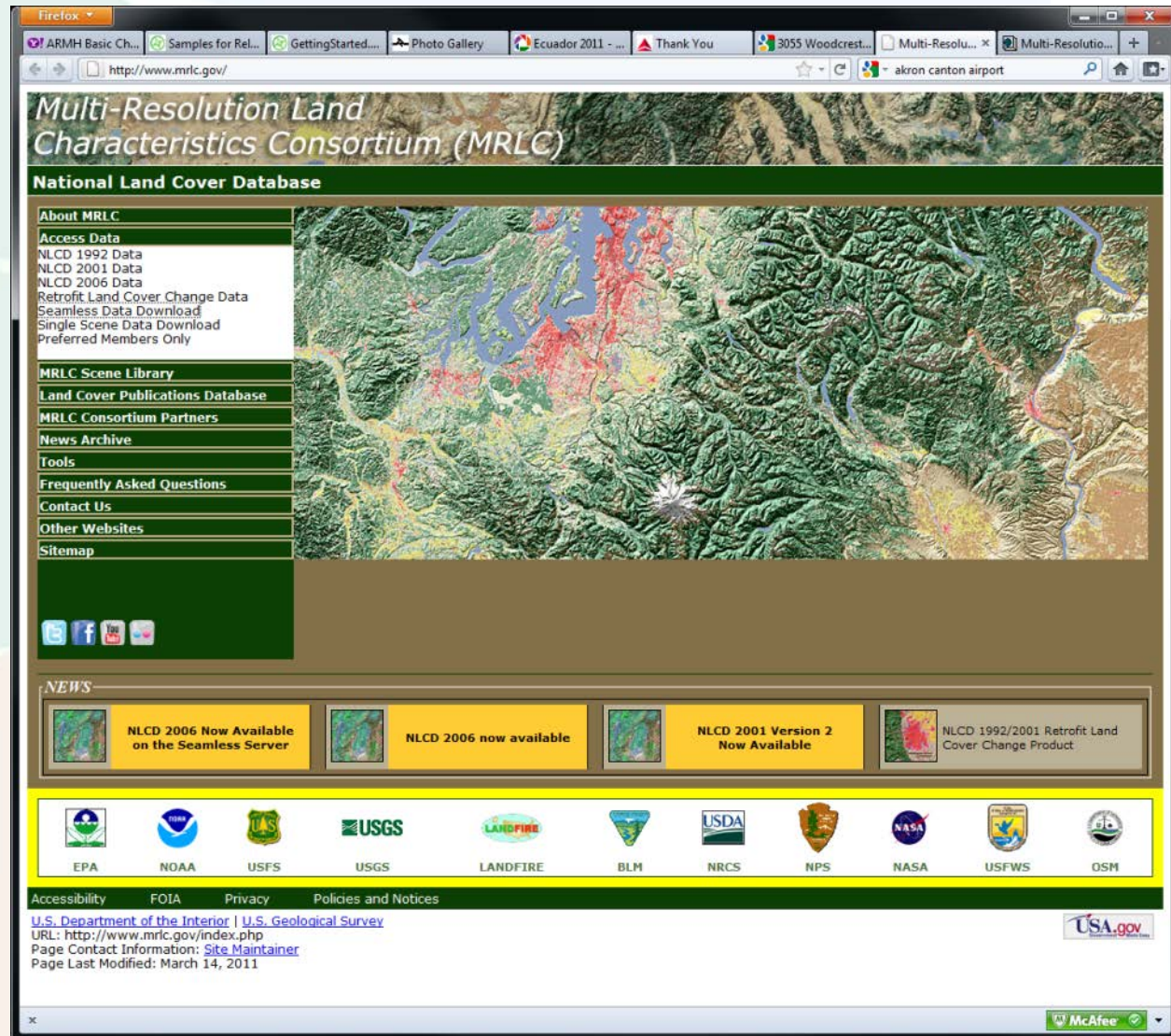
14th St Bridge

i-Tree Vue: Obtaining Data

Free!
Nationwide!
Easy to Download!

www.mrlc.gov

- >Access Data
- >Seamless Data Download
- >Launch Consortium Viewer



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i-Tree Vue

Startup:

Load
&
Clip
Imagery

The screenshot displays the i-Tree Vue (beta) application window. On the left is a Google Maps sidebar showing a map of Kent, WA, with a red polygon indicating the Area of Interest (AOI). The main window is divided into four map panes and a statistics panel on the right.

- NLCD Land Cover:** Shows a map with red and green patches on a black background. File path: *C:\A_Davey\Tree\itreeWorking\KSNLCD\LandCover_KSU.tif*
- NLCD Percent Tree Canopy:** Shows a map with green patches on a grey background. File path: *C:\TreeCanopy_KSU.tif*
- NLCD Percent Urban Impervious Cover:** Shows a map with red patches on a grey background. File path: *C:\ImperviousCover_KSU.tif*
- Analysis Map Output:** Shows a map with a complex pattern of grey and black patches on a black background. Status: *Output Not Saved Yet.*

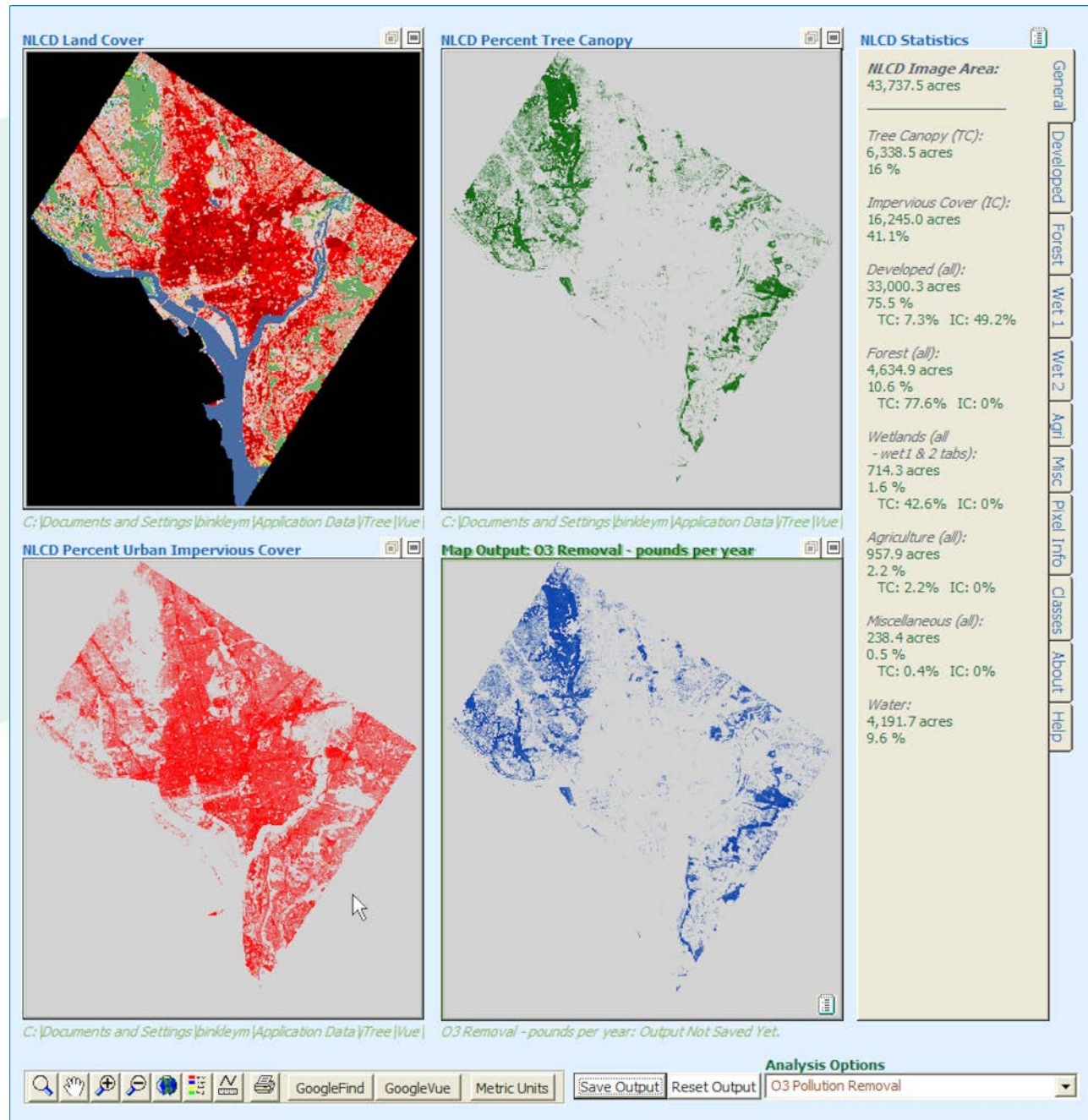
NLCD Statistics (General tab):

- NLCD Image Area:** 723.0 acres
- Tree Canopy (TC):** 89.2 acres, 12.3 %
- Impervious Cover (IC):** 271.1 acres, 37.5 %
- Developed (all):** 592.5 acres, 81.9 %
 - TC: 4.5% IC: 45.8%
- Forest (all):** 71.8 acres, 9.9 %
 - TC: 70.6% IC: 0%
- Wetlands (all - wet1 & 2 tabs):** 4.9 acres, 0.7 %
 - TC: 69.3% IC: 0%
- Agriculture (all):** 27.1 acres, 3.8 %
 - TC: 12% IC: 0%
- Miscellaneous (all):** 26.7 acres, 3.7 %
 - TC: 19.9% IC: 0%
- Water:** 0.0 acres, 0 %

Analysis Options: Save Output, Reset Output

i-Tree Vue

Main Screen



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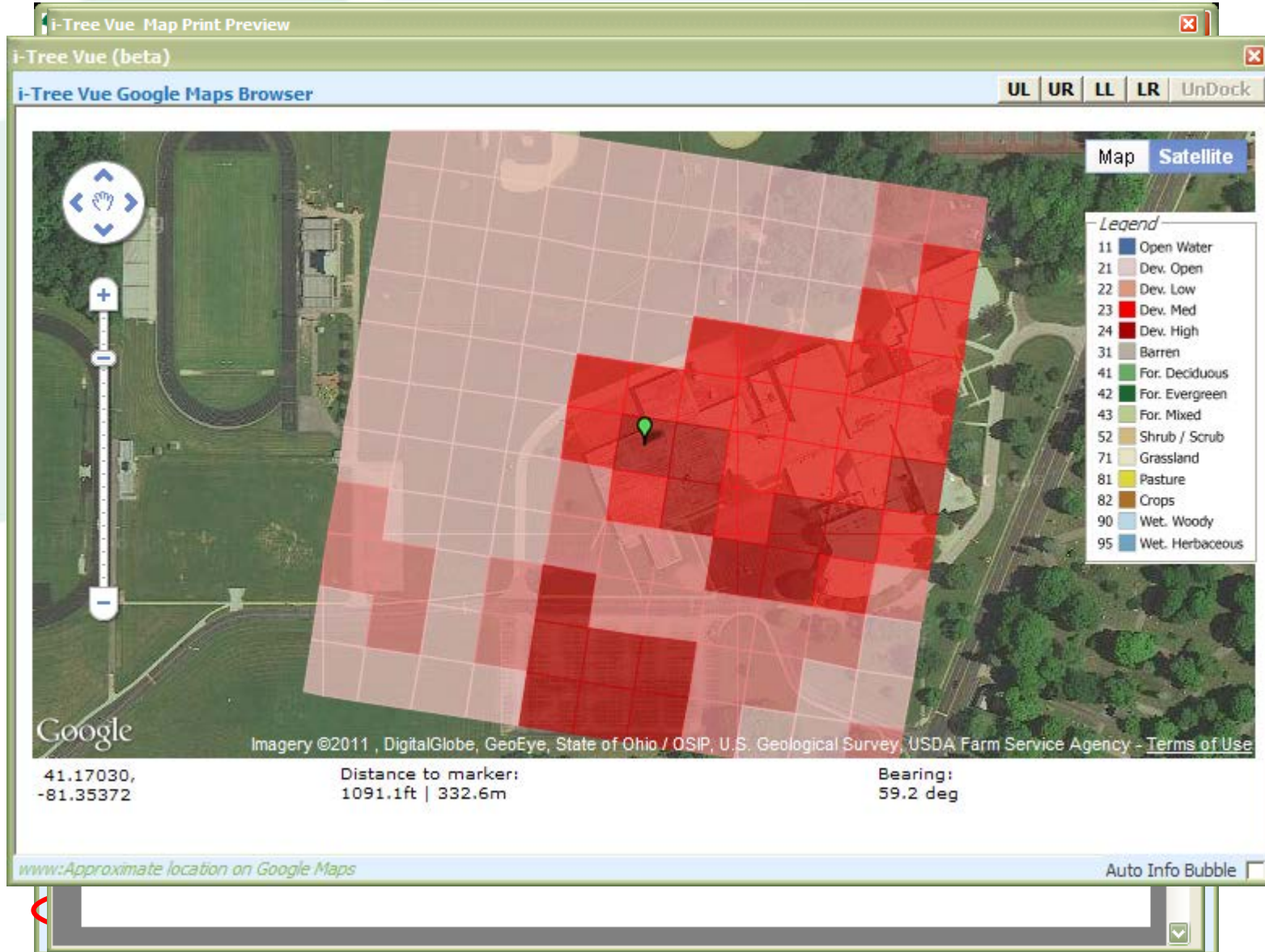
i-Tree Vue

Main Screen

Assorted
Tools:

Zoom/Pan
Measure
Print

Pixel Info
GoogleFind
GoogleVue



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i-Tree Vue

Report Output

Estimates for:
Amounts
Dollars

By Land Cover
Class

By Modeling
Scenario
(gain/loss)

>5% increase

[-] Existing Tree Canopy

7,491,488.5 acres

28.7 %

Carbon Storage: 304,110,611.0 short tons; \$6,290,166,727.9 @ \$20.68 per short ton

CO2 Equivalent Storage: 1,114,869,500.1 short tons; \$6,290,166,727.9 @ \$5.64 per short ton

Carbon Sequestration: 10,025,624.5 short tons; \$207,368,125.0 @ \$20.68 per short ton

CO2 Equivalent Sequestration: 36,753,939.6 short tons; \$207,368,125.0 @ \$5.64 per short ton

Pollution Removal - CO: 3,715.2 short tons; \$4,742,117.5 @ \$1276.41 per short ton

Pollution Removal - NO2: 45,742.7 short tons; \$411,069,907.3 @ \$8986.57 per short ton

Pollution Removal - O3: 109,295.0 short tons; \$982,187,012.4 @ \$8986.57 per short ton

Pollution Removal - SO2: 23,078.1 short tons; \$50,770,035.2 @ \$2199.92 per short ton

Pollution Removal - PM10: 79,889.7 short tons; \$479,348,005.9 @ \$6000.12 per short ton

[-] New User-Defined Tree Canopy

8,749,833.6 acres

Difference: 1,258,345.0 acres

33.5 %

Difference: 4.8 %

Carbon Storage: 355,192,058.4 short tons; \$7,346,725,785.7 @ \$20.68 per short ton

Difference: 51,081,447.4 short tons; \$1,056,559,058

CO2 Equivalent Storage: 1,302,134,086.1 short tons; \$7,346,725,785.7 @ \$5.64 per short ton

Difference: 187,264,586.1 short tons; \$1,056,559,058

Carbon Sequestration: 11,709,628.3 short tons; \$242,199,740.8 @ \$20.68 per short ton

Difference: 1,684,003.8 short tons; \$34,831,616

CO2 Equivalent Sequestration: 42,927,497.3 short tons; \$242,199,740.8 @ \$5.64 per short ton

Difference: 6,173,557.8 short tons; \$34,831,616

Pollution Removal - CO: 4,339.2 short tons; \$5,538,650.8 @ \$1276.41 per short ton

Difference: 624.0 short tons; \$796,533

Pollution Removal - NO2: 53,426.1 short tons; \$480,117,303.4 @ \$8986.57 per short ton

Difference: 7,683.4 short tons; \$69,047,396

Pollution Removal - O3: 127,653.2 short tons; \$1,147,164,926.3 @ \$8986.57 per short ton

Difference: 18,358.3 short tons; \$164,977,914



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i-Tree Canopy

Main Screen

- Web App
- No Login
- Required

1. Load shapefile
2. Configure survey
3. Assess points

i-Tree Tools for Assessing and Managing Community Forests

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Technical Notes Report Export Start Over Exit ?

Map Satellite Hybrid Terrain

i-Tree Canopy

Percent Cover (\pm SE)

Id	Cover Class	Latitude	Longitude
1	Water	41.797858741309	-72.64722820779
2	Non-Tree	41.789652187085	-72.70758794779
3	Non-Tree	41.72977938796	-72.68885971042
4	Non-Tree	41.74477714313	-72.69408831927
5	Non-Tree	41.77068147283	-72.70286798009
6	Tree	41.74429952193	-72.6804620972

Page 1 of 1 View 1 - 6 of 6

Remember, the more points you survey, the lower your Standard Error, and the more precise your sampling will be. More points surveyed provide for a better estimation of Land Cover across your study area.

Save Your Data

Save Data Save Early. Save Often. Don't lose your project data!



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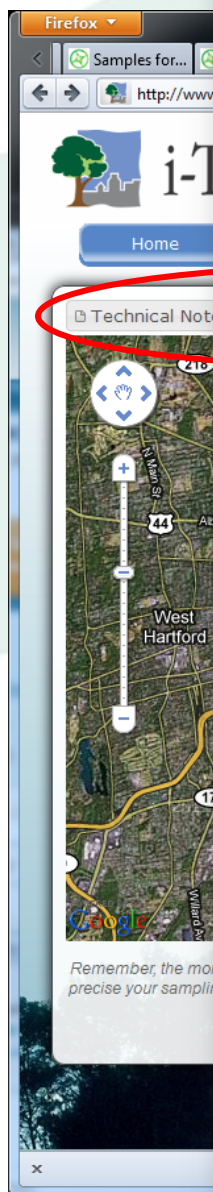
i-Tree Canopy

Output

Report

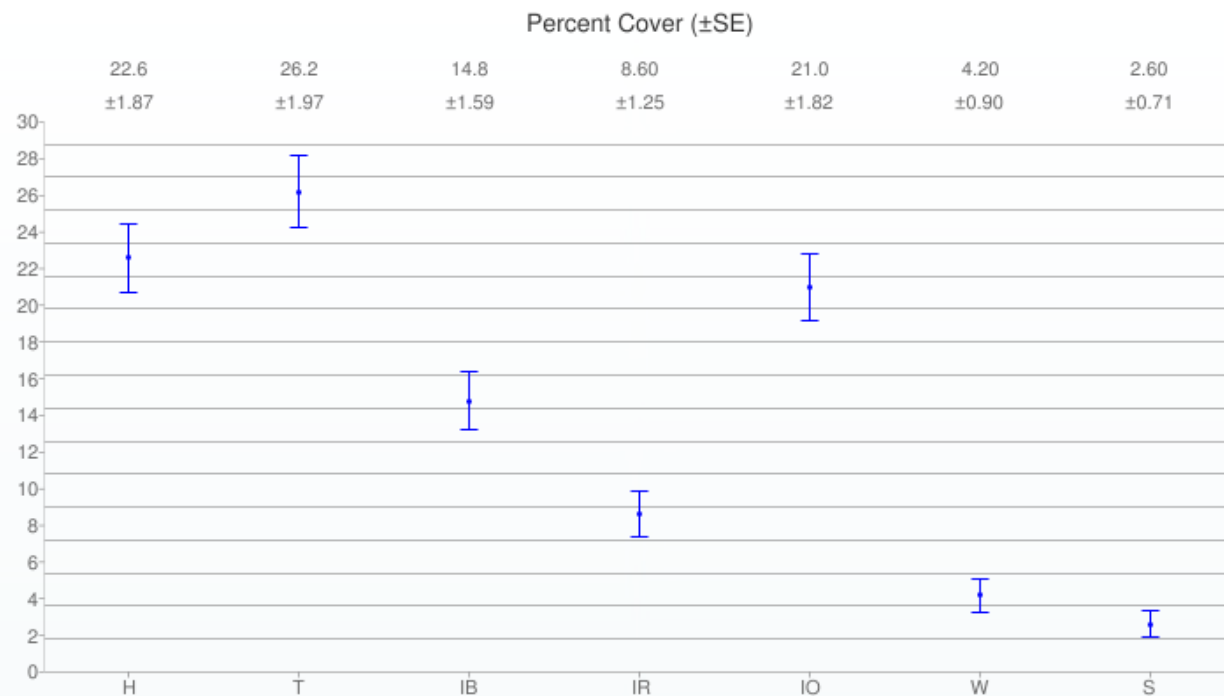
Export

Save
Project



i-Tree Canopy

Cover Report



Cover Class	Description	Abbr.	% Cover
Grass/Herbaceous		H	22.6 \pm 1.87
Tree/Shrub		T	26.2 \pm 1.97
Impervious Buildings		IB	14.8 \pm 1.59
Impervious Road		IR	8.60 \pm 1.25
Impervious Other		IO	21.0 \pm 1.82
Water		W	4.20 \pm 0.90
Soil/Bare Ground		S	2.60 \pm 0.71

About i-Tree Canopy

The concept and prototype of this program were developed by David J. Nowak, Jeffery T. Walton and Eric J. Greenfield (USDA Forest Service). The current version of this program was developed and adapted to i-Tree by David Ellingsworth, Mike Binkley, and Scott Maco (The Davey Tree Expert Company).

Limitations of i-Tree Canopy

The accuracy of the analysis depends upon the ability of the user to correctly classify each point into its correct class. As the number of points increase, the precision of the estimate will increase as the standard error of the estimate will decrease. If too few points are classified, the standard error will be



i-Tree is a
Cooperative
Initiative



i-Tree: Your Tools for Calculating Tree Benefits

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Easy to use



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