



i-Tree 2015

New Innovations for Assessing Community Tree Services and Values

*Al Zelaya, The Davey Institute, Chicago, IL
Jason Henning PhD, USDA Forest Service & Davey Institute, Philadelphia, PA
Mike Binkley, The Davey Institute, Kent, OH*

Plan for this afternoon...

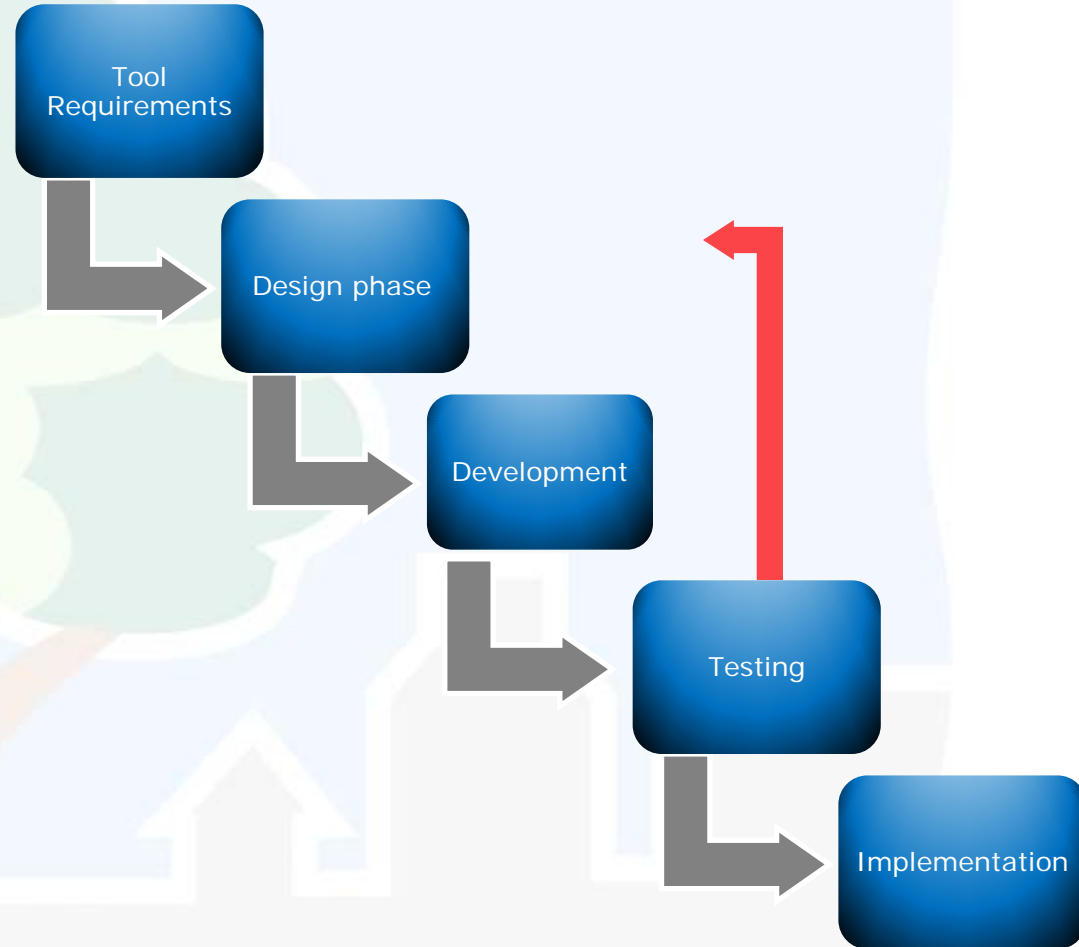
🌳 i-Tree 2015 intro & core tool overview

🌳 i-Tree Canopy

🌳 i-Tree Landscape

🌳 i-Tree Eco

🌳 Discussion



Learning Objectives

1. Learn about free tools to assess community tree ecosystem services and values.
2. Understand the advantages and limitations of key tools and updates to best address objectives.
3. Recognize how tools may be used strategically to improve tree management and create opportunities
4. Build a foundation for continued exploration



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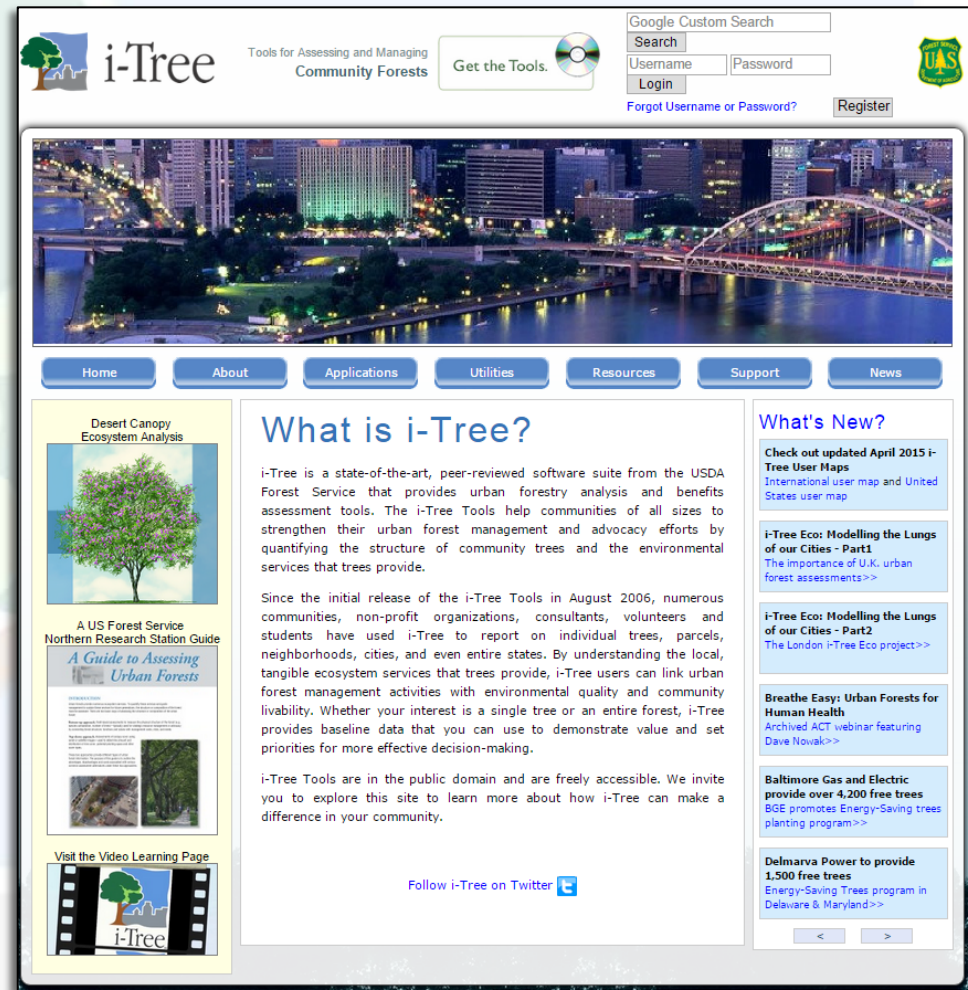


i-Tree...

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

- Public Domain Software
- Based on peer-reviewed research
- Technical support
- Continuously improved

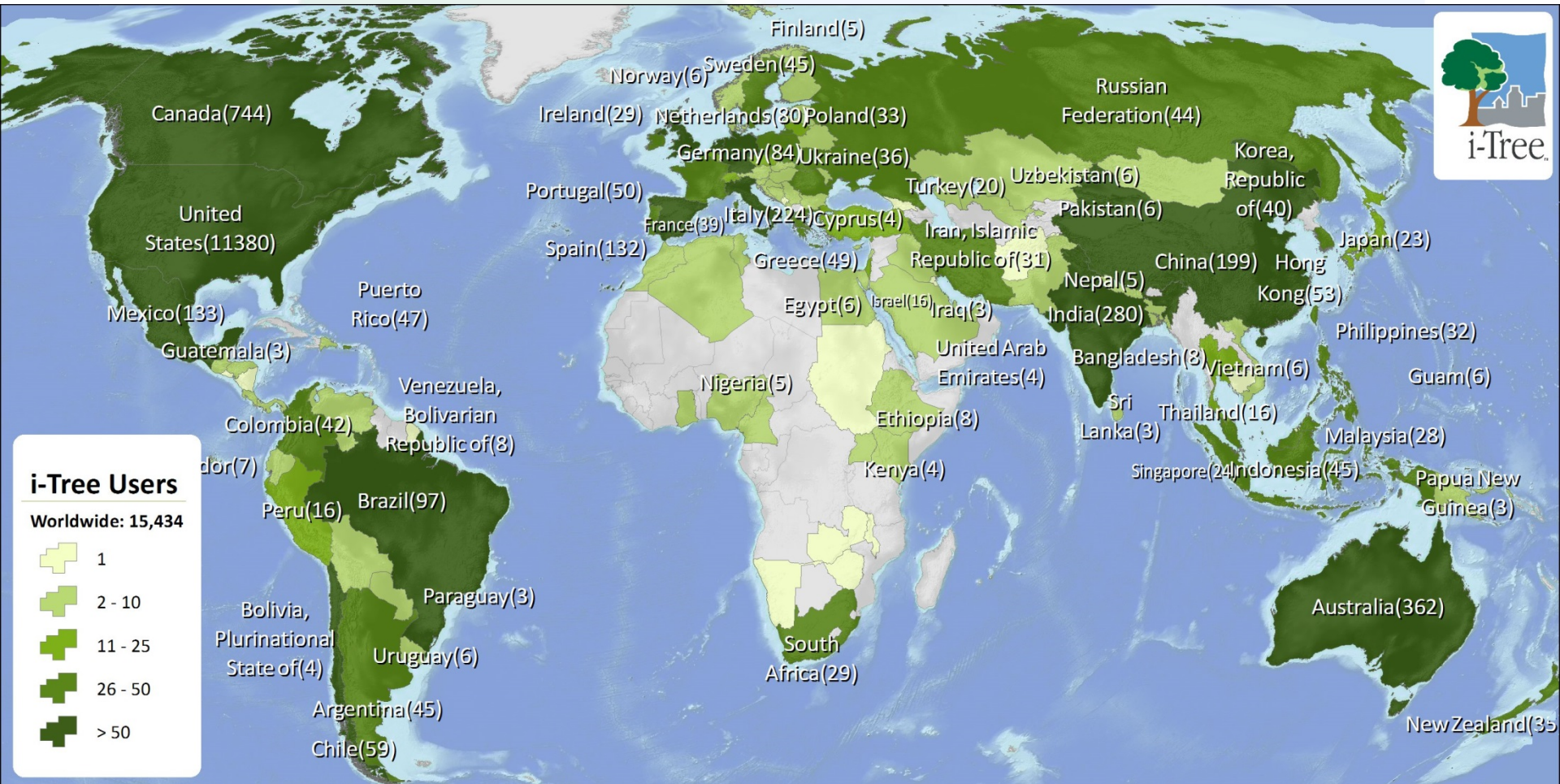
www.itreetools.org



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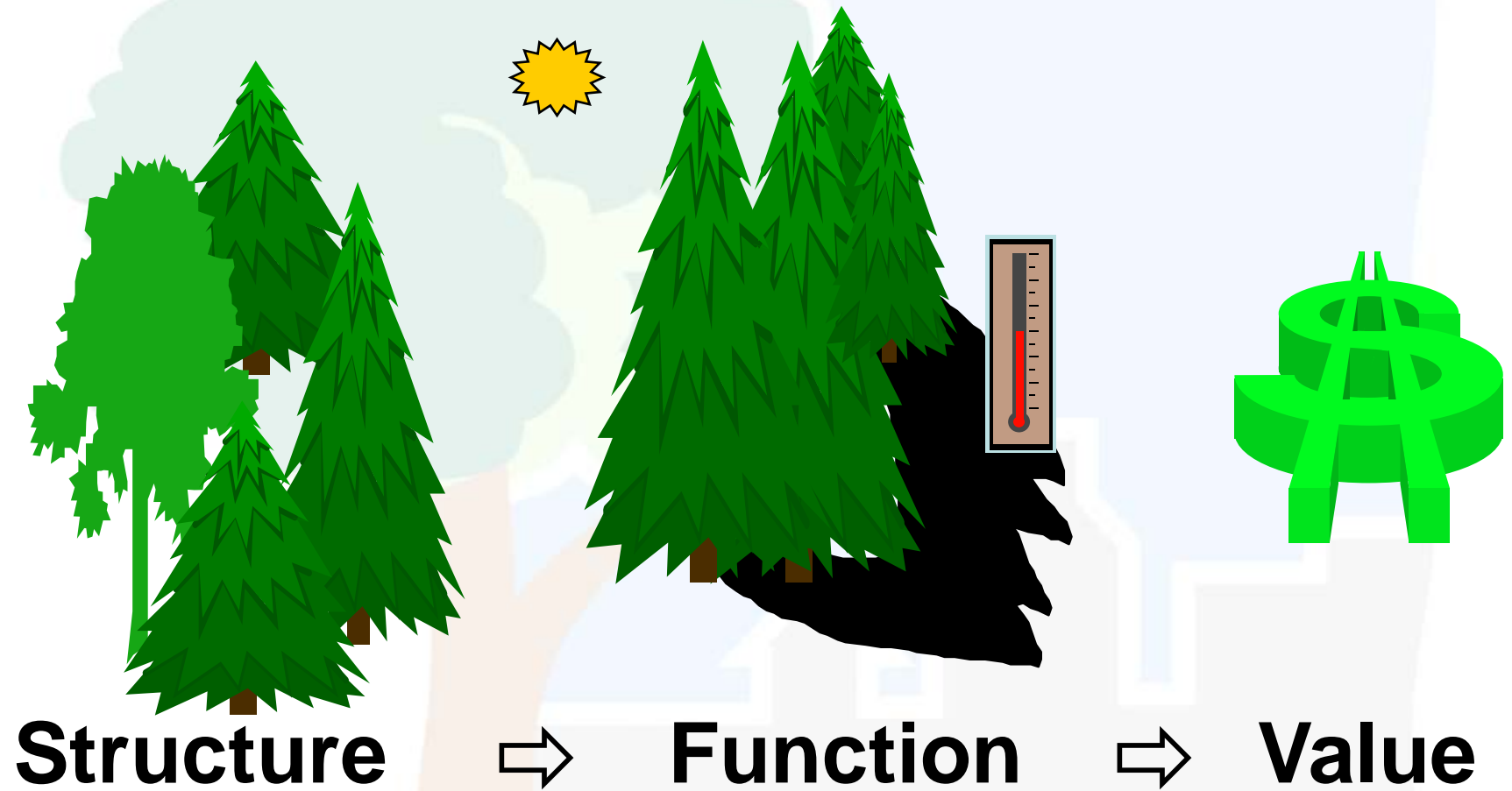
i-Tree Tool User maps



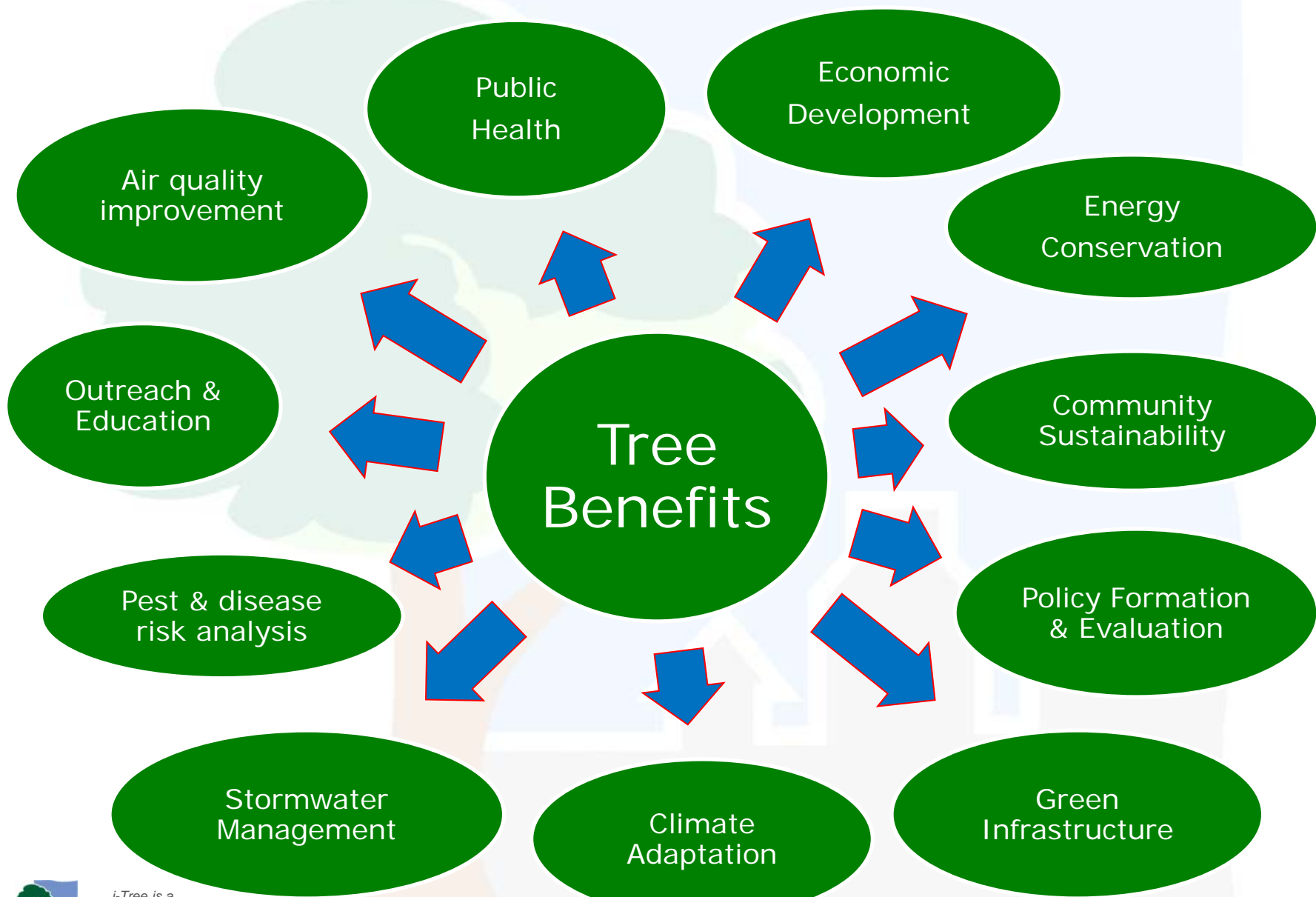
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The i-Tree Foundation:



Numerous opportunities...



Connect Tools with Opportunities



“Today, I am proud to say that our inventories and management plans make a difference in how trees are perceived and valued.”

Dale Carlon

<http://www.dalecarlonconsulting.com/index.php>



Phone: (775) 287-1732
Email: DaleCarlon@yahoo.com

Dale Carlon Consulting, LLC
5246 Canyon Crest Court
Sparks, Nevada 89436

Genoa Lakes Resort HOA

Detailed Tree Inventory



Minden

Total Annual Benefits of Public Trees by Species (\$)

10/26/201

Species	Energy	CO ₂	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error
Austrian pine	983	115	156	462	2,261	3,978	(±0)
London planetree	1,269	111	141	591	3,993	6,105	(±0)
Broadleaf Deciduous M	374	30	51	99	700	1,255	(±0)
Conifer Evergreen Large	328	34	51	174	1,306	1,894	(±0)
Callery pear	81	9	11	19	82	202	(±0)
White Pine	231	15	35	89	48	418	(±0)
Broadleaf Deciduous La	283	30	41	86	1,097	1,537	(±0)
flowering crabapple	73	6	10	12	30	130	(±0)
Silver maple	49	5	7	11	166	237	(±0)
Broadleaf Deciduous Sn	35	3	4	7	25	75	(±0)
Conifer Evergreen Medi	111	13	17	49	250	440	(±0)
Purple leaf plum	45	5	6	9	20	85	(±0)
Spruce	41	4	6	11	74	136	(±0)
Siberian elm	306	30	47	110	526	1,019	(±0)
White ash	38	4	5	10	134	191	(±0)
Oak	28	3	4	7	99	140	(±0)
OTHER STREET TREE	378	29	49	144	831	1,432	(±0)
Citywide Total	4,652	443	642	1,892	11,642	19,272	(±0)



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i-Tree Suite of Tools 2015

Web-based, run
in your browser



i-Tree™

Design



i-Tree™

Canopy



i-Tree™

Landscape



i-Tree™

Eco



i-Tree™

Streets



i-Tree™

Hydro

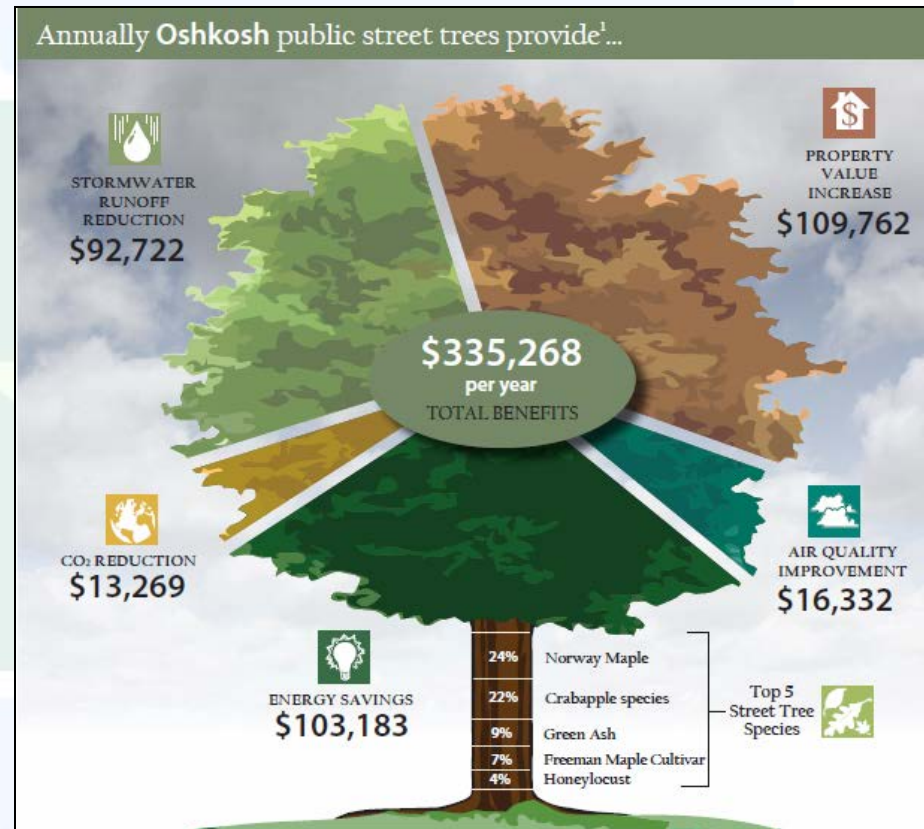


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i-Tree Streets

- **Structure** (species condition, age distribution, importance, etc.)
- **Function**
 - Energy
 - Air pollution
 - Stormwater interception
 - Carbon
 - Aesthetic value
- **Values (\$)**
- **Some management needs**
- **Pest detection module** (optional)



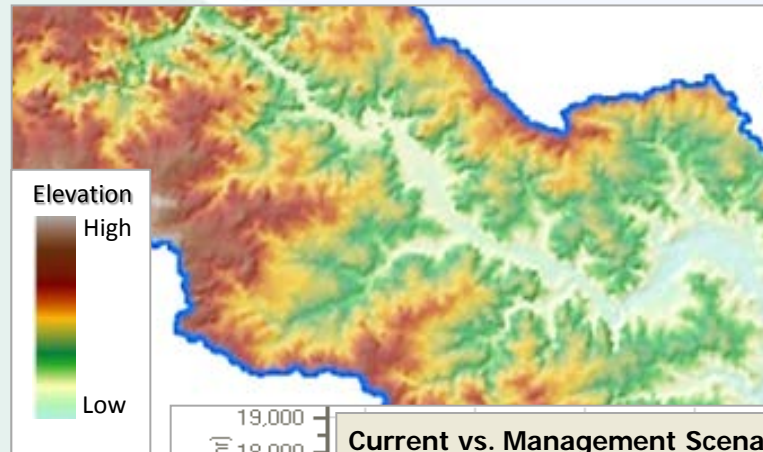
i-Tree Streets: Key considerations

- Regional U.S. model
- Easy to use
- Provides a “snap shot” in time
- Not for park trees
- No work history tracking
- Some data flexibility
- Not being upgraded in the future
- Future crosswalk to Eco



i-Tree Hydro

www.itreetools.org

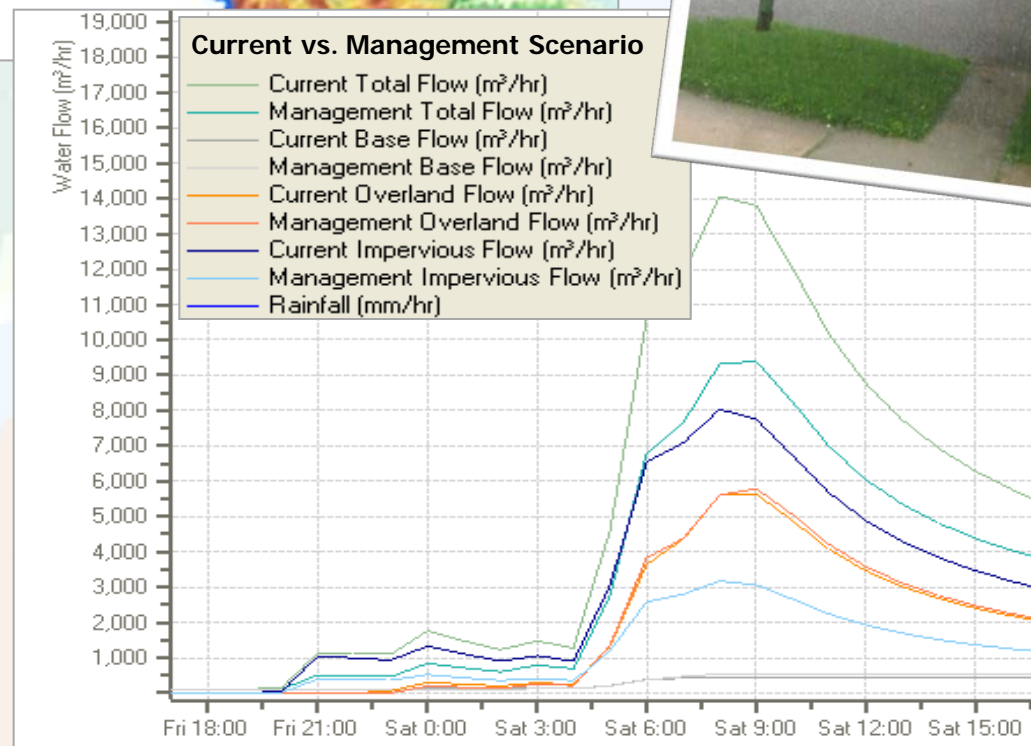


Quantifies effects of:

- Tree cover
- Impervious cover

on:

- Stream flow
- Water quality



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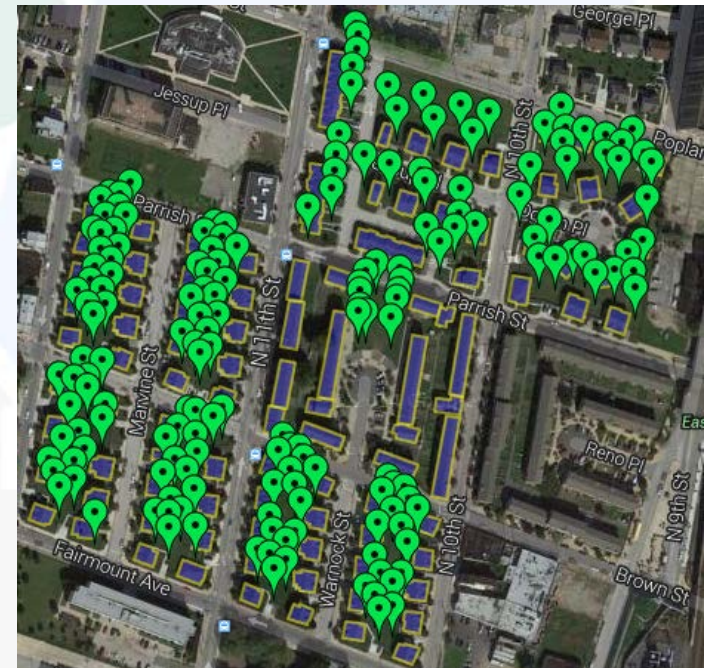


i-Tree Hydro Considerations

- Works best on watershed basis (with gauging station)
- Qualitative modeling can be easily completed using preprocessed topographic indexes (TIs) & i-Tree Canopy
- Understanding model inputs & results can be challenging
- Difficult for use outside U.S. due to data needs



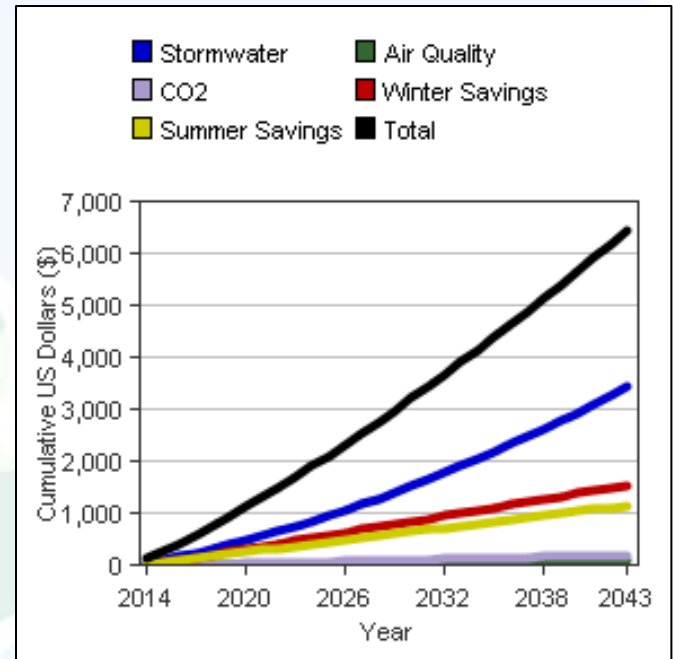
- Analysis of individual trees associated with structures (*US & Canada*)
- Calculates benefits over time
- General public use
- Web accessible



i-Tree Design

Estimates 4 core ecosystem services

- Stormwater interception
- Energy (impacts on heating/cooling)
- Air quality improvement
- Carbon sequestration



\$6,476 worth of benefits over the next 30 years ...and growing

Assesses value (\$) of current and future benefits



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Opportunities with i-Tree Design

- Engage residential & private property owners
- Advocacy and outreach efforts
- Sustainability programs
- Evaluate tree planting projects
- Work with educators & schools
- Integrate in your organization's website

Home Lessons About i-Tree About NGSS Environmental Enrichment Fellowship

Welcome to iTreeLessons.com

Integrate the iTree Software Suite with NGSS Standards-based lesson plans in your classroom.

View Lessons

Lesson Plans

All lesson plans are hosted on Google Drive. You will need a Google Account in order to access the files. If you don't have a Google Account, [sign up for an account now.](#)



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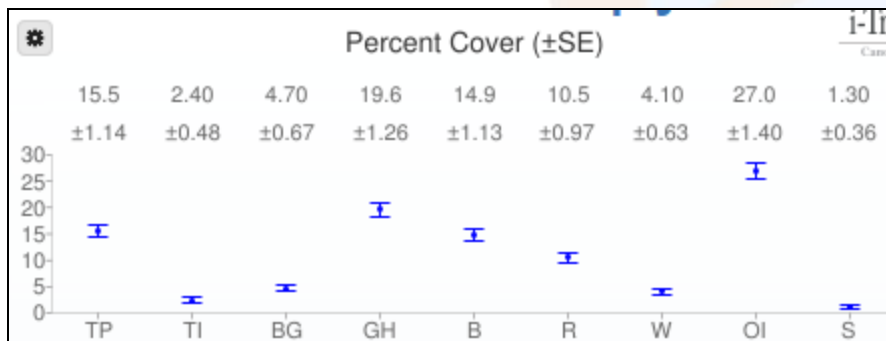
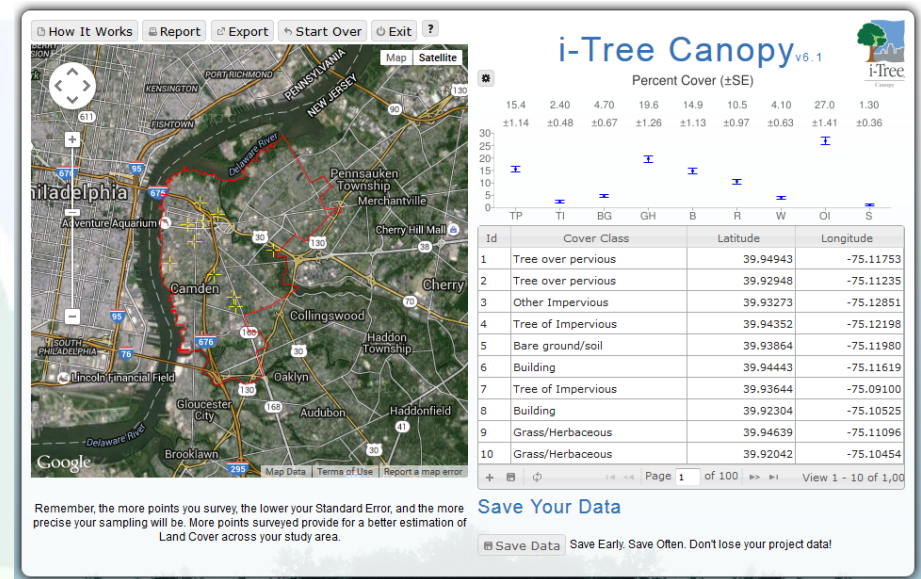


i-Tree Canopy 2015

What is i-Tree Canopy?

Tool to estimate tree canopy cover

- Facilitates user guided aerial image interpretation
- Flexible, user-defined boundaries
- Flexible, user-defined cover categories
- Estimates air pollution and carbon benefits of tree canopy
- Estimates value of benefits



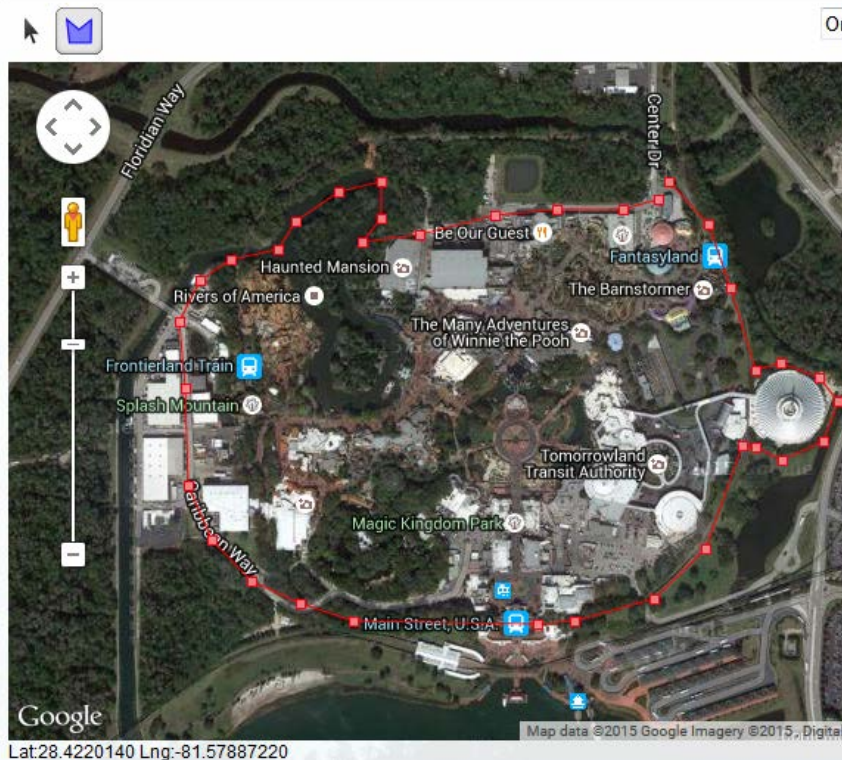
Conducting an i-Tree Canopy assessment

1. User defines area of interest (valid from parcel to larger scales)

User drawn

i-Tree Canopy v6.1

Define Project Area



Loaded shapefile



Conducting an i-Tree Canopy assessment

2a. User defines cover categories

Anything you can see on Google satellite image

i-Tree Canopy v6.1

On this page, please configure the cover classes you wish to sample. The default is Tree and Non-Tree, but you may add many other classes such as water, impervious, grassland, etc., as well as different types of tree cover, such as deciduous and evergreen.



Save Load ? Help

Cover Classes

	Cover Class	Abbreviation	Description
1	Tree	T	tree, non-shrub
2	Impervious Surface	I	impervious surfaces
3	Water	W	open water
4	Other Vegetation	OV	all non-tree vegetation, grass, shrubs, etc.
5	Other	O	anything not in other classes

+ - ✕ \$

Add Record

Cover Class

Abbreviation

Description

Page 1 of 1 >> <<

View 1 - 5 of 5

Next >



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Conducting an i-Tree Canopy assessment

2b. Select location and customize benefits estimates

Select Project Locations

- ☐ Manatee
- ☐ Marion
- ☐ Martin
- ☐ Miami-Dade
- ☐ Monroe
- ☐ Nassau
- ☐ Okaloosa
- ☐ Okeechobee
- ☐ Orange
- ☒ Osceola
- ☐ Palm Beach
- ☐ Pasco
- ☐ Pinellas

Selected Locations

- United States of America
 - Florida
 - Osceola
 - All ○ Rural ○ Urban

Benefit Options

Which represent Tree Canopy?

- ☒ T - Tree
- ☐ I - Impervious Surface
- ☐ W - Water
- ☐ OV - Other Vegetation
- ☐ O - Other

Currency

Denomination USD

Symbol \$

Measurement

Units English

The chosen cover classes and currency amounts will be used to estimate Tree Benefits. For proper estimation, make sure the chosen cover class(es) at left represent only tree canopy.

These currency values are courtesy of openexchangerates.org

Tree Benefits				
	Abbreviation	Benefit Description	Removal Rate (lbs/acre/yr)	Monetary Value (\$/T/yr)
1	CO	Carbon Monoxide removed annually	2.212	\$162.00
2	NO2	Nitrogen Dioxide removed annually	5.076	\$39.54
3	O3	Ozone removed annually	62.963	\$177.74
4	PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	16.467	\$710.58
5	PM2.5	Particulate Matter less than 2.5 microns removed annually	2.725	\$6,045.11
6	SO2	Sulfur Dioxide removed annually	0.858	\$9.07
7	CO2seq	Carbon Dioxide sequestered annually in trees	15,528.322	\$19.43
8	CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	251,395.359	\$19.43

Page 1 of 1
View 1 - 8 of 8



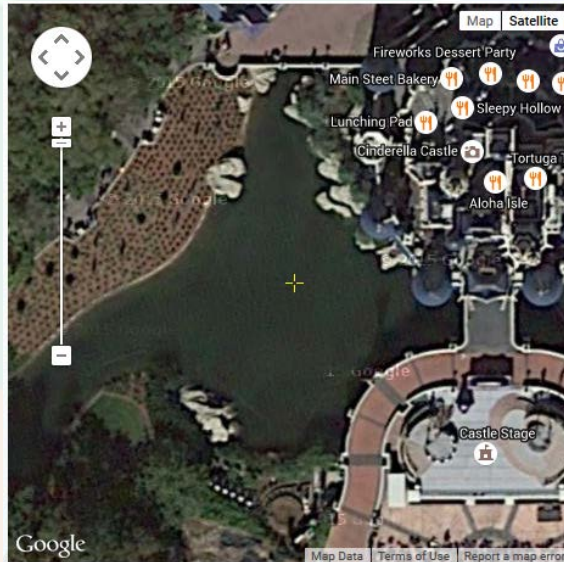
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Conducting an i-Tree Canopy assessment

3. i-Tree Canopy generates random points ...
...user classifies each point into a cover class

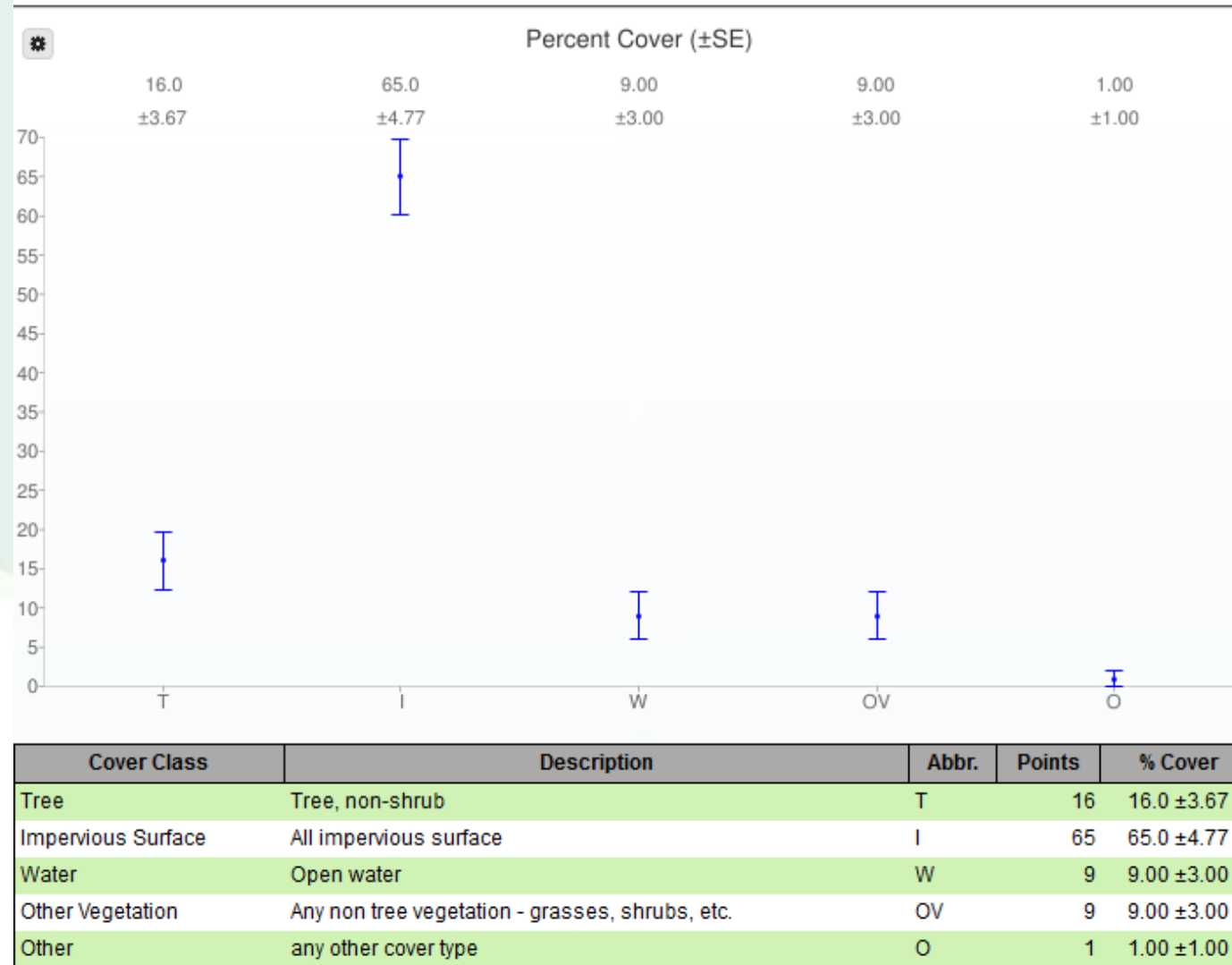
Id	Cover Class
1	Tree
+	Tree
	Impervious Surface
	Water
	Other Vegetation
	Other



500-1000 points later ... Results!

$$\% \text{ cover} = \frac{\text{points in cover type}}{\text{total points assessed}}$$

$$\text{cover type area} = \% \text{ cover} \times \text{total area}$$



...Results!



Tree Benefit Estimates

Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	\$3.06	±0.70	37.96 lb	±8.70
NO2	Nitrogen Dioxide removed annually	\$1.72	±0.39	87.11 lb	±19.96
O3	Ozone removed annually	\$95.70	±21.93	1,080.66 lb	±247.61
PM2.5	Particulate Matter less than 2.5 microns removed annually	\$140.89	±32.28	46.78 lb	±10.72
SO2	Sulfur Dioxide removed annually	\$0.07	±0.02	14.73 lb	±3.38
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	\$100.06	±22.93	282.63 lb	±64.76
CO2seq	Carbon Dioxide sequestered annually in trees	\$2,580.34	±591.23	133.26 T	±30.53
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	\$41,774.41	±9,571.72	2,157.40 T	±494.32

Pollutant removal and carbon sequestration rates per acre of canopy were determined for the urban and rural areas in each county using i-Tree Eco methodology

Valuations for pollutant removals are based the EPA's BenMAP model and incorporate the estimates of the human population affected.



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Let's try a quick example

6000 W. Osceola Parkway Kissimmee, Florida 34746
Osceola County



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Advantages

- Statistically valid estimates
- Canopy cover estimated in ½ a day
- Flexible boundaries and cover types
- No GIS software or experience needed
- Web-based, only requires an internet connection and a browser

Limitations

- Removal rates and valuations based on US data
- Limited to imagery available in Google satellite view
- Date of image not readily available
- Results are not spatially explicit
- GIS expertise needed for more complex projects



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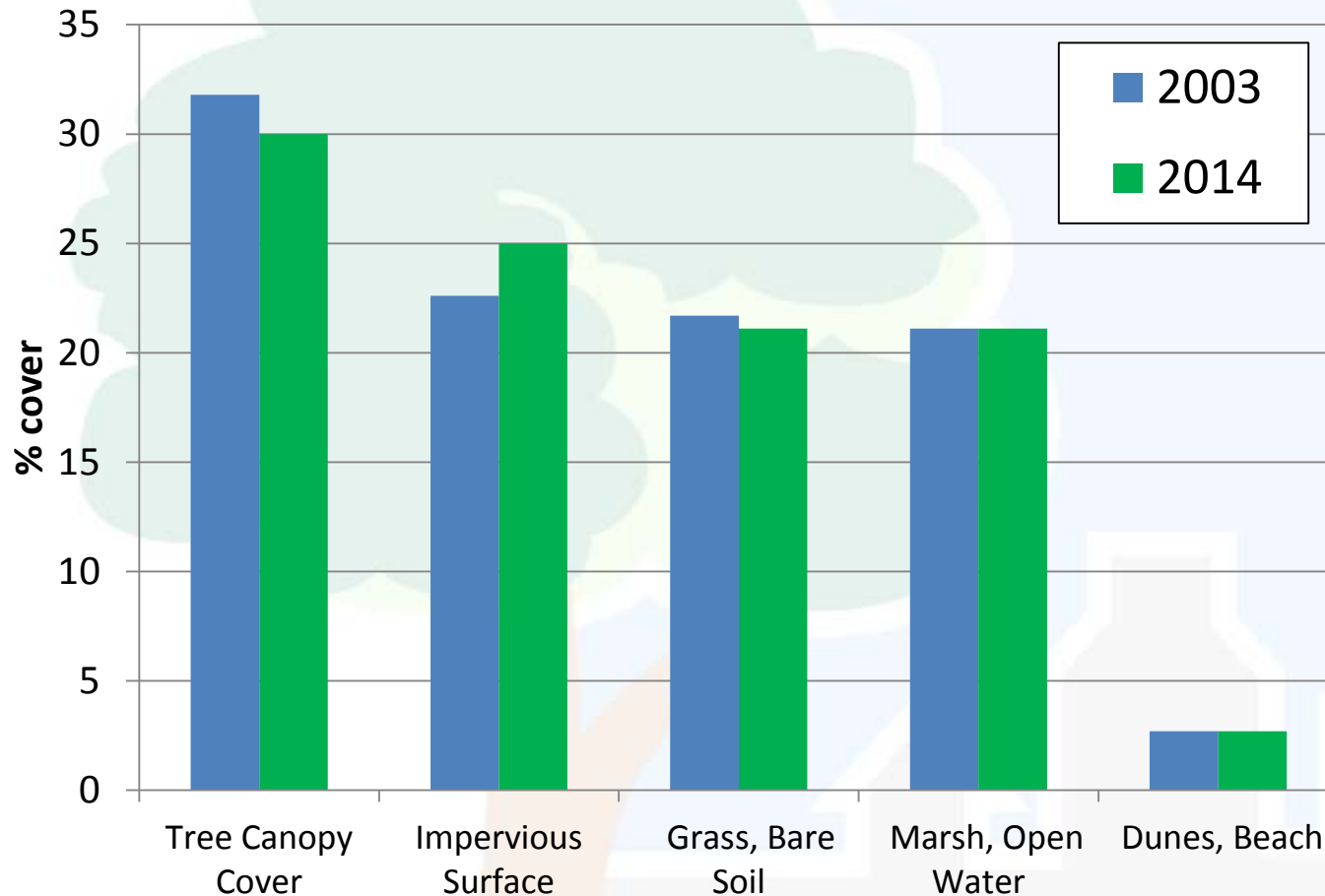
Change survey

Export survey to Google Earth

Use Google Earth's historical imagery to "update"



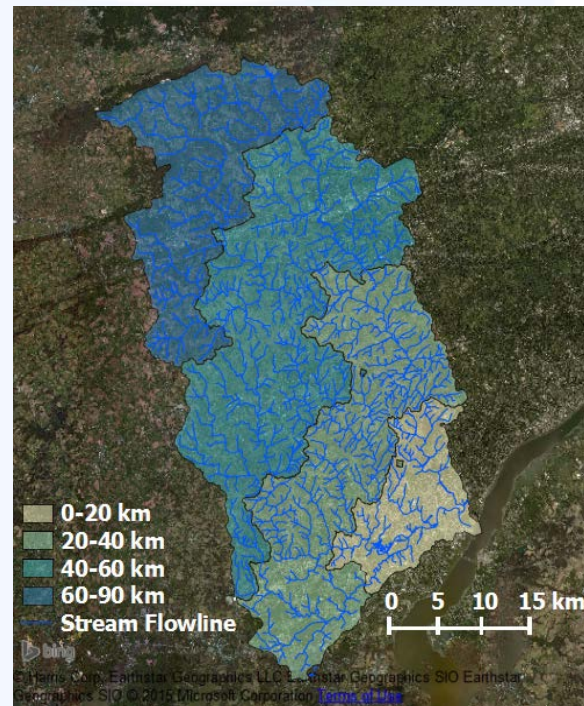
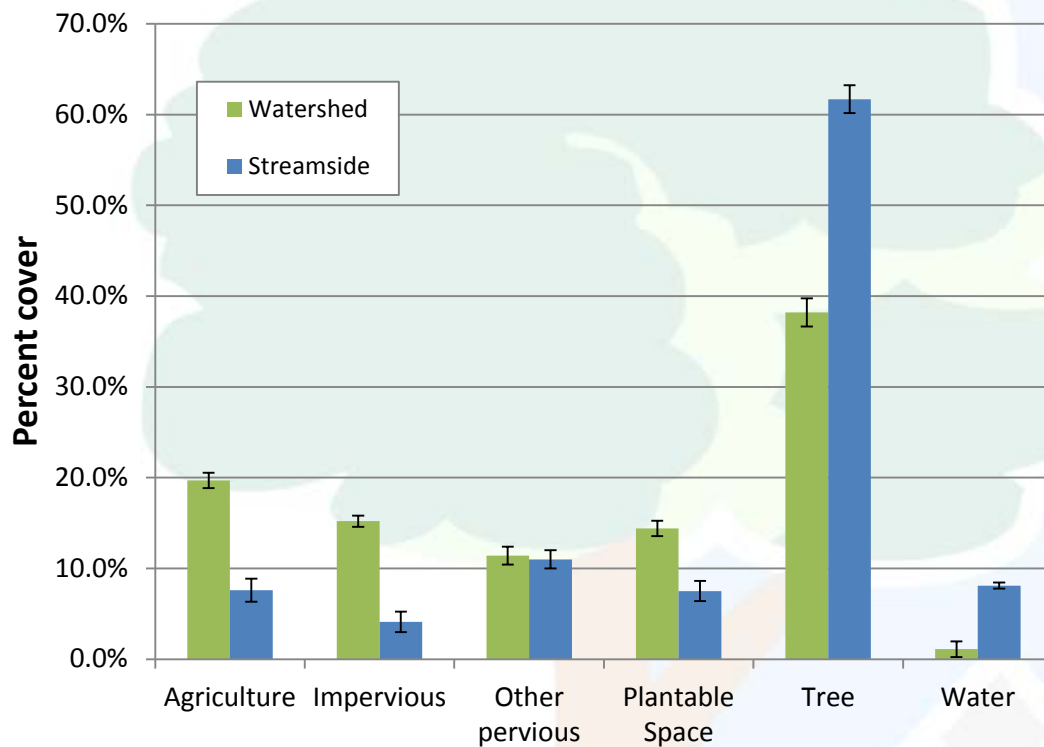
Change survey: Example from Atlantic Beach, FL



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Complicated boundaries: Stream buffers



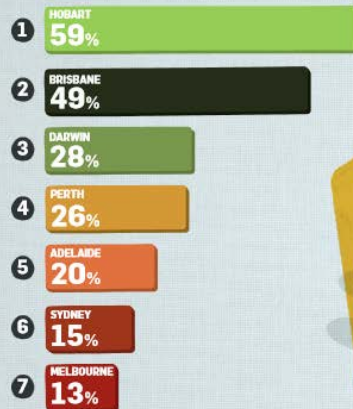
Large multifaceted projects: “Where are all the trees?”

- Country-wide project from Australia
- Analyzed 139 local government areas
- 68% of the country's population lives within assessed area



OUR CAPITAL CITIES AT A GLANCE

TREE CANOPY: HOW OUR CITIES* COMPARE



There are vast differences in tree canopy cover rates across Australia's capital cities. These variations may be attributed to any number of factors—geography, population and climate, to cite a few—and should not be seen as a comment on any particular council's attitudes towards green space projects.**

However, these figures will serve as a useful reference point for evaluating the amount of green space as we march toward the year 2020.



IMPRESSIVE TREE CANOPY COVER

Most urban LGAs will struggle to achieve tree canopy rates like those found in this selection due to their urban density, among other factors.

- 1 Cairns Regional Council (QLD)
- 2 City of Launceston (TAS)
- 3 Townsville City Council (QLD)
- 4 Shire of Kalamunda (WA)

OPPORTUNITIES DUE TO GRASS-BARE GROUND

Golf courses and sports grounds are not plantable, but there is nothing to stop you planting between fairways, or around an oval.

- 1 City of Wyndham (VIC)
- 2 City of Wanneroo (WA)
- 3 Town of Gawler (SA)
- 4 Camden Council (NSW)

HARD SURFACE HEAVY

Lots of concrete demands creative approaches to urban greening. Think roof and wall gardens for a start.

- 1 City of Maribyrnong (VIC)
- 2 City of Fremantle (WA)
- 3 City of Holdfast Bay (SA)
- 4 City of Rockdale (NSW)



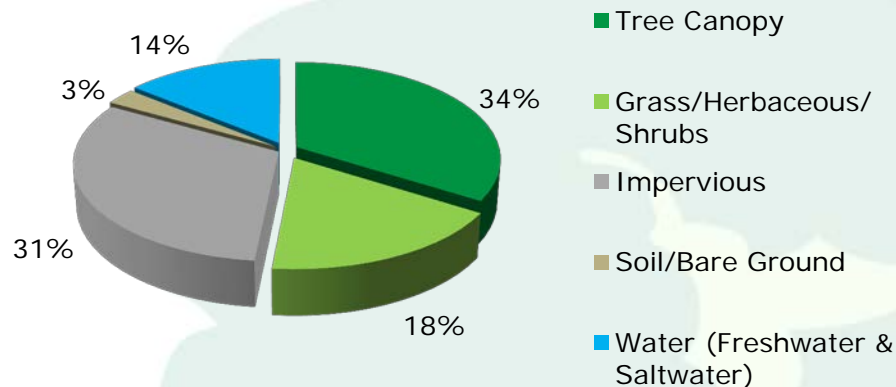
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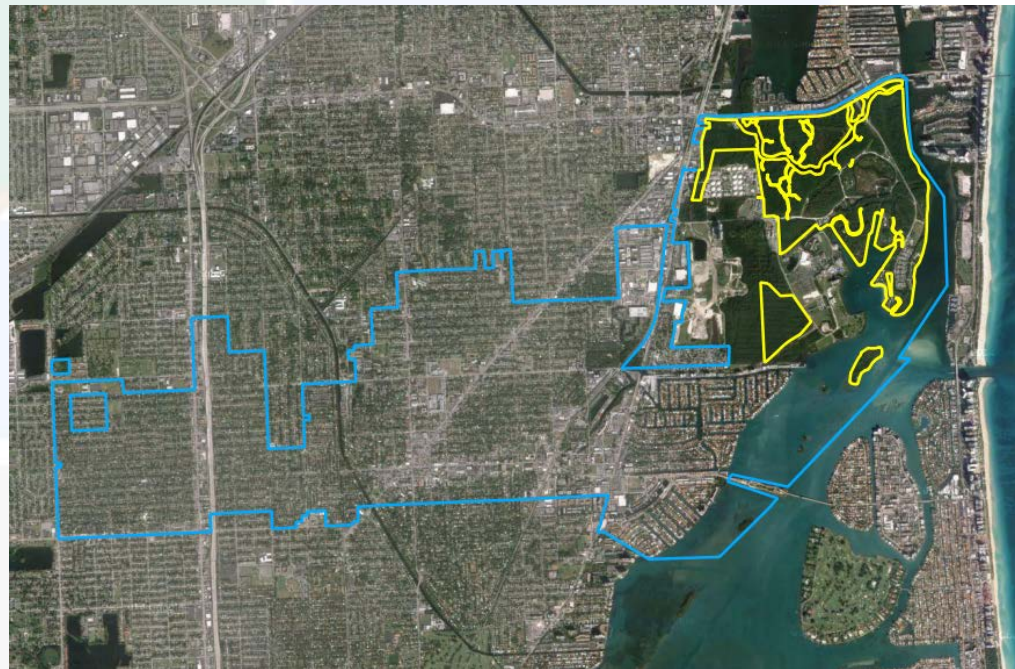
State University of New York
College of Environmental Science and Forestry

Targeted analysis: Separating by ownership

North Miami Cover Types in 2015



All Cover Class Types	2015 % Cover
Tree Canopy - City	22.2
Tree Canopy - State	11.7
Grass/Herbaceous/ Shrubs	17.7
Impervious - Building	12.2
Impervious - Road	8.41
Impervious - Other	11
Soil/Bare Ground	2.7
Water - Freshwater	1.47
Water - Saltwater	12.6



Discussion and Questions

Visit www.itreetools.org/canopy to give it a try

Jason.Henning@davey.com



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i-Tree Landscape

Overview

Mike Binkley
The Davey Institute
The Davey Tree Expert Company
mike.binkley@davey.com



i-Tree Landscape Overview

- 1) Technology
- 2) Walk-Through



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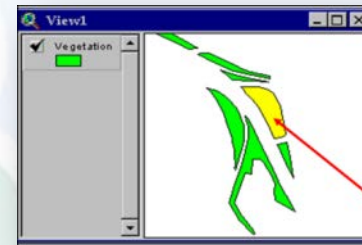


Geographic Information Systems (GIS)



GIS: the Information Systems (IS) technology that allows us to properly manipulate geographic data.

- IS: tables with records
- GIS: tables with records tied to graphic features with geographic locations

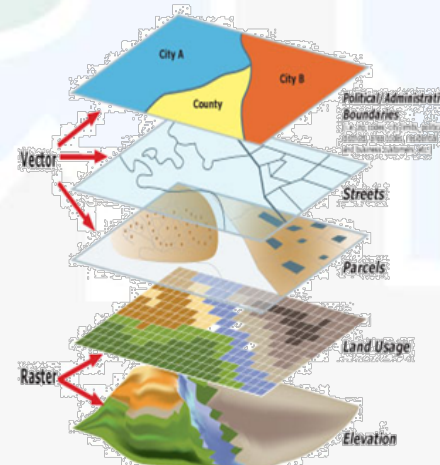


Shape	Area_sq	Perim	Spans Length	Accept or Inland?
Polygon	71V	2.00	1.95	0.05
Polygon	71BB	3.75	3.00	0.50
Polygon	71AA	3.00	0.00	0.00
Polygon	71U	0.00	0.00	0.00
Polygon	71S	0.00	0.00	0.00
Polygon	71R	0.00	0.00	0.00



The power of GIS:

- intra- and inter-layer analysis



Two large considerations:

- Data
- Software



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GIS vs. Web Mapping



Traditional GIS

- Higher end computer needed
- \$\$ proprietary software
- Skills / Training in GIS and regular computing
- Variable, raw map data

Powerful, but limited to specialists



“GIS” served over the Internet

- \$\$ backend server(s) and care thereof
- 0\$ - \$\$\$ server software
- Accessed via a simple web-browser map interface
- Specific maps & functionality

Wider Audience, but necessarily limited functionality

Moves the GIS part behind the scenes



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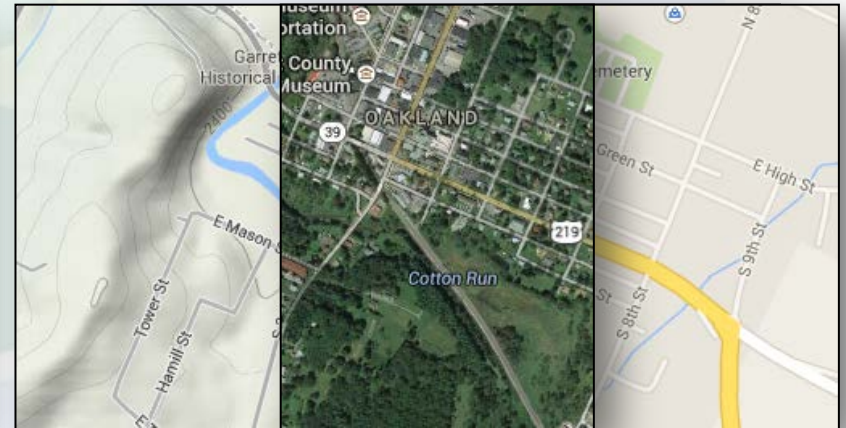
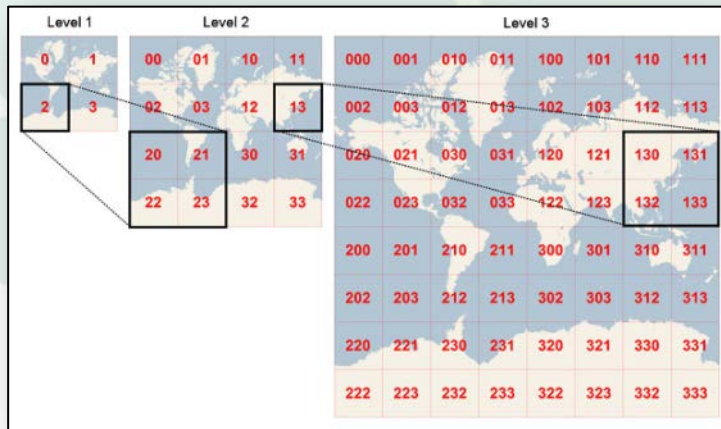


How does Google do it?



via four “tricks”:

1. Maps served up as “pre-recorded” image tiles (for zoom/pan)
2. Limited to a few primary layers – streets, satellite, terrain, traffic



3. Points of interest as markers on top of those tiles
4. Limited user interaction – zoom, pan, click a marker for info

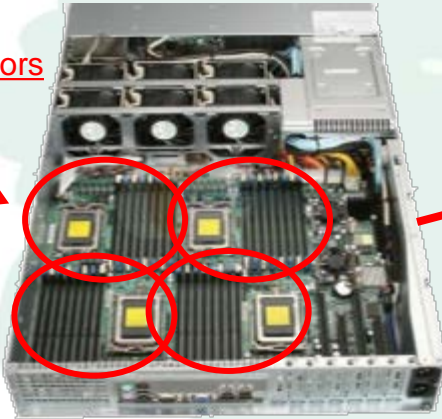
One can build more functionality with programming...

How does Google do it?



...and with a “little bit” of hardware:

CPU:
4+ processors
RAM:
32+ GB



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i-Tree Landscape Vision

- 🌳 A spatially distributed model of inputs & outputs.
- 🌳 **National** - and where available - high-resolution (**UTC**) tree, land, and impervious cover data.
- 🌳 Allow aggregation via land management and political boundaries.
- 🌳 Estimate **tree benefits** (carbon, air pollution, hydrology).
- 🌳 Identify **priority planting** areas based upon user criteria.
- 🌳 Assist with optimal **Canopy Goals** based upon user criteria and available space.
- 🌳 Free, minimal skills, **user friendly**.



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Construction Challenges

🌳 Use the **Web-Mapping** model (*“GIS” over the internet*) to deliver Urban Forestry GIS content, tools, and skills:


- to a wide range of users,
- needing very large GIS datasets,
- across a large number of layers,
- combined with “canned” GIS ops,
- and provide on-the-fly processing
 - *between datasets*
 - *with rapidly changing user inputs,*
- as simply as possible
 - *(and make it good-looking too!)*



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Construction Challenges & Responses

 **Use the Web-Mapping model (“GIS” over the internet) to deliver Urban Forestry GIS content, tools, and skills:**

- to a wide range of users,
 - needing very large GIS datasets,
 - across a large number of layers,
 - combined with “canned” GIS ops,
 - and provide on-the-fly processing
 - *between datasets*
 - *with rapidly changing user inputs,*
 - as simply as possible
 - *(and make it good looking too!)*
- Intuitive user interface
 - Pre-process & hardware
 - Web mapping software
 - Create set user-functions
 - Clearly define these
 - hardware
 - structure the inputs
 - User Experience (UX) design and graphic designer



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Our initial approach

Round I: research/refine open-source web-mapping tools

- Specifically geared to Urban Forestry goals / UTC Goal-Setting
 - *How much canopy do I have and where?*
 - *Where should I prioritize planting?*
- Get the web-mapping software environments configured and running
 - *PostGIS - PostGreSQL (database)*
 - *GeoServer (GIS engine)*
 - *OpenLayers (GIS display)*
 - *GeoExt - (mapping user interaction tools)*
- Preprocess as much **LARGE** data as possible
 - *NLCD (images)*
 - *UTC (images or vector)*
 - *Census block groups (vector)*

Round II: Get the basic environment up and running

- Build a “Geoserver” and a Database server: 64cores, 128GB, 22TB

Round III: Develop a functional foundation

- On which more advanced functions can be added...



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i-Tree Landscape Overview

- 1) Technology
- 2) Walk-Through

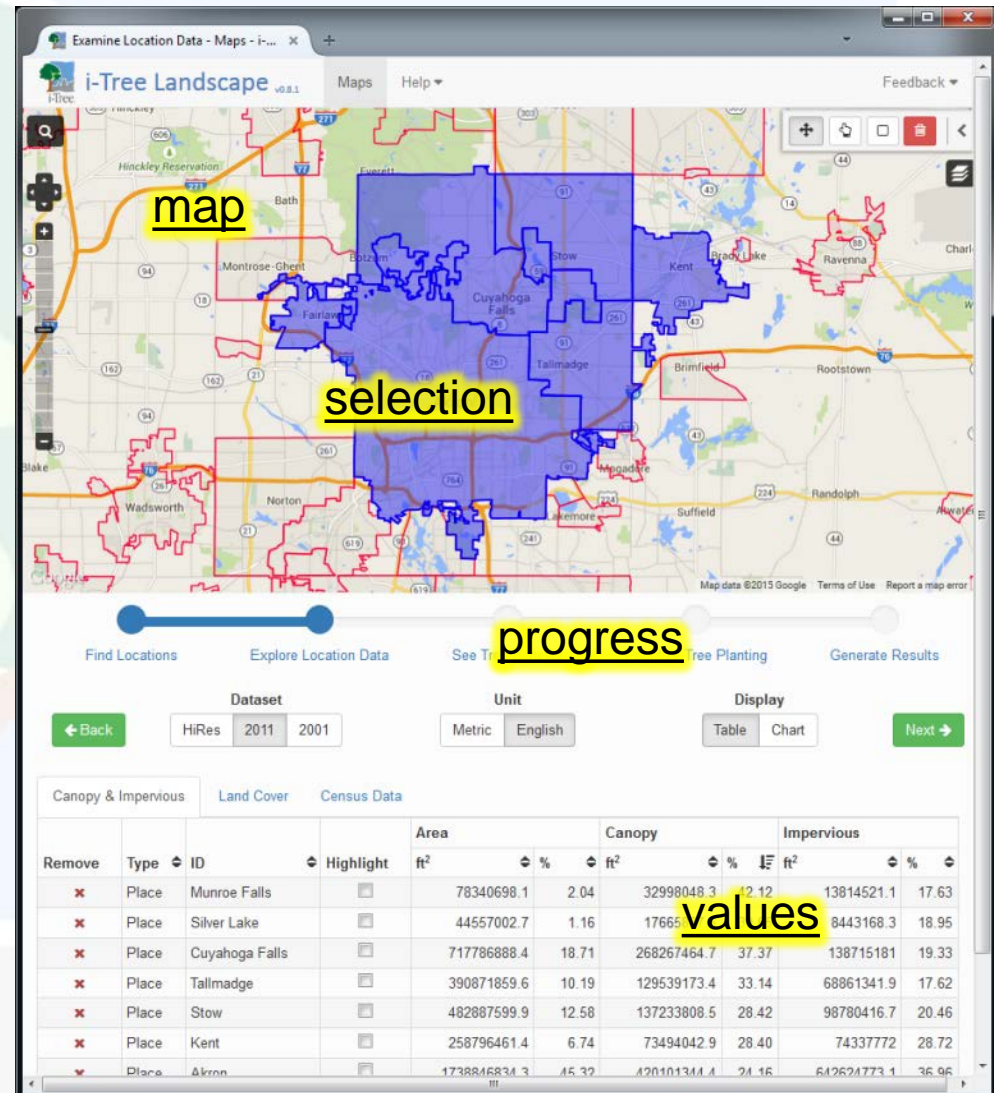


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i-Tree Landscape: Methods, Results & Outputs

- 🌳 Location Information
 - 🌳 Census Demographics
 - 🌳 Estimated Tree Benefits
 - 🌳 Tree Planting Prioritization
- 🌳 Consistent Interface:
- map
 - selection
 - progress
 - values



Home Page

Home - i-Tree Landscape

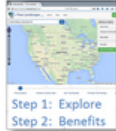
**i-Tree Landscape** v0.7.1

Maps Help


Feedback

Welcome to i-Tree Landscape! v0.7.1

Providing more than just beauty and shade, trees produce intangible benefits, such as removal of atmospheric carbon dioxide and pollution, storm water reduction, temperature modification, and more. i-Tree Landscape was created to allow you to explore tree canopy, land cover, and basic demographic information in an area of your choosing. With the information provided by i-Tree Landscape, you will learn about the benefits of trees in the area, allowing you to see how planting trees will increase the benefits provided, and map areas in which to prioritize your tree planting efforts.




Step 1: Explore
Step 2: Benefits



Washington

Ozone	
\$	g/m ² /yr
90122.16	8.59
PM2.5	
\$	g/m ² /yr
202948.10	0.42





Get Started

Explore Place

See Tree Benefits

Prioritize Tree Planting

Generate Outputs

By removing carbon dioxide, trees help mitigate climate change. The shade provided by urban tree canopies can also help tame the urban heat island effect. In addition, trees intercept storm water, which can reduce flooding and improve water quality within their watershed. And, as if more benefits were needed, trees reduce air pollution, such as ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, and fine particulate matter-the reduction of which has proven benefits to human health. Trees truly can improve our lives! Click the Get Started button and begin exploring.

**DAVEY** 

**Arbor Day Foundation**

**ISA** 

**ESF**



Help & References

Help - i-Tree Landscape

i-Tree Landscape v0.7.1 Maps Help Feedback

How to use
References
F.A.Q.
About

Help

Welcome to i-Tree Landscape

i-Tree Landscape was created to allow you to explore tree canopy, land cover, and basic demographic information in an area of your choosing. With the information provided by i-Tree Landscape, you will learn about the benefits of trees in the area, allowing you to see how planting trees will increase the benefits provided, and map areas in which to prioritize your tree planting efforts.

How to use i-Tree Landscape

The [Maps](#) webpage contains all of the steps to complete an i-Tree Landscape project.

A project is broken into five, simple steps. The current stage of a project is represented by the progress bar, which is shown below the map.

The Steps

1. [Find Locations](#)
2. [Examine Location Data](#)
3. [See Tree Benefits](#)
4. [Prioritize Tree Planting](#)
5. [Generate Results](#)

Find Locations

On the [Maps](#) page, this section also lists an abbreviated version of this help document.

First, the search bar at the top-left of the map can be used to quickly view a location, such as a city, state or street address. This feature is comparable to the search feature in routing or navigation software (car GPS, [MapQuest](#), [Google Maps](#), [Bing Maps](#), [Yahoo Maps](#), [OpenStreetMap](#)...).

The vertical bar on the left edge of the map represents the current zoom level. The directional arrows above the zoom-bar may be used to pan (navigate) about the map, instead of "click-dragging" or "touch-dragging" on supported devices.

Now, having an area of interest viewable, geographic regions must be selected by clicking on the map. The map's control panel is used to view region boundaries and control which type is being selected.

The **control panel**, located on the top-right of the map, has several uses; it features lists of available datasets and maps; it contains the toolbar to changing what tool/mode is interacting with the map, i.e. what happens when the map is clicked (pan, select, identify, ...); it also controls which region type can be selected. Some of the controls are nested under a heading that can be clicked to expand or collapse the controls it contains.

To view the data of a layer, simply click the box next to its title that says [on/off]. Here is an overview of the available options:

Map Layers Choose to view a boundary type on the map, such as administrative or water, including U.S. Census block groups, places, counties, and states. This can also be thought of as viewing the "resolution" or "granularity" of the

<https://landscape.itreetools.org:9443/help/>

Home Page

Home - i-Tree Landscape

**i-Tree Landscape** v0.7.1

Maps Help

Feedback

Welcome to i-Tree Landscape! v0.7.1

Providing more than just beauty and shade, trees produce intangible benefits, such as removal of atmospheric carbon dioxide and pollution, storm water reduction, temperature modification, and more. i-Tree Landscape was created to allow you to explore tree canopy, land cover, and basic demographic information in an area of your choosing. With the information provided by i-Tree Landscape, you will learn about the benefits of trees in the area, allowing you to see how planting trees will increase the benefits provided, and map areas in which to prioritize your tree planting efforts.



Step 1: Explore
Step 2: Benefits



Washington

Ozone	
\$	g/m ² /yr
90122.16	8.59
PM2.5	
\$	g/m ² /yr
202948.10	0.42





Get Started

Explore Place

See Tree Benefits


Prioritize Tree Planting

Generate Outputs

By removing carbon dioxide, trees help mitigate climate change. The shade provided by urban tree canopies can also help tame the urban heat island effect. In addition, trees intercept storm water, which can reduce flooding and improve water quality within their watershed. And, as if more benefits were needed, trees reduce air pollution, such as ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, and fine particulate matter-the reduction of which has proven benefits to human health. Trees truly can improve our lives! Click the Get Started button and begin exploring.

**DAVEY** 

**Arbor Day Foundation**


**ISA** 

**ESF**




Maps!


Maps - i-Tree Landscape


 **i-Tree Landscape** v0.7.1


Maps Help


Feedback









 Select

Map Layers 

Canopy & Land Layers 

Base Maps 

Select By

(Ctrl + click) to (de)select multiple regions.

Process Statistics


Find Locations

Explore Location Data

See Tree Benefits

Prioritize Tree Planting

Generate Results

Next 

The [Help](#) page has a thorough *How-To* that adds greater detail to the below descriptions, which are of the steps involved in completing an analysis with i-Tree Landscape.

Lets Get Started!

A project is broken into five, simple steps. The current stage of a project is represented by the progress bar, which is shown below the map.

At any stage, regions can be added and removed from the selection group.

1. Find Locations

First, the search bar at the top-left of the map can be used to quickly view a location, such as a city or street address. This feature is comparable to the search feature in routing or navigation software.

Maps!

i-Tree Landscape v0.7.1 Maps Help Feedback

Akron, OH

Map Layers

- ☒ Tree Canopy
Transparency: 0 %
- ☐ Impervious
Transparency: 0 %
- ☐ Land Cover
Transparency: 0 %

Base Maps

Select By

US Census Block Group

(ctrl + click) to (de)select multiple regions.

Process Statistics

Find Locations **Explore Location Data** **See Tree Benefits** **Prioritize**

The [Help](#) page has a thorough How-To that adds greater detail to the below descriptions, which are of the steps involved in completing an analysis with i-Tree Landscape.

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Maps!

Maps - i-Tree Landscape

i-Tree Landscape v0.7.1 Maps Help Feedback

Akron, OH

Find Locations Explore Location Data See Tree Benefits Prioritize

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Lets Get Started!

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1. Find Locations

First, the search bar at the top-left of the map can be used to quickly view a location, such as a city or street address. This feature is comparable to the search feature in routing or navigation software.

Step 1: Find a Location

Maps - i-Tree Landscape v0.7.1 Maps Help Feedback

Find Locations Explore Location Data See Tree Benefits Prioritize

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Lets Get Started!

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1. Find Locations

First, the search bar at the top-left of the map can be used to quickly view a location, such as a city or street address. This feature is comparable to the search feature in routing or navigation software.

Map Layers

- Administrative**
 - ☐ US Census Block Groups
 - ☒ US Census Places
 - ☐ US Congressional Districts
 - ☐ US Counties
 - ☐ US States
- Canopy & Land Layers**
 - ☐ Tree Canopy
 - Transparency: 51 %
 - ☐ Impervious
 - Transparency: 0 %
 - ☐ Land Cover
 - Transparency: 0 %
- Base Maps**
- Select By**
 - US Census Block Group
- [Process Statistics](#)

Step 1: Find a Location

Maps - i-Tree Landscape

i-Tree Landscape v0.7.1 Maps Help Feedback

Find Locations Explore Location Data See Tree Benefits Prioritize

Map Layers

Administrative

- ☐ US Census Block Groups
- ☒ US Census Places
- ☐ US Congressional Districts
- ☐ US Counties
- ☐ US States

Canopy & Land Layers

Base Maps

Google Aerial

Google Streets

Google Aerial

Bing Streets

Bing Aerial

Open Street Map

Blank Canvas

(ctrl + click) to (de)select multiple regions.

Process Statistics

Next

The [Help](#) page has a thorough How-To that adds greater detail to the below descriptions, which are of the steps involved in completing an analysis with i-Tree Landscape.

Lets Get Started!

A project is broken into five, simple steps. The current stage of a project is represented by the progress bar, which is shown below the map.

At any stage, regions can be added and removed from the selection group.

1. Find Locations

First, the search bar at the top-left of the map can be used to quickly view a location, such as a city or street address. This feature is comparable to the search feature in routing or navigation software.

Now, having an area of interest viewable, geographic regions must be selected by clicking on the map. The map's control panel is used to

Step 1: Find a Location

Maps - i-Tree Landscape

i-Tree Landscape v0.7.1 Maps Help Feedback

Find Locations Explore Location Data See Tree Benefits Prioritize

The [Help](#) page has a thorough How-To that adds greater detail to the below descriptions, which are of the same type as the regions you will select with i-Tree Landscape.

Lets Get Started!

A project is broken into five, simple steps. The current stage of a project is represented by the progress bar above. At any stage, regions can be added and removed from the selection group.

1. Find Locations

First, the search bar at the top-left of the map can be used to quickly view a location, such as a city or neighborhood, comparable to the search feature in routing or navigation software.

Now, having an area of interest viewable, geographic regions must be selected by clicking on the map. The map's control panel is used to

Map Layers

Administrative

- ☐ US Census Block Groups
- ☒ US Census Places
- ☐ US Congressional Districts
- ☐ US Counties
- ☐ US States

Canopy & Land Layers

☐ Tree Canopy

Transparency 34 %

☐ Impervious

Transparency 0 %

☐ Land Cover

Transparency 0 %

Base Maps

Google Aerial

Select By

US Census Block Group

(Ctrl + click) to (de)select multiple regions.

Process Statistics

Step 1: Find a Location

Maps - i-Tree Landscape

i-Tree Landscape v0.7.1 Maps Help Feedback

Find Locations Explore Location Data See Tree Benefits Prioritize

The [Help](#) page has a thorough How-To that adds greater detail to the below descriptions, which are of the same type as the regions you will select with i-Tree Landscape.

Lets Get Started!

A project is broken into five, simple steps. The current stage of a project is represented by the progress bar at the bottom of the screen.

At any stage, regions can be added and removed from the selection group.

1. Find Locations

First, the search bar at the top-left of the map can be used to quickly view a location, such as a city or zip code. This is comparable to the search feature in routing or navigation software.

Now, having an area of interest viewable, geographic regions must be selected by clicking on the map. The map's control panel is used to

Map Layers

- ☐ Administrative
 - ☐ US Census Block Groups
 - ☒ US Census Places
 - ☐ US Congressional Districts
 - ☐ US Counties
 - ☐ US States

Canopy & Land Layers

- ☒ Tree Canopy
 - Transparency: 34 %
- ☐ Impervious
 - Transparency: 0 %
- ☐ Land Cover
 - Transparency: 0 %

Base Maps

Google Aerial

Select By


US Census Block Group

(Ctrl + click) to (de)select multiple regions.

[Process Statistics](#)

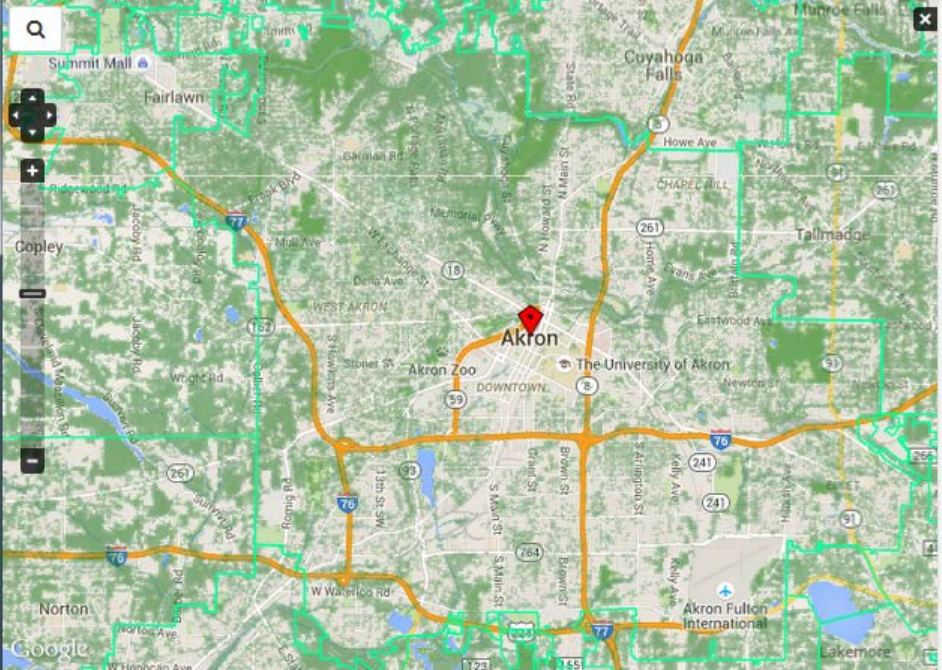
Step 1: Find a Location

Maps - i-Tree Landscape

 i-Tree Landscape v0.7.1

Maps Help

Feedback



Find Locations

Explore Location Data

See Tree Benefits

Prioritize

Map Layers

Administrative

☐ US Census Block Groups

☒ US Census Places

☐ US Congressional Districts

☐ US Counties

☐ US States

Canopy & Land Layers

☒ Tree Canopy

Transparency 51 %

☐ Impervious

Transparency 0 %

☐ Land Cover

Transparency 0 %

Base Maps

Select By

US Census Block Group

(ctrl + click) to (de)select multiple regions.

Process Statistics

The [Help](#) page has a thorough How-To that adds greater detail to the below descriptions, which are of the with i-Tree Landscape.

Lets Get Started!

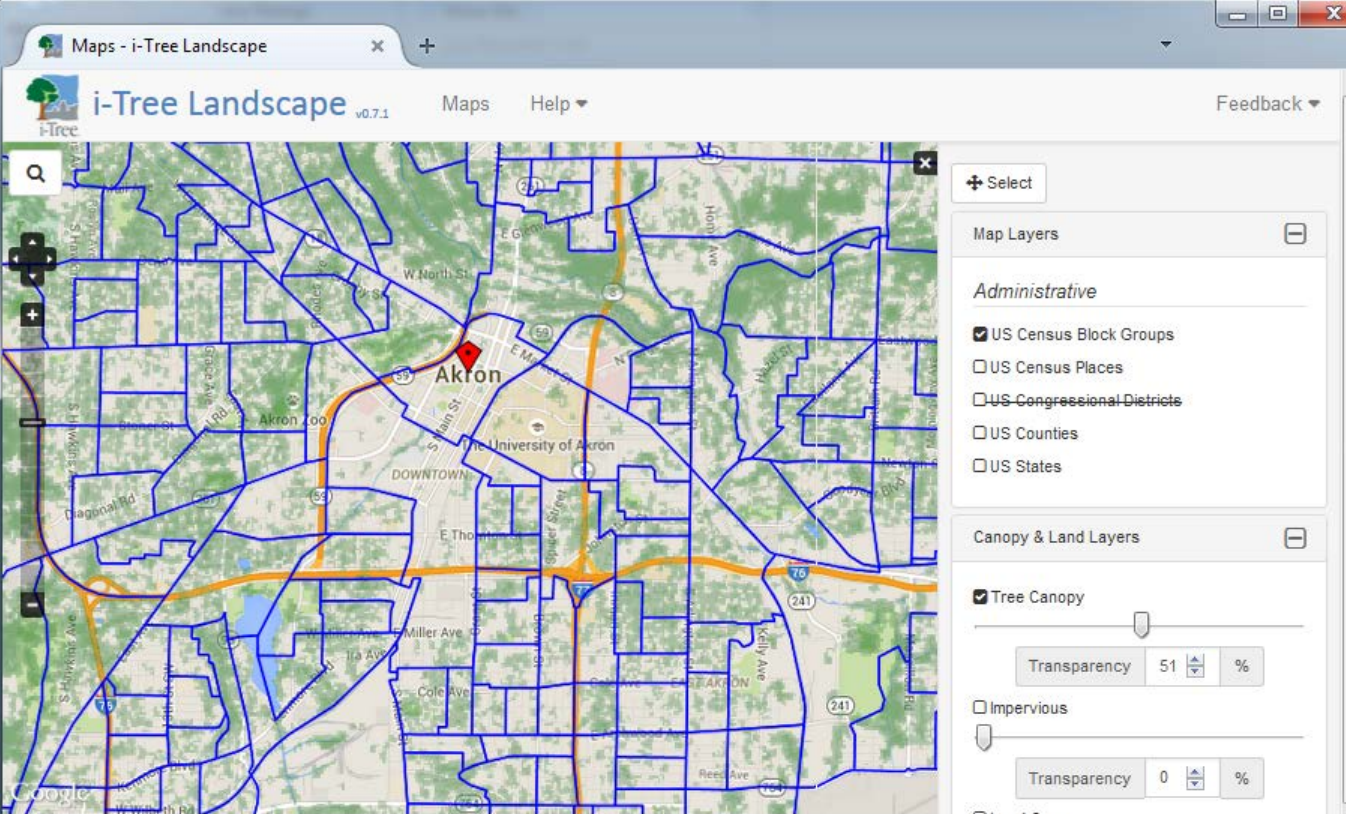
A project is broken into five, simple steps. The current stage of a project is represented by the progress

At any stage, regions can be added and removed from the selection group.

1. Find Locations

First, the search bar at the top-left of the map can be used to quickly view a location, such as a city or street address. This feature is comparable to the search feature in routing or navigation software.

Step 1: Find a Location



Maps - i-Tree Landscape v0.7.1 Maps Help Feedback

Map Layers

- ☒ Administrative
 - ☒ US Census Block Groups
 - ☐ US Census Places
 - ☐ US Congressional Districts
 - ☐ US Counties
 - ☐ US States
- ☒ Canopy & Land Layers
 - ☒ Tree Canopy
 - Transparency: 51 %
 - ☐ Impervious
 - Transparency: 0 %
 - ☐ Land Cover
 - Transparency: 0 %
- ☐ Base Maps

Select By

US Census Block Group

(ctrl + click) to (de)select multiple regions.

Process Statistics

Find Locations **Explore Location Data** **See Tree Benefits** **Prioritize**

The [Help](#) page has a thorough How-To that adds greater detail to the below descriptions, which are of the same type as the descriptions with i-Tree Landscape.

Lets Get Started!

A project is broken into five, simple steps. The current stage of a project is represented by the progress bar below.

At any stage, regions can be added and removed from the selection group.

1. Find Locations

First, the search bar at the top-left of the map can be used to quickly view a location, such as a city or street address. This feature is comparable to the search feature in routing or navigation software.

Step 1: Find a Location

i-Tree Landscape v0.7.1 Maps Help Feedback

Map Layers

- Administrative**
 - ☒ US Census Block Groups
 - ☐ US Census Places
 - ☐ US Congressional Districts
 - ☐ US Counties
 - ☐ US States
- Canopy & Land Layers**
 - ☒ Tree Canopy
 - Transparency: 51 %
 - ☐ Impervious
 - Transparency: 0 %
 - ☐ Land Cover
 - Transparency: 0 %
- Base Maps**
- Select By**
 - US Census Block Group
- Process Statistics**

Find Locations Explore Location Data See Tree Benefits Prioritize

The Help page has a thorough How-To that adds greater detail to the below descriptions, which are of the same type as the descriptions with i-Tree Landscape.

Lets Get Started!

A project is broken into five, simple steps. The current stage of a project is represented by the progress bar at the top of the page.

At any stage, regions can be added and removed from the selection group.

1. Find Locations

First, the search bar at the top-left of the map can be used to quickly view a location, such as a city or street address. This feature is comparable to the search feature in routing or navigation software.

Step 2: Explore the Location

Examine Location Data - Maps - i-Tree v0.7.1

i-Tree Landscape Maps Help Feedback

Akron, OH

Find Locations Explore Location Data See Tree Benefits Prioritize Tree Planting Generate Results

Dataset Unit Display

← Back HiRes 2011 2001 Metric English Table Chart Next →

Canopy & Impervious Land Cover Census Data

Remove	Type	ID	Highlight	Area		Canopy		Impervious	
				m ²	%	m ²	%	m ²	%
✗	to-do	391535083012		66988.3	4.41	12850.4	19.18	27915.6	41.67
✗	to-do	391535066001		18932.2	1.25	2520.4	13.31	10944.9	57.81
✗	to-do	391535066002		20887.3	1.37	4195	20.08	10303	49.33
✗	to-do	391535064003		18897.8	1.24	1237.3	6.55	11409.9	60.38

Step 2: Explore the Location

Examine Location Data - Maps - i-Tree v0.7.1

i-Tree Landscape Maps Help Feedback

Akron, OH

Find Locations Explore Location Data See Tree Benefits Prioritize Tree Planting Generate Results

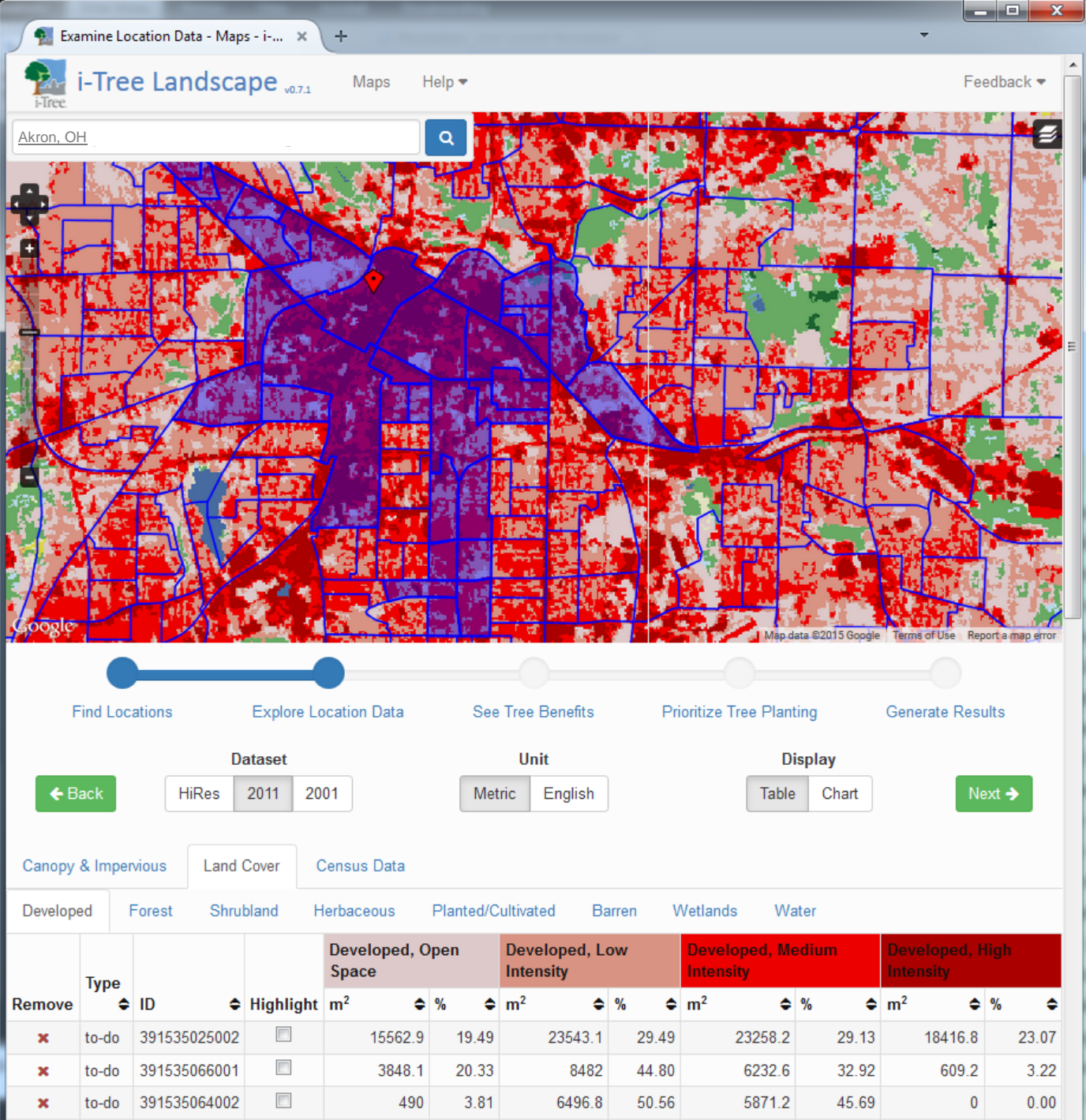
Dataset Unit Display

← Back HiRes 2011 2001 Metric English Table Chart Next →

Canopy & Impervious Land Cover Census Data

Remove	Type	ID	Highlight	Area		Canopy		Impervious	
				m ²	%	m ²	%	m ²	%
✗	to-do	391535090003	<input checked="" type="checkbox"/>	29678.8	1.95	6158.8	20.75	12752.5	42.97
✗	to-do	391535066002	<input checked="" type="checkbox"/>	20887.3	1.37	4195	20.08	10303	49.33
✗	to-do	391535025001	<input type="checkbox"/>	65978.8	4.34	13100.6	19.86	36815.3	55.80
✗	to-do	391535083012	<input checked="" type="checkbox"/>	66988.3	4.41	12850.4	19.18	27915.6	41.67

Step 2: Explore the Location



Step 2: Explore the Location

Examine Location Data - Maps - i-Tree v0.7.1

i-Tree Landscape Maps Help Feedback

Akron, OH

Map Layers

Canopy & Land Layers

☐ Tree Canopy

Transparency 0 %

☐ Impervious

Transparency 0 %

☐ Land Cover

Transparency 50 %

Base Maps

Select By

US Census Block Group

(ctrl + click) to (de)select multiple regions.

Process Statistics

Find Locations Explore Location Data See Tree Benefits Prioritize Tree

Dataset Unit

Back HiRes 2011 2001 Metric English

Canopy & Impervious Land Cover Census Data

Developed Forest Shrubland Herbaceous Planted/Cultivated Barren Wetlands Water

Remove	Type	ID	Highlight	Developed, Open Space		Developed, Low Intensity		Developed, Medium Intensity		Developed, High Intensity	
				m ²	%	m ²	%	m ²	%	m ²	%
	to-do	391535019001		512.4	1.30	13453.8	34.01	23117.8	58.44	2416	6.11
	to-do	391535068001		112868.8	45.14	97177.1	38.87	31761.3	12.70	7194.8	2.88
	to-do	391535086002		0	0.00	13046.9	18.61	22440.6	32.00	20685.2	29.50

Step 2: Explore the Location

Examine Location Data - Maps - i-Tree v0.7.1

i-Tree Landscape Maps Help Feedback

Akron, OH

Map Layers

Canopy & Land Layers

☐ Tree Canopy

Transparency 0 %

☐ Impervious

Transparency 0 %

☒ Land Cover

Transparency 50 %

Base Maps

Select By

US Census Block Group

(ctrl + click) to (de)select multiple regions.

Process Statistics

Find Locations Explore Location Data See Tree Benefits Prioritize Tree

Dataset Unit

Back HiRes 2011 2001 Metric English

Canopy & Impervious Land Cover Census Data

Developed Forest Shrubland Herbaceous Planted/Cultivated Barren Wetlands Water

Remove	Type	ID	Highlight	Developed, Open Space		Developed, Low Intensity		Developed, Medium Intensity		Developed, High Intensity	
				m ²	%	m ²	%	m ²	%	m ²	%
	to-do	391535019001		512.4	1.30	13453.8	34.01	23117.8	58.44	2416	6.11
	to-do	391535068001		112868.8	45.14	97177.1	38.87	31761.3	12.70	7194.8	2.88
	to-do	391535086002		0	0.00	13046.9	18.61	22440.6	32.00	20685.2	29.50

Step 2: Explore the Location

Examine Location Data - Maps - i-Tree v0.7.1

i-Tree Landscape Maps Help Feedback

Akron, OH

Find Locations Explore Location Data See Tree Benefits Prioritize Tree Planting Generate Results

Dataset Unit Display

← Back HiRes 2011 2001 Metric English Table Chart Next →

Canopy & Impervious Land Cover Census Data

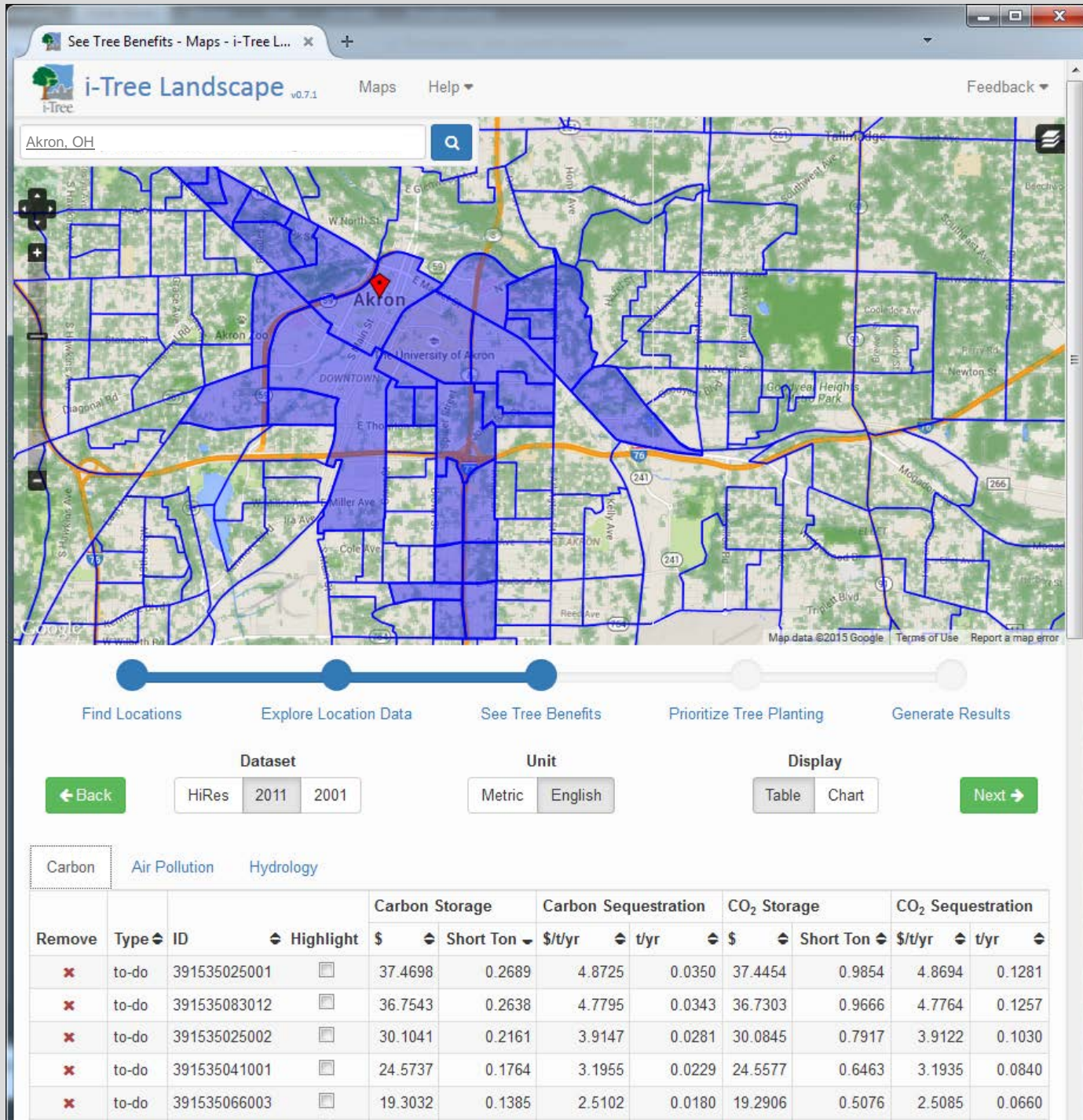
Population Income Overview Home Overview Household Type Home Tenure Educational Attainment

Remove	Type	ID	Highlight	Population	Median Age	Minority Percent
✖	to-do	391535089002	<input type="checkbox"/>	2046	19.9	19.11
✖	to-do	391535089003	<input type="checkbox"/>	1803	20.5	32.39
✖	to-do	391535019001	<input type="checkbox"/>	1513	44.3	78.98
✖	to-do	391535068001	<input type="checkbox"/>	1414	38.6	52.97
✖	to-do	391535083011	<input type="checkbox"/>	1396	36.8	37.54

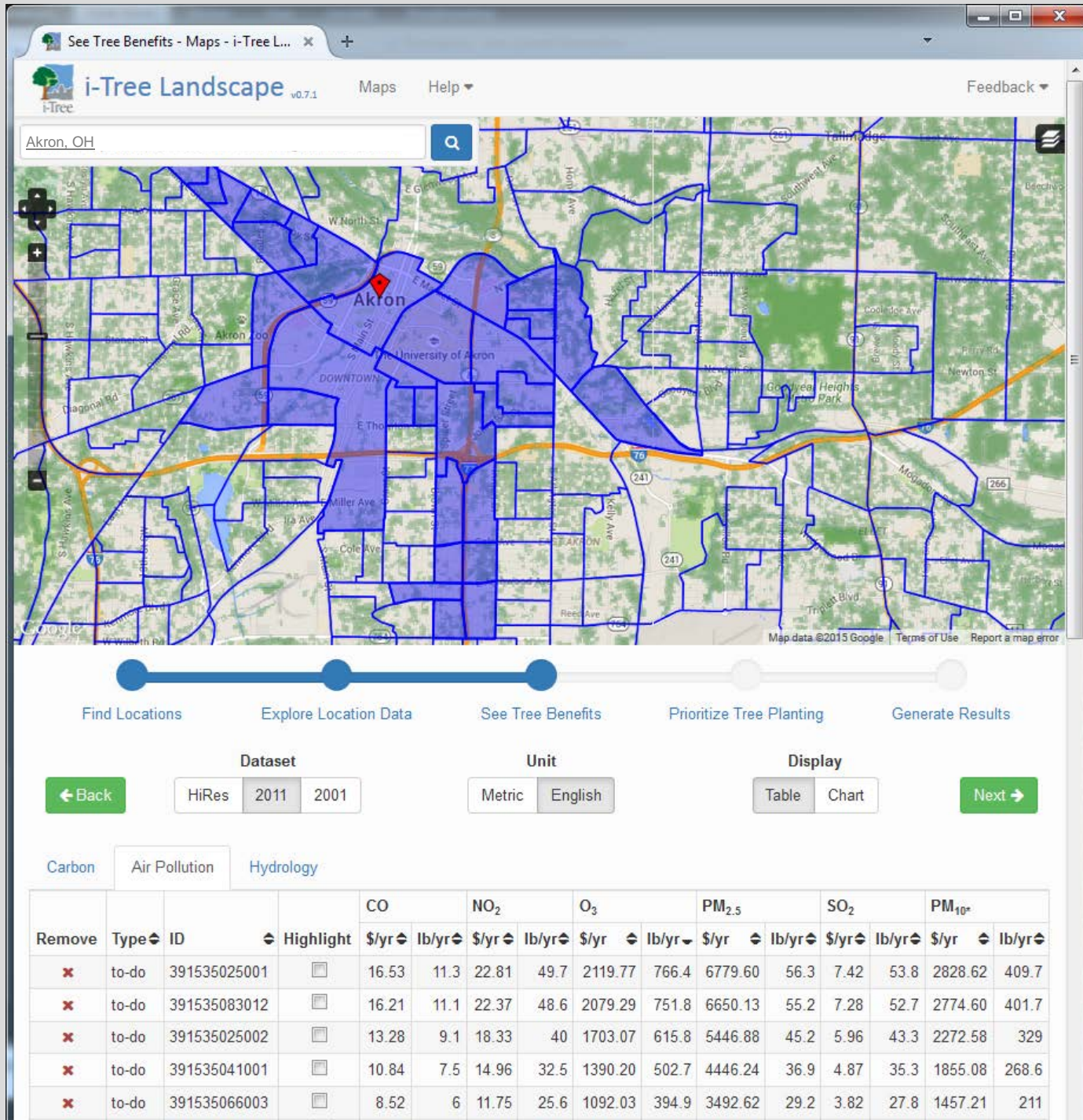
Step 2: Explore the Location



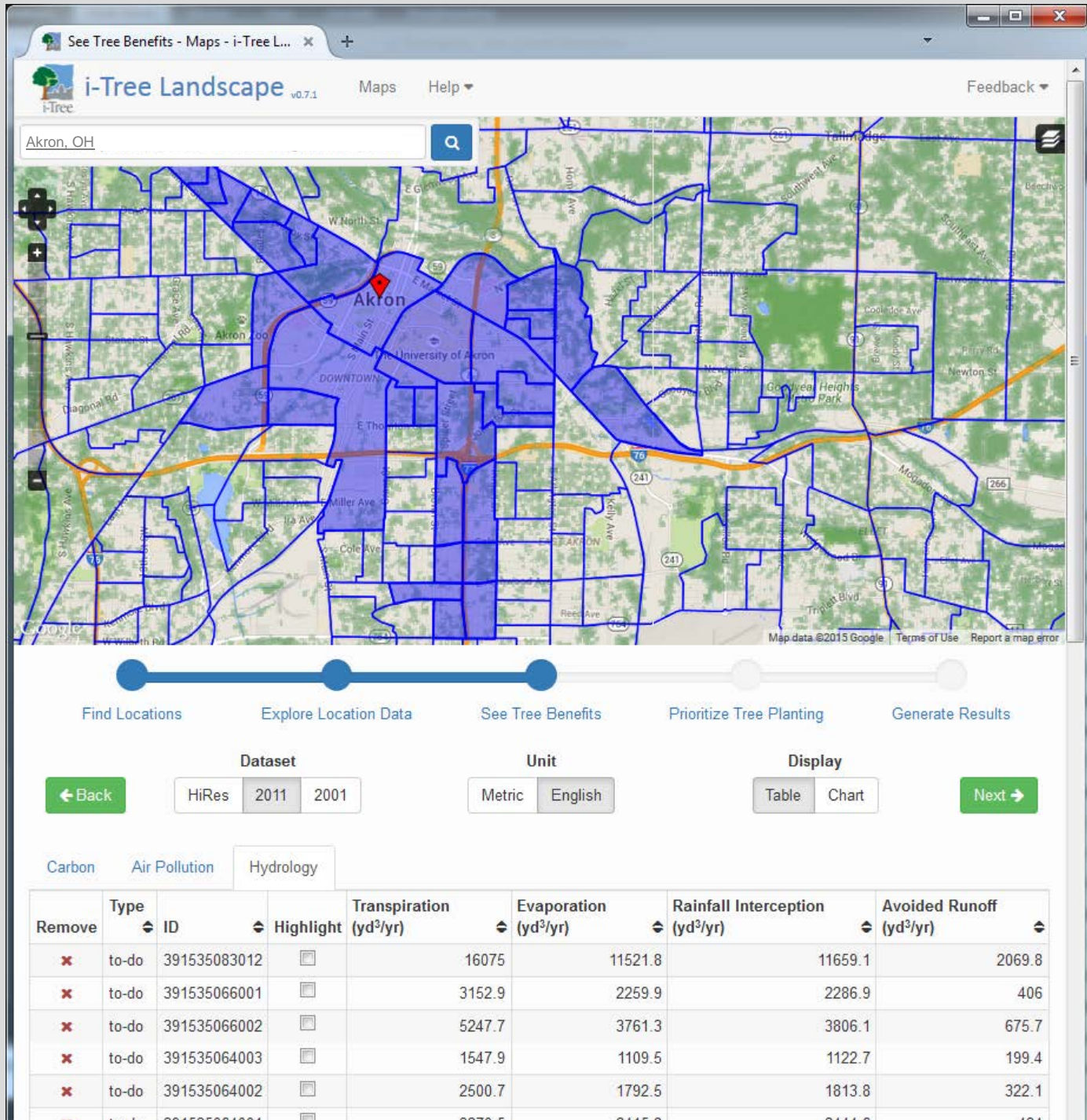
Step 3: Tree Benefits!



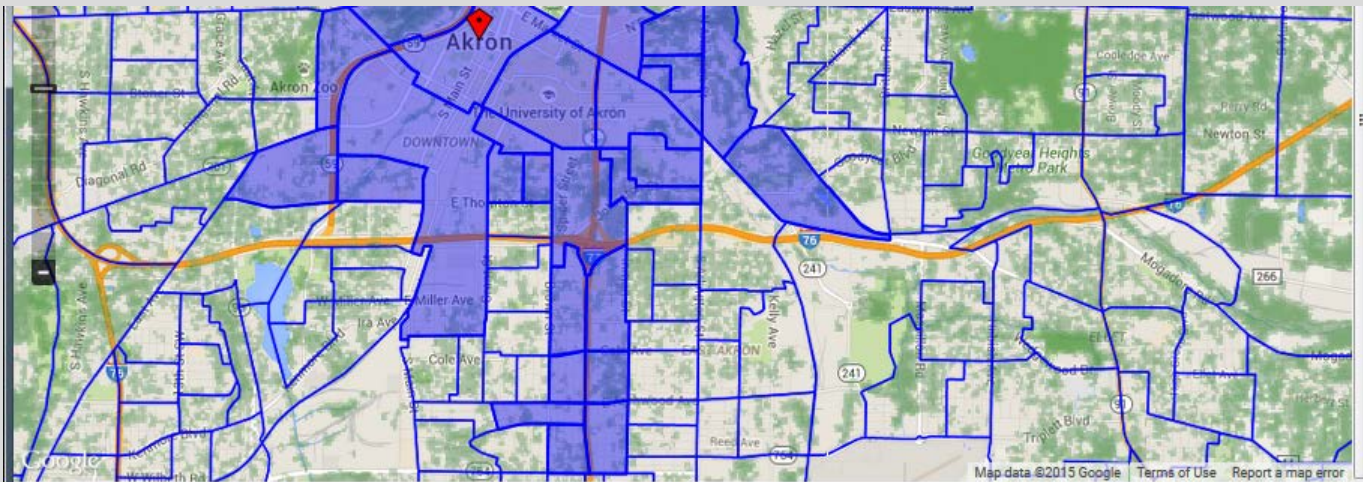
Step 3: Tree Benefits!



Step 3: Tree Benefits!



Step 3: Tree Benefits!



Find Locations

Explore Location Data

See Tree Benefits

Prioritize Tree Planting

Generate Results

Dataset

← Back

HiRes

2011

2001

Unit

Metric

English

Display

Table

Chart

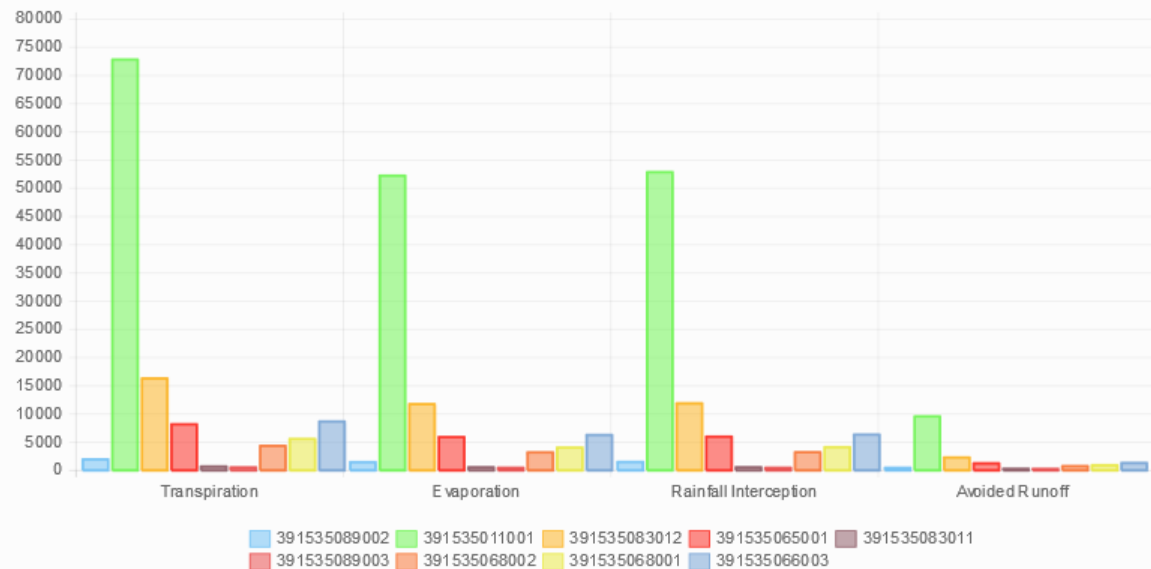
Next →

Carbon

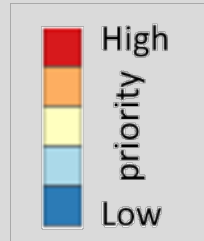
Air Pollution

Hydrology

Hydrology



Step 4: Prioritize Tree Planting



Prioritize Tree Planting - Maps - i-Tree Landscape v0.7.1 Maps Help Feedback

Akron, OH

The map displays the city of Akron, Ohio, with various areas shaded in colors representing tree planting priority. The colors range from red (High priority) to blue (Low priority). The map includes street names, parks, and major roads. A search bar at the top left shows "Akron, OH".

Find Locations Explore Location Data See Tree Benefits **Prioritize Tree Planting** Generate Results

← Back Update Map Display Next →

Transparency 0 100%

How To Prioritize Tree Planting

Better areas to plant trees, based on existing tree canopy and impervious ground cover, can be expressed by a “**Priority Planting Index**”. This index is built upon individual indices calculated for each of the selected regions on the map. Each criteria affects a region's priority for tree planting:

Recommended (as space is needed for new trees):

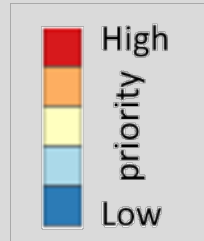
- *Tree Stocking Level*: low level indicate land area that could

Common Scenarios

PPI Social Enviro Stormwater

Tree Stocking Level

Step 4: Prioritize Tree Planting



Prioritize Tree Planting - Maps - i-Tree Landscape v0.7.1 Maps Help Feedback

Akron, OH

Find Locations

Explore Location Data

See Tree Benefits

Prioritize Tree Planting

Generate Results

← Back

Update Map Display

Transparency 40 %

100%

Next →

How To Prioritize Tree Planting

Better areas to plant trees, based on existing tree canopy and impervious ground cover, can be expressed by a “**Priority Planting Index**”. This index is built upon individual indices calculated for each of the selected regions on the map. Each criteria affects a region's priority for tree planting:

Recommended (as space is needed for new trees):

- *Tree Stocking Level*: low level indicate land area that could

Common Scenarios

PPI Social Enviro Stormwater

Tree Stocking Level

Step 4: Prioritize Tree Planting

The screenshot shows a web application titled "Prioritize Tree Planting - Maps - i-...". At the top, a progress bar with five steps is shown: "Find Locations", "Explore Location Data", "See Tree Benefits", "Prioritize Tree Planting" (the current step, highlighted with a blue dot), and "Generate Results". Below the progress bar are navigation buttons: "Back" (green), "Update Map Display" (blue), and "Next" (green). A "Transparency" slider is set to 30, with a green bar below it indicating 100%.

How To Prioritize Tree Planting

Better areas to plant trees, based on existing tree canopy and impervious ground cover, can be expressed by a **"Priority Planting Index"**. This index is built upon individual indices calculated for each of the selected regions on the map. Each criteria affects a region's priority for tree planting:

Recommended (as space is needed for new trees):

- *Tree Stocking Level*: low level indicate land area that could accommodate trees, but currently do not.

Optional (select 1 to 4):

- *Tree Cover per Capita*: low amounts of tree cover relative to population.
- *Population Density*: higher density, more urban-like areas.
- *Minority Population Density*: areas possibly underserved by tree cover due to ethnic make-up.
- *Percent Population Below Poverty Line*: areas possibly underserved by tree cover due to economic circumstances.

Each criteria is standardized on a scale of 0 to 1, with 1 representing the selection with the highest priority. Individual criteria scores for each selected region are combined and standardized based on common scenarios or user defined importance (i.e. weight) of each, to produce an overall Priority Planting Index (PPI) value between 0 and 100.

Common Scenarios

Buttons for scenarios: PPI, Social, Enviro, Stormwater.

Three criteria panels are visible, each with a dropdown menu, a slider, and an "Importance (weight)" input field:

- Tree Stocking Level**: Importance (weight) is 30%.
- Tree Cover per Capita**: Importance (weight) is 30%.
- Population Density**: Importance (weight) is 40%.

At the bottom, a green box shows "100%" and a blue button says "Equalize".

Step 4: Prioritize Tree Planting

The screenshot shows a web browser window with the title 'Prioritize Tree Planting - Maps - i-...'. The interface features a progress bar at the top with five steps: 'Find Locations', 'Explore Location Data', 'See Tree Benefits', 'Prioritize Tree Planting' (the current step), and 'Generate Results'. Below the progress bar are navigation buttons: 'Back', 'Update Map Display', and 'Next'. A 'Transparency' slider is set to 30%, with a green bar indicating 100% completion. The main content area is divided into two columns. The left column, titled 'How To Prioritize Tree Planting', explains the 'Priority Planting Index' and lists recommended and optional criteria. The right column, titled 'Common Scenarios', includes tabs for 'PPI', 'Social', 'Enviro', and 'Stormwater'. Below these are three configuration panels for 'Tree Stocking Level', 'Population Density', and 'Tree Cover per Capita', each with a slider and an 'Importance (weight)' dropdown. A list of criteria is shown at the bottom right, with 'Below Poverty Line' selected. At the bottom of the interface, there are buttons for '100%', 'Equalize', and a plus sign.

Prioritize Tree Planting - Maps - i-...

Find Locations Explore Location Data See Tree Benefits **Prioritize Tree Planting** Generate Results

Back Update Map Display Next

Transparency 30 % 100%

How To Prioritize Tree Planting

Better areas to plant trees, based on existing tree canopy and impervious ground cover, can be expressed by a “**Priority Planting Index**”. This index is built upon individual indices calculated for each of the selected regions on the map. Each criteria affects a region's priority for tree planting:

Recommended (as space is needed for new trees):

- *Tree Stocking Level*: low level indicate land area that could accommodate trees, but currently do not.

Optional (select 1 to 4):

- *Tree Cover per Capita*: low amounts of tree cover relative to population.
- *Population Density*: higher density, more urban-like areas.
- *Minority Population Density*: areas possibly underserved by tree cover due to ethnic make-up.
- *Percent Population Below Poverty Line*: areas possibly underserved by tree cover due to economic circumstances.

Each criteria is standardized on a scale of 0 to 1, with 1 representing the selection with the highest priority. Individual criteria scores for each selected region are combined and standardized based on common scenarios or user defined importance (i.e. weight) of each, to produce an overall Priority Planting Index (PPI) value between 0 and 100.

Common Scenarios

PPI Social Enviro Stormwater

Tree Stocking Level

Importance (weight) 30 %

Population Density

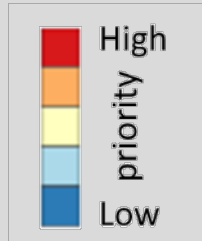
Importance (weight) 40 %

Tree Cover per Capita

Tree Cover per Capita
Minority Population Density
Population Density
Below Poverty Line
Tree Stocking Level

100% Equalize +

Step 4: Prioritize Tree Planting



Prioritize Tree Planting - Maps - i-Tree Landscape v0.7.1 Maps Help Feedback

Akron, OH

The map displays the city of Akron, Ohio, with various areas shaded in colors representing tree planting priority. The colors range from red (High priority) to dark blue (Low priority). The map includes street names, highways, and parks. A search bar at the top left shows "Akron, OH".

Find Locations Explore Location Data See Tree Benefits **Prioritize Tree Planting** Generate Results

← Back Update Map Display Next →

Transparency 30 % 100%

How To Prioritize Tree Planting

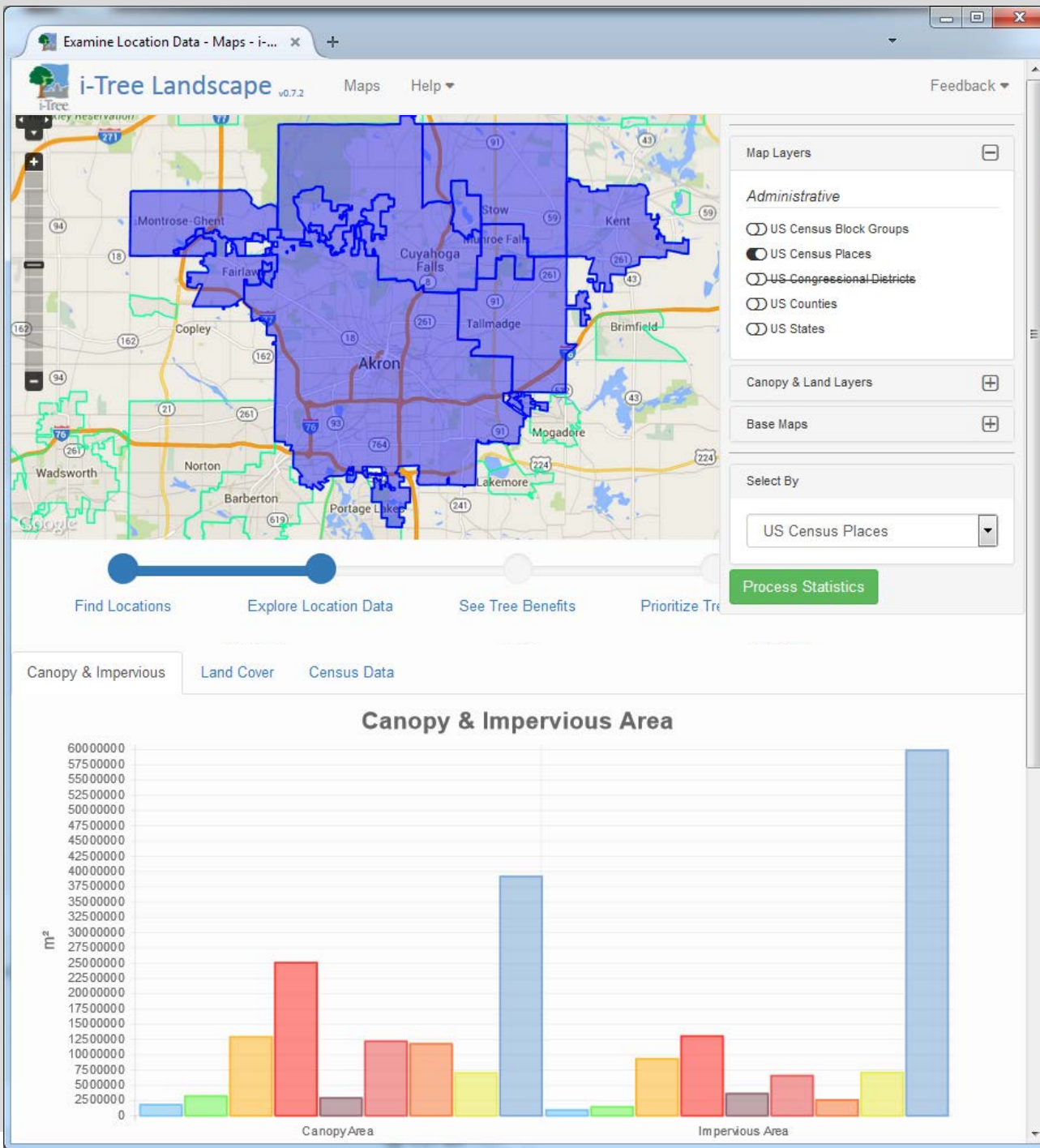
Better areas to plant trees, based on existing tree canopy and impervious ground cover, can be expressed by a “**Priority Planting Index**”. This index is built upon individual indices calculated for each of the selected regions on the map. Each criteria affects a region's priority for tree planting:

- Recommended (as space is needed for new trees):
 - *Tree Stocking Level*: low level indicate land area that could

Common Scenarios

PPI Social Enviro Stormwater

Tree Stocking Level



Other Geographic Aggregations

- Place
- Counties
- States
- Congressional Districts
- National Forests
- Watersheds
- Riparian Corridors
- ...

Next Steps – v2.0



Bug Fixes



Web Browser Compatibility



UX

- User Accounts
- Tweaks based upon user feedback to v1.0



Tables

- CSV export
- Standard errors and display thereof



Map Interaction

- Thematic mapping of most variables
- Feature investigation
- Selecting geographies - tools (square, polygon, lasso)
- Query Builder



Layers

- National Forests & Parks
- Watersheds
- Riparian Buffers



Prioritization

- Additional “canned” scenarios



Modeling

- Canopy increase/decrease and values impacts



Mobile



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Future Development

- 🌳 Grow Out Scenarios
- 🌳 Planting Goals
- 🌳 Runoff reduction / Water Quality / Floods
- 🌳 Air Temperature Maps / Surface Temperature
- 🌳 Climate Change & Species Changes
- 🌳 Social: Crime / UV radiation / Human Health Impacts
- 🌳 Elevation / Soils
- 🌳 Weather: Boundary Layer Heights / NEXRAD PPT / Future Weather
- 🌳 Pollution & Air Quality: Ozone impacts / VOC emissions / road source emissions / Pollution Dispersal
- 🌳 Pests / Invasives
- 🌳 Wildlife
- 🌳 Energy



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i-Tree Landscape Overview

Mike Binkley
The Davey Institute
The Davey Tree Expert Company
mike.binkley@davey.com



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Technology



Web services we are providing:

- GeoServer - provides WMS, WFS (generates the map tiles: PNG images from the map layers at different resolutions)
- WebGeoCache - a spatial storage of already generated tiles
- PostgreSQL - relational database
- PostGIS - SQL based geographic operations
- Memcache-d - keeps generated webpages in the machines memory



Databases in use:

- Administrative boundary shapefiles
- MRLC NLCD rasters
- US Census
- i-Tree: Locations, Species, benefits, etc.



Software/Libraries (our application is primarily written in Python and JavaScript.)

- Python 3
 - Django - running on Apache httpd through mod_wsgi
 - - also provides CSS and JS compression
- JavaScript
 - iQuery
 - OpenLayers - map display
 - C3 and/or ChartNew.js
 - Twitter Bootstrap (JavaScript and CSS)
 - Modernizer
- There are also many dependencies & configurations maintained on the machine to support GeoServer and PostGIS.



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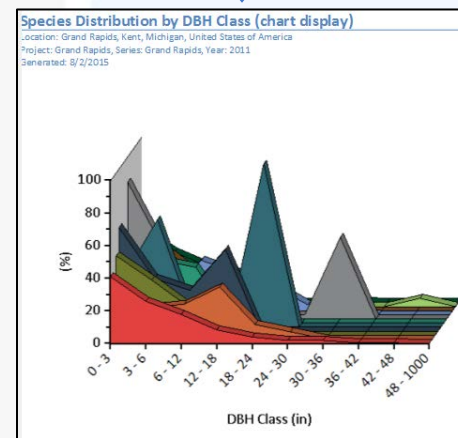




i-Tree Eco 2015

What is i-Tree Eco?

- Field-based assessment requiring inventory data
- Flagship software based on latest science & local data
- Originally developed for assessing whole urban forest
- Adapted for individual tree assessments
- Internationally functional

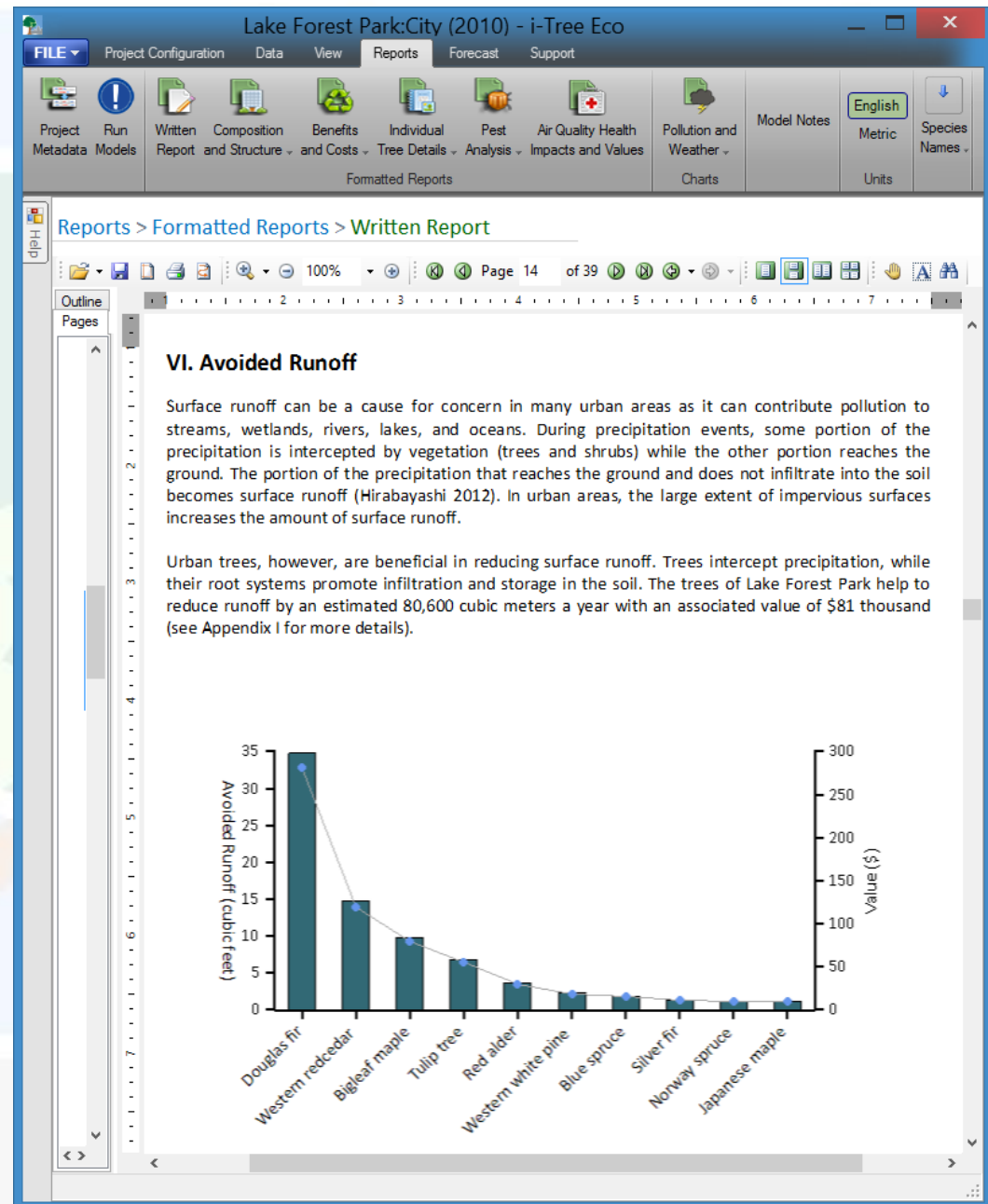


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i-Tree Eco Assess:

- Structure
- Function
 - Energy effects
 - Air quality
 - Carbon
 - Avoided runoff
 - Human health impacts
 - VOCs
- Value (\$)
- Management info
 - Pest risk
 - Tree health
 - Exotic/invasive spp.



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Providence i-Tree Eco Summary

Urban Forest Characteristics

- Number of trees: 415,000, or 34.4 trees per acre
- Tree cover: 23.9%
- Structural values: \$582 million
- Most common species: Norway maple, Northern red oak, Honeylocust
- Percentage of trees less than 6" (15.2 cm) diameter: 49.6%
- Ground Cover: 59% impermeable vs. 41% permeable

Environmental Benefits

- Total annual environmental benefits: \$4.7 million per year
 - Pollution removal: 91 tons/year (\$3.5 million/year)
 - Carbon sequestration: 4,030 tons/year (\$287 thousand/year)
 - Avoided runoff: 31.5 million gallons/year (\$281 thousand/year)
 - Building energy savings: \$591 thousand/year
 - Avoided carbon emissions: 500 tons/year (\$35.6 thousand/year)
- Total estimated carbon storage: 124 thousand tons (\$8.80 million)

Threats to our Urban Forest

- Pest Impacts: Asian Longhorned Beetle has the potential to impact 43.2% of the urban forest, a potential loss of \$265 million. Emerald Ash Borer would affect 4.2%, worth \$25.4 million.

Providence's Urban Forest: Structure, Effects and Values



i-Tree Eco System Analysis
February 2014

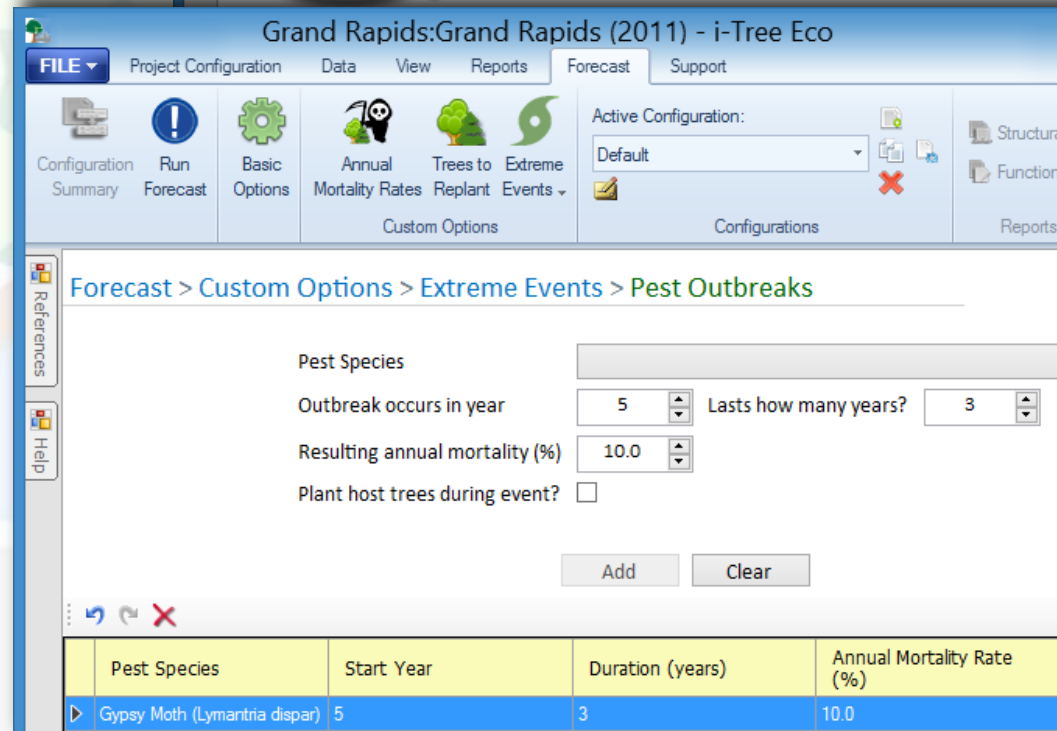
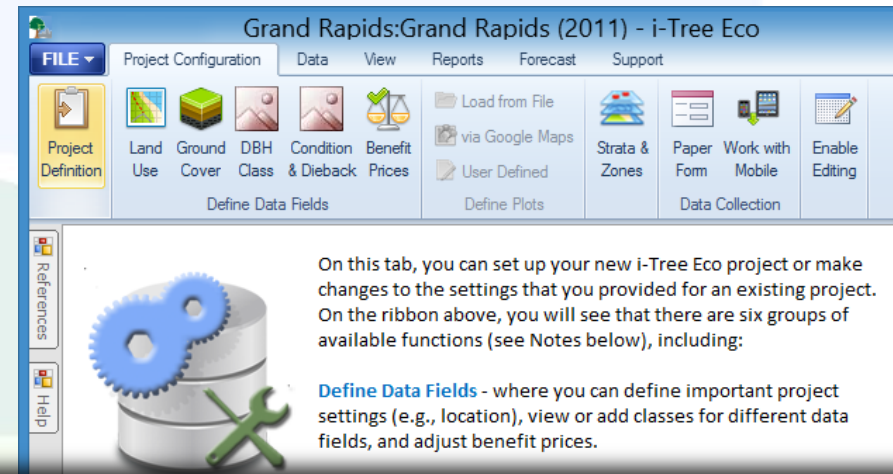


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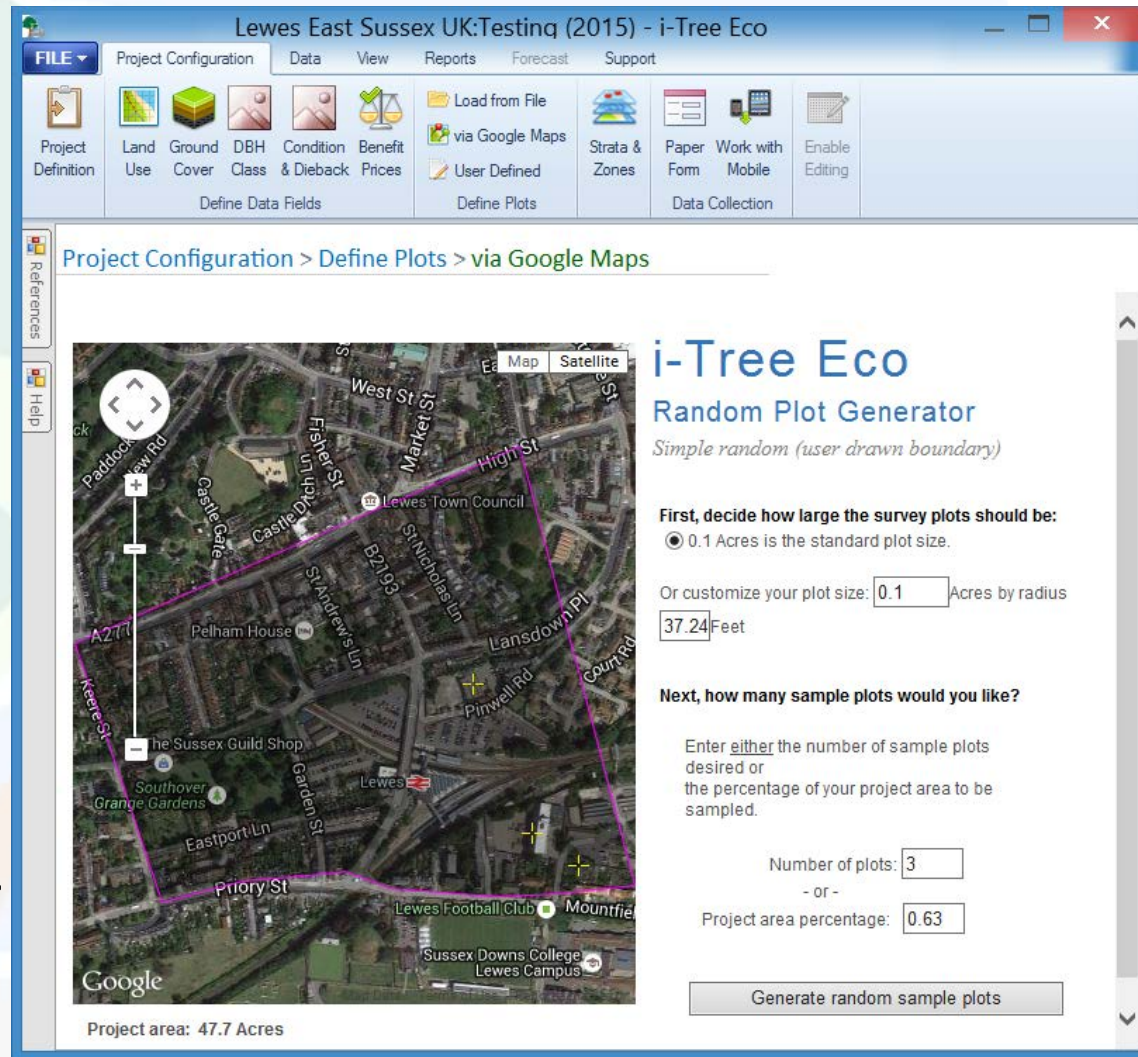
Eco 2015 Highlights...

- Simplified & new data collection options
- Forecasting capabilities
- Multiple years of hourly pollution & weather data now available



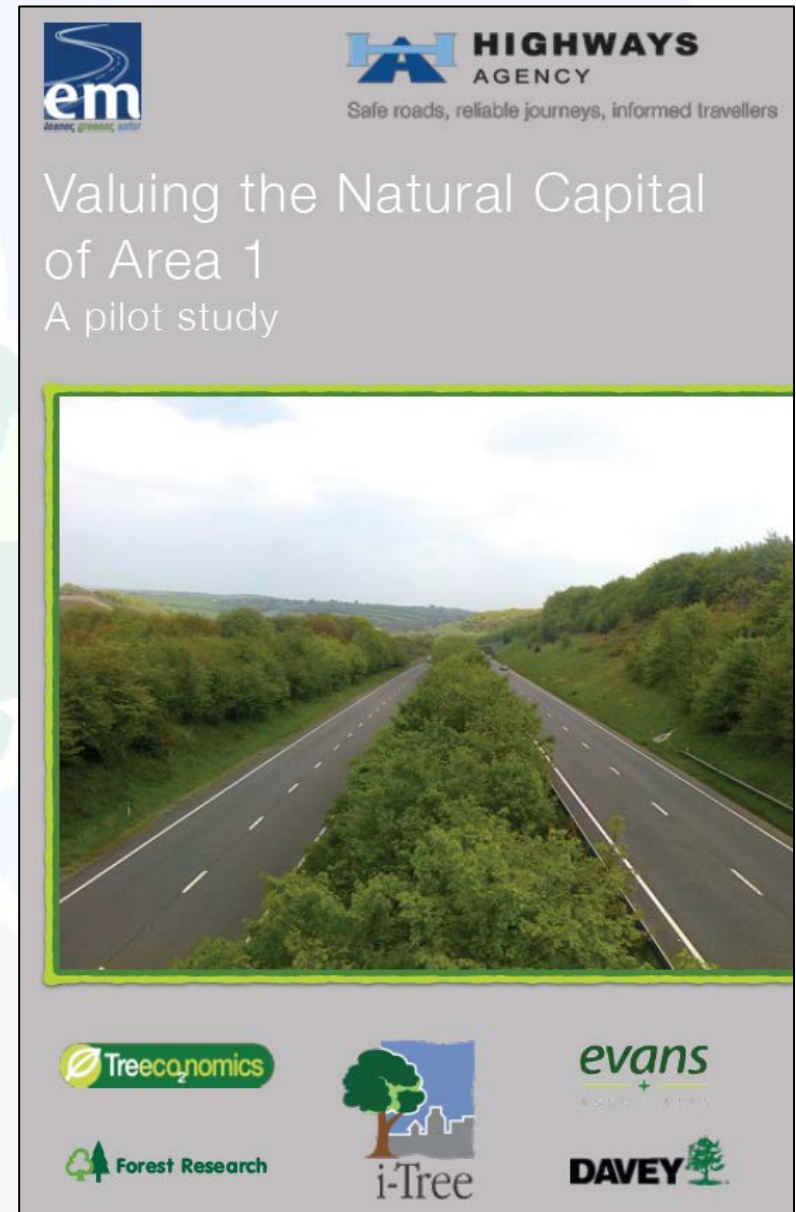
Eco 2015 Highlights...

- New user interface design
- Updated and expanded reporting options
- Desktop processing for USA, AUS, CAN & UK projects

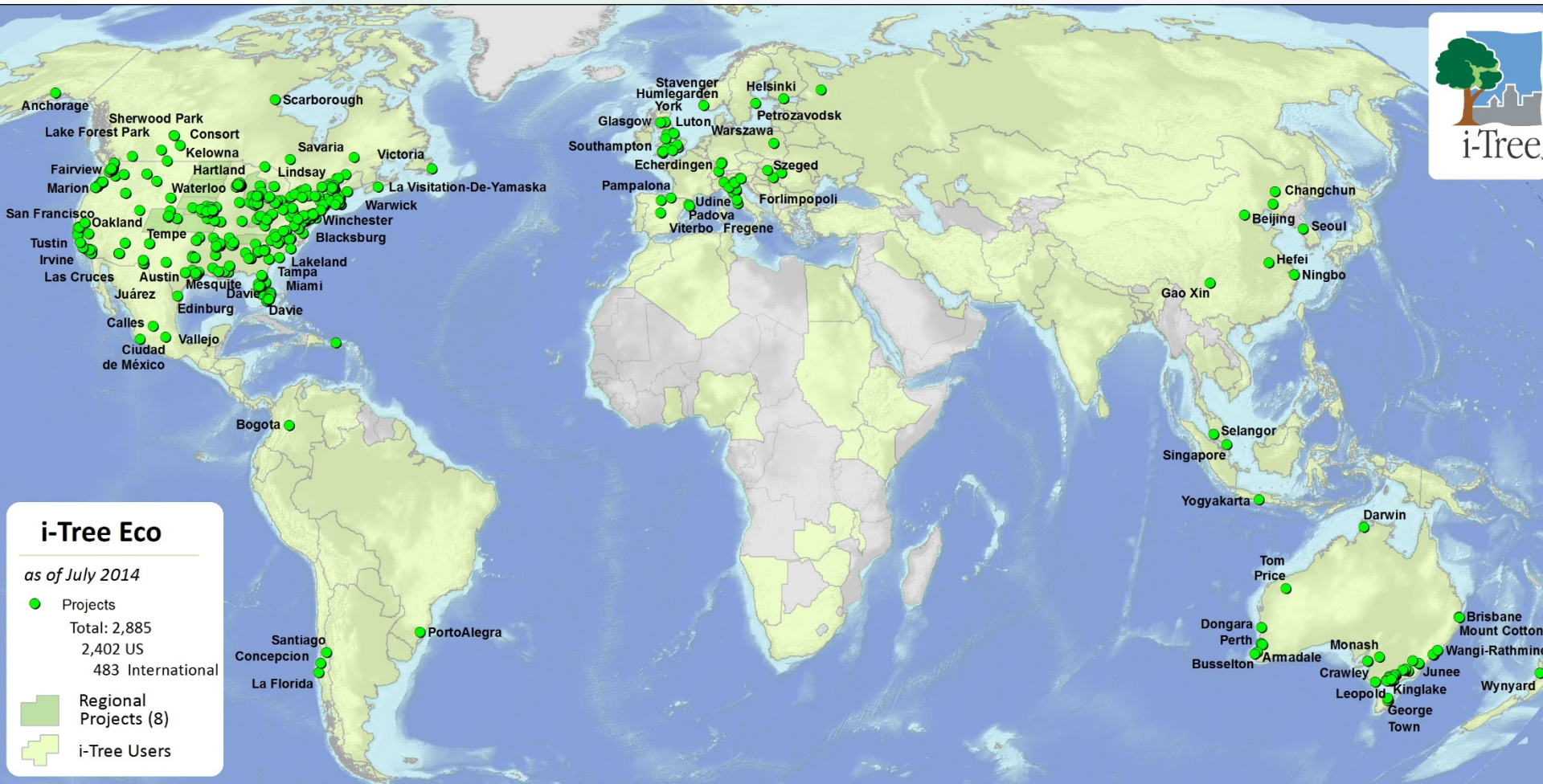


Who is using Eco?

- Governments – Kansas City, Pittsburg, Plano
- Non-Profits- SacTree, Casey Tree, Morton Arboretum, Forterra
- Universities & campuses
- Graduate student research
- International users
- Consultants
- Increasing interest from ecological restoration & parks



i-Tree Eco projects in the U.S. & abroad

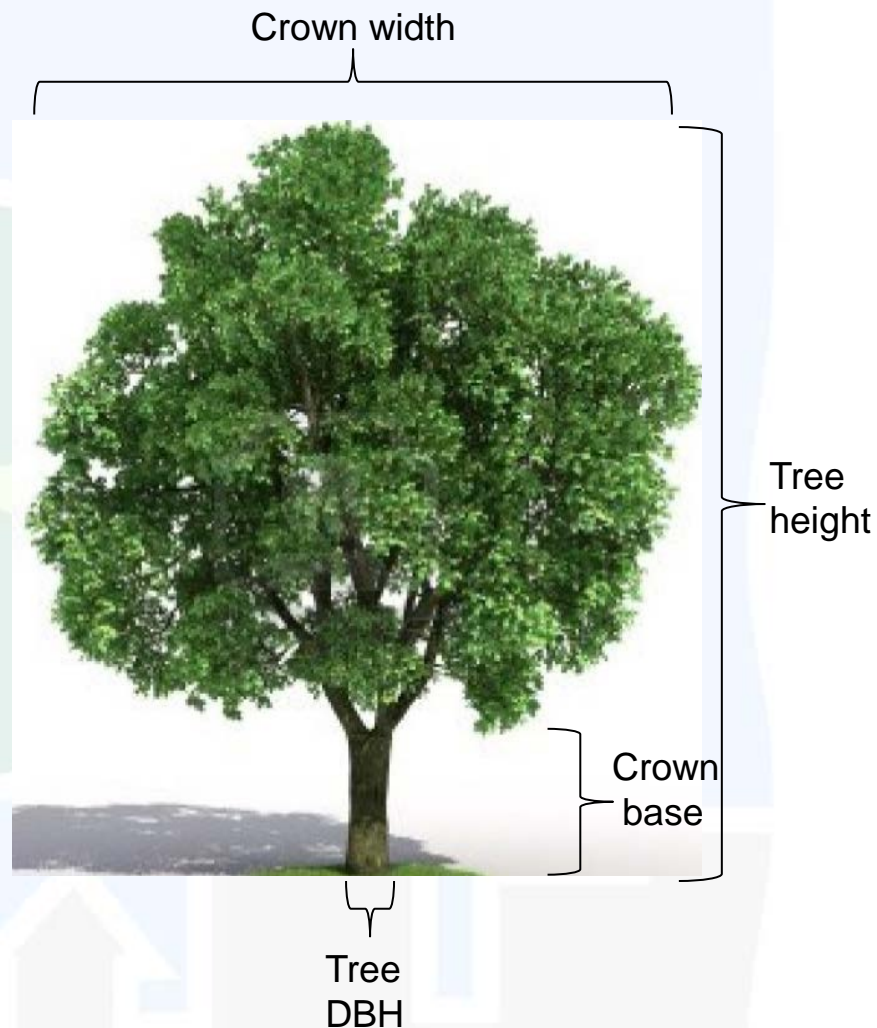


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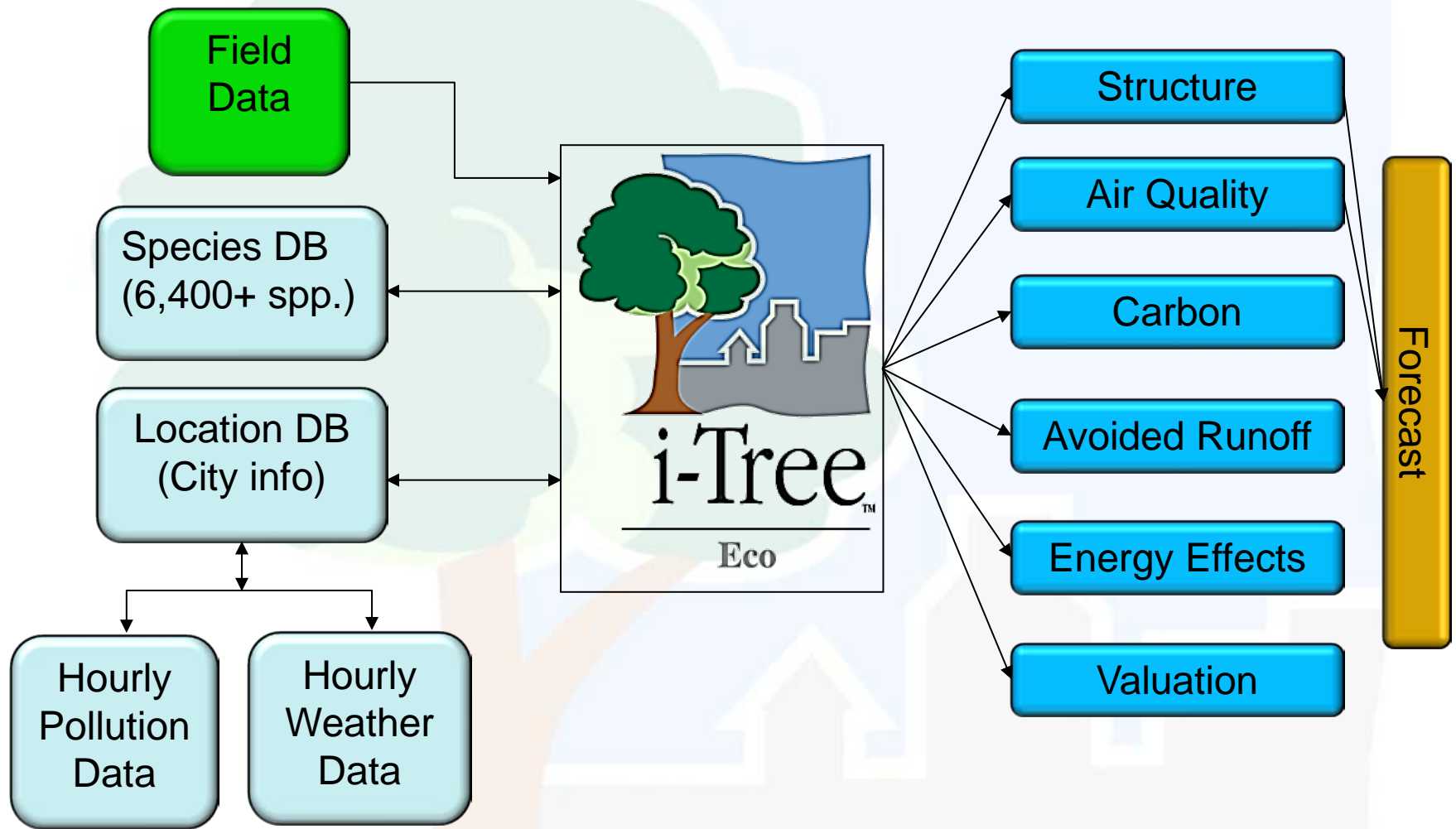
The Basic Science

- Measured variables to estimate foliage volume and wood volume
- Estimate tree leaf area using species specific equations
- Estimate benefits largely based on leaf area interactions with local weather and air pollution
- Summarize structure, function, value



www.itreetools.org/resources/archives.php

i-Tree Eco Model Schematic



www.itreetools.org/resources/archives.php



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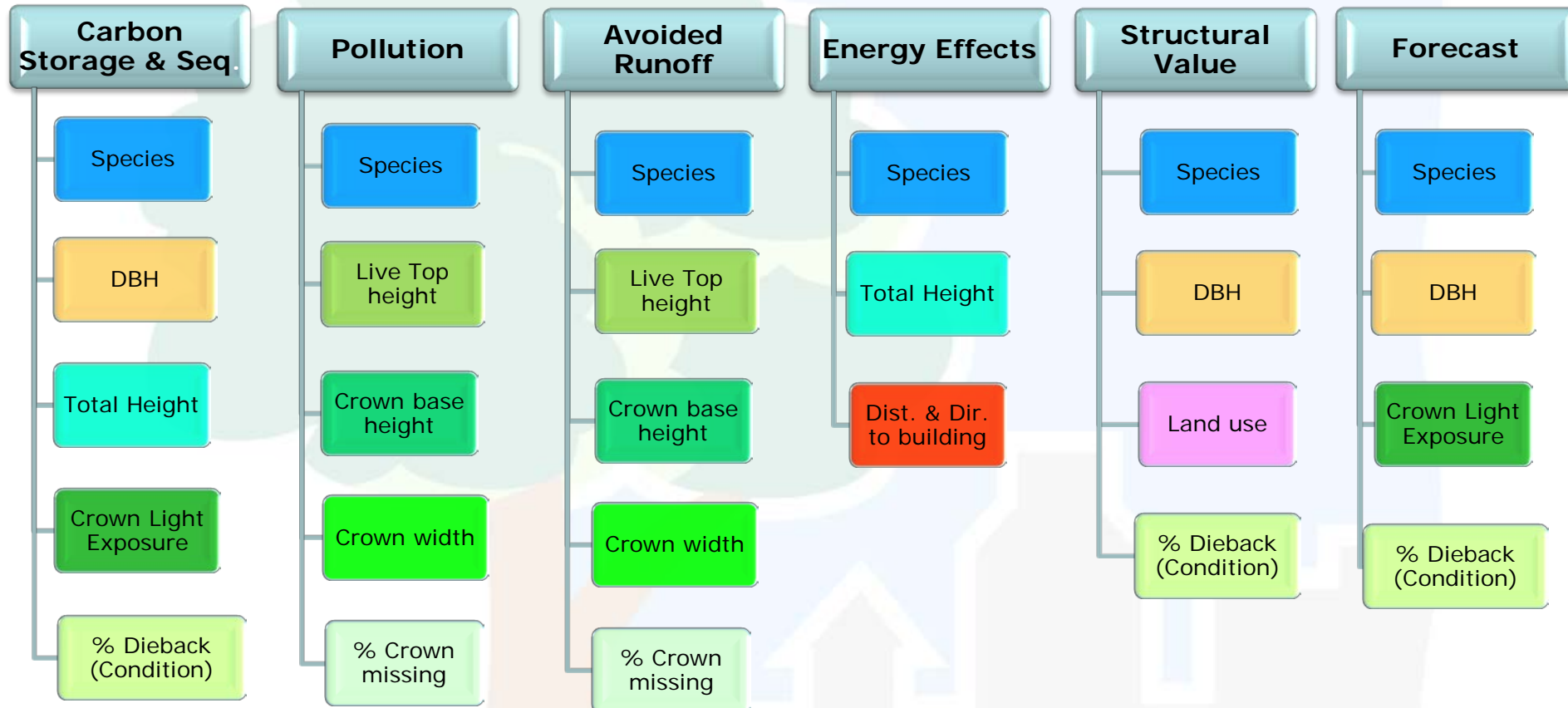


Eco “Classic” Tree Data Variables

1. Tree species
2. Diameter at breast height DBH
3. Total tree height
4. Height to live top
5. Height to crown base
6. Crown width (N-S & E-W)
7. % Crown missing
8. Condition (% dieback)
9. Crown light exposure
10. Direction to building
11. Distance to building
12. Land use



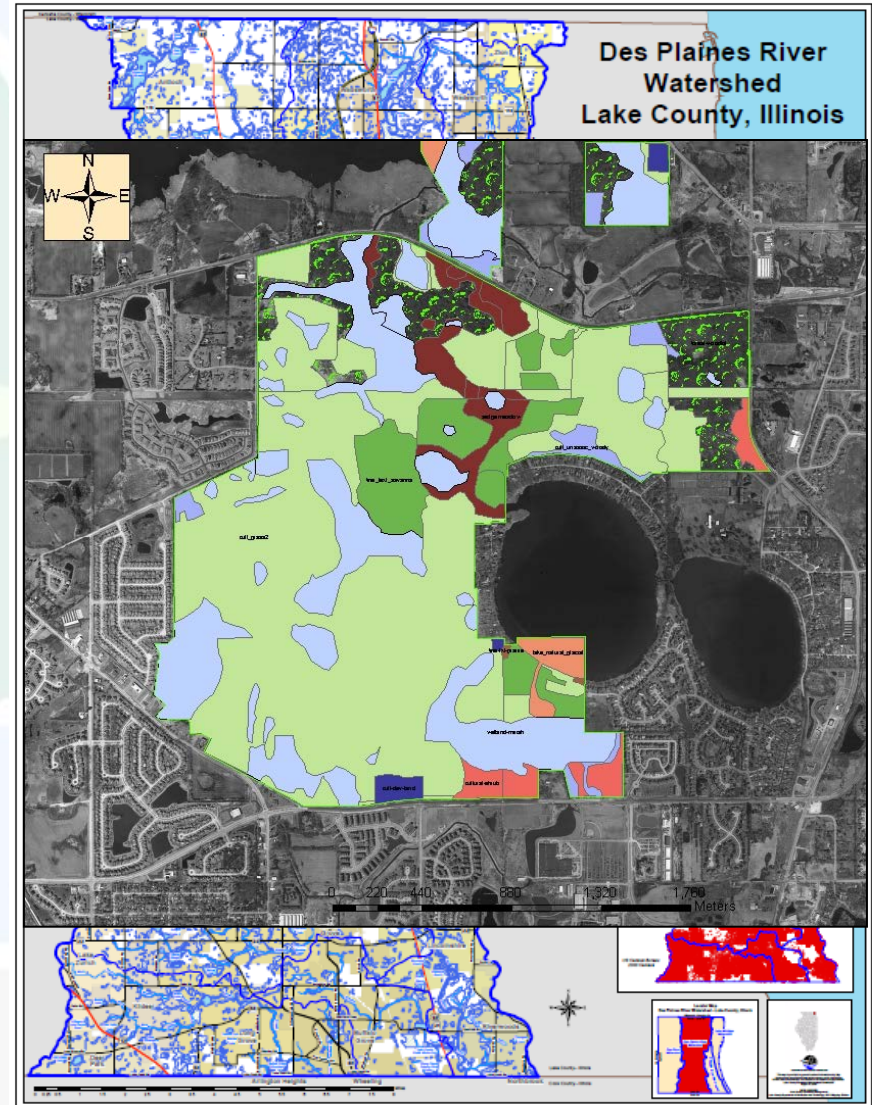
Eco Model Routines and Data Associations



Eco Project Considerations

Project Design & Planning

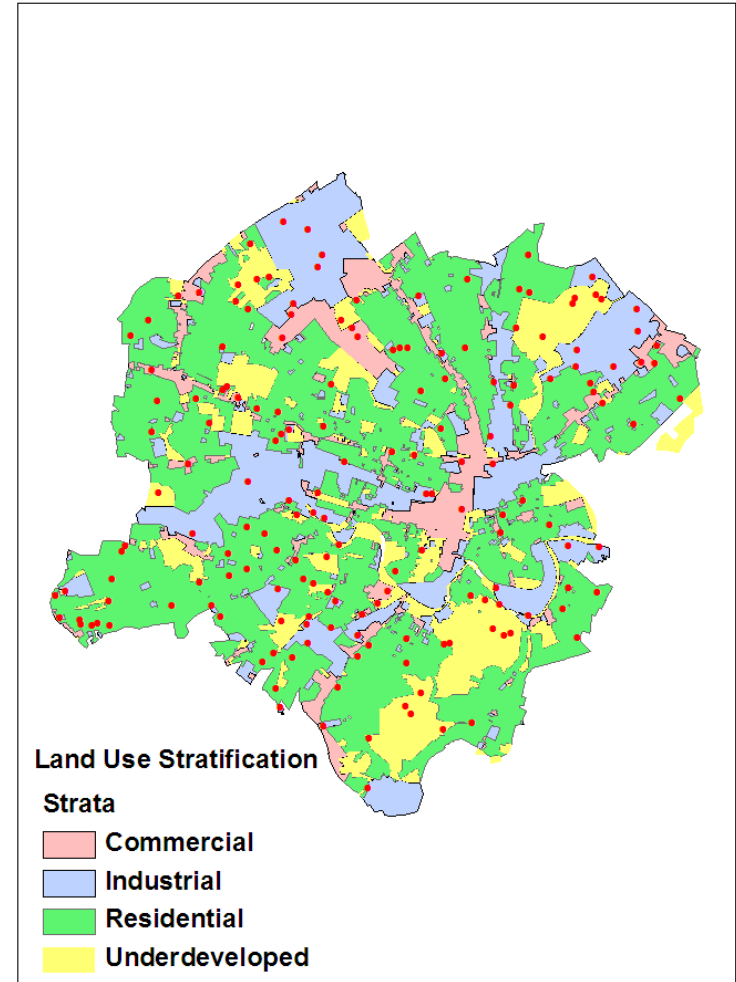
- Consider objectives & resources
- Consider standard & optional metrics
- Consider & define area of interest
 - Scale
 - Vegetation
 - Access



Eco Project Considerations

Select Inventory Method

- Complete inventory (parks, campuses, street trees)
- Random sample plots (recommend 200, 1/10th acre for urban areas)
- Stratification options (sample & inventories)



Eco Data Collection

- Web-enabled mobile device, ~~PDA~~ or paper
- Measure required & optional variables
- Run data in model to obtain results



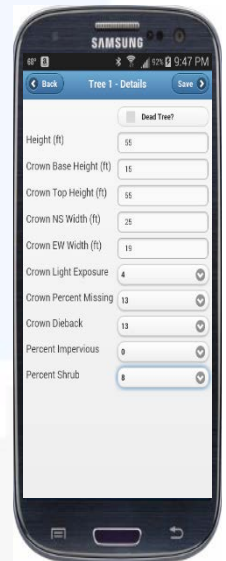
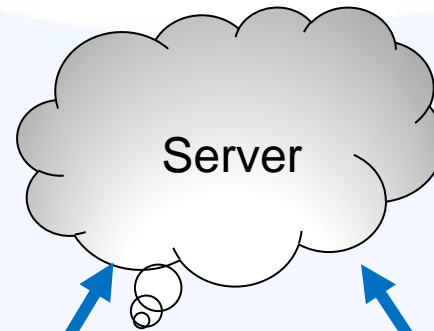
Eco sample plot
data link



Eco inventory
data link

ID	STATUS	ADDRESS	DATE	CREW	CONTACT INFO
1	Large Resident	beachfront dr	8/25/2010	Team 1, Mike	
2	Large Resident	lake washington	8/25/2010	Team 1, Mike	
3	Large Resident	lake washington	8/25/2010	Team 1, Mike	
4	Large Resident	18418 5th of ne	8/20/2010	Team 1, Mike	
5	Large Resident	18418 5th of ne	8/20/2010	Team 1, Mike	
6	Large Resident	18418 5th of ne	8/20/2010	Team 1, Mike	
7	Large Resident	3321 ne 202nd	9/22/2010		
8	Large Resident	east side of arctic ave	8/21/2010		
9	Large Resident	Arctic Cemetery	9/18/2010		
10	Large Resident	newly covered invasive hedges/black berry	9/15/2010		
11	Large Resident	northshore utility district 4th ave ne	9/18/2010		
12	Small Resident	15327 beach drive ne	10/14/2010		
13	Small Resident	19017 large of	10/1/2010		
14	Large Resident	5105 ne 180th st	8/17/2010	Team 1, Mike	
15	Large Resident	2547 ne 180th st	10/6/2010		
16	Large Resident	18424 4th of ne	9/24/2010	Team 1, Mike	
17	Large Resident	19025 4th ave ne	10/4/2010		
18	Large Resident	18211 Ballinger Way NE	9/26/2010		
19	Large Resident	18005 5th ave ne	8/21/2010		

ID	Status	Distance (ft)	Direction	Species	Land Use	DBH 1 (in)
1	Planted	21.00	96	Western redcedar (Thuja plicata)	Vacant	4.2
2	Planted	17.00	104	Western redcedar (Thuja plicata)	Vacant	5.6
3	Planted	26.00	112	Western redcedar (Thuja plicata)	Vacant	7.3
4	Planted	17.75	11	English holly (Ilex aquifolium)	Vacant	7.7
5	Planted	11.00	4	Western redcedar (Thuja plicata)	Vacant	4.2
6	Planted	11.00	393	Western redcedar (Thuja plicata)	Vacant	18.0
7	Planted	3.00	193	Western redcedar (Thuja plicata)	Vacant	20.7
8	Planted	28.00	208	Western redcedar (Thuja plicata)	Vacant	4.5
9	Planted	26.00	210	Western redcedar (Thuja plicata)	Vacant	1.7
10	Planted	17.00	232	English holly (Ilex aquifolium)	Vacant	1.4
11	Planted	22.00	231	Douglas fir (Pseudotsuga menziesii)	Vacant	32.3
12	Planted	8.00	236	Western hemlock (Thuja heterophylla)	Vacant	8.5
13	Planted	18.00	241	English holly (Ilex aquifolium)	Vacant	3.2

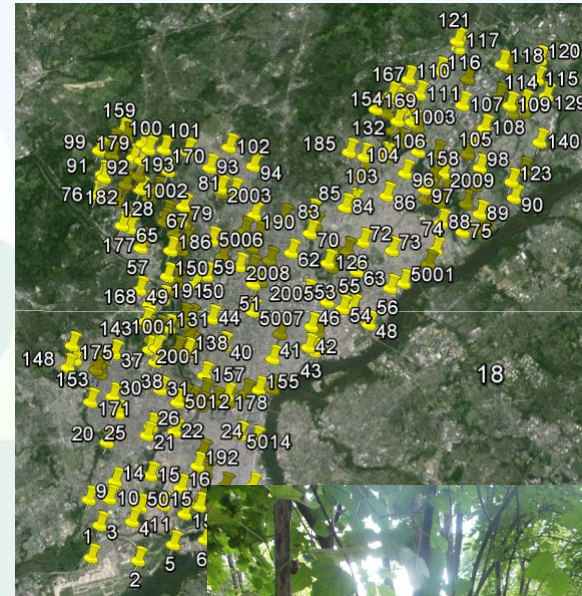


<http://goo.gl/nMzjw0>

<http://goo.gl/ISzU2E>

Project Management Considerations

- Assign a project manager & train data collectors
- May need permission to access private property
- Difficult in more natural areas (> 1 day per plot)
- Travel between plots and locating plots can be time consuming



i-Tree Eco Interface



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i-Tree Eco 2015: Reports

What's new?

- All results available for complete inventories
 - Including “written report”
- New reports including the best outputs from i-Tree streets
 - Size class distribution graphs
 - Cost benefit analysis
 - Maintenance and user defined data categories
- Enhanced individual tree reporting



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Complete Inventory Reporting

Additional reports support inventory projects of all sizes

- Full street tree inventories
- Corporate campuses
- Parks
- Individual properties

Species Composition by DBH Class

Location: Athens-Clarke County (balance), Clarke, Georgia, United States of America
Project: UGA Campus Arboretum, Series: Campus Inventory, Year: 2011
Generated: 8/7/2015

Species	DBH Class (in)													
	0 - 3		3 - 6		6 - 12		12 - 18		18 - 24		24 - 30		30 - 36	
	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE
maple spp							100.0	0.0						
Florida maple	37.0	0.0	48.1	0.0	14.8	0.0								
Trident maple	6.7	0.0	46.7	0.0	37.8	0.0	6.7	0.0			2.2	0.0		
Hedge maple							100.0	0.0						
Freeman maple	43.5	0.0	30.4	0.0	26.1	0.0								
Amur maple	33.3	0.0			66.7	0.0								
Paperbark maple	33.3	0.0	66.7	0.0										
Painted maple					100.0	0.0								
Boxelder					33.3	0.0	66.7	0.0						
Japanese maple	59.6	0.0	30.7	0.0	8.8	0.0	0.9	0.0						
Norway maple					66.7	0.0	33.3	0.0						



Population Summary	By Species	By Strata	By Strata per Unit Area
Species Distribution	By DBH Class (chart display)	By DBH Class and Species (vertical display)	By DBH Class and Species (horizontal display)
Species Range	Native Status by Strata		
Condition	By Species	By Strata and Species	By DBH Class and Species
Leaf Area	By Strata	By Strata per Unit Area	
Leaf Area and Biomass	Of Trees By DBH Class and Species (vertical display)	Of Trees By DBH Class and Species (horizontal display)	Of Shrubs by Strata
			Of Trees and Shrubs by Strata
Ground Cover Composition	By Strata		

Forest structure reports from older

Species distribution (chart)

Importance value

Species condition

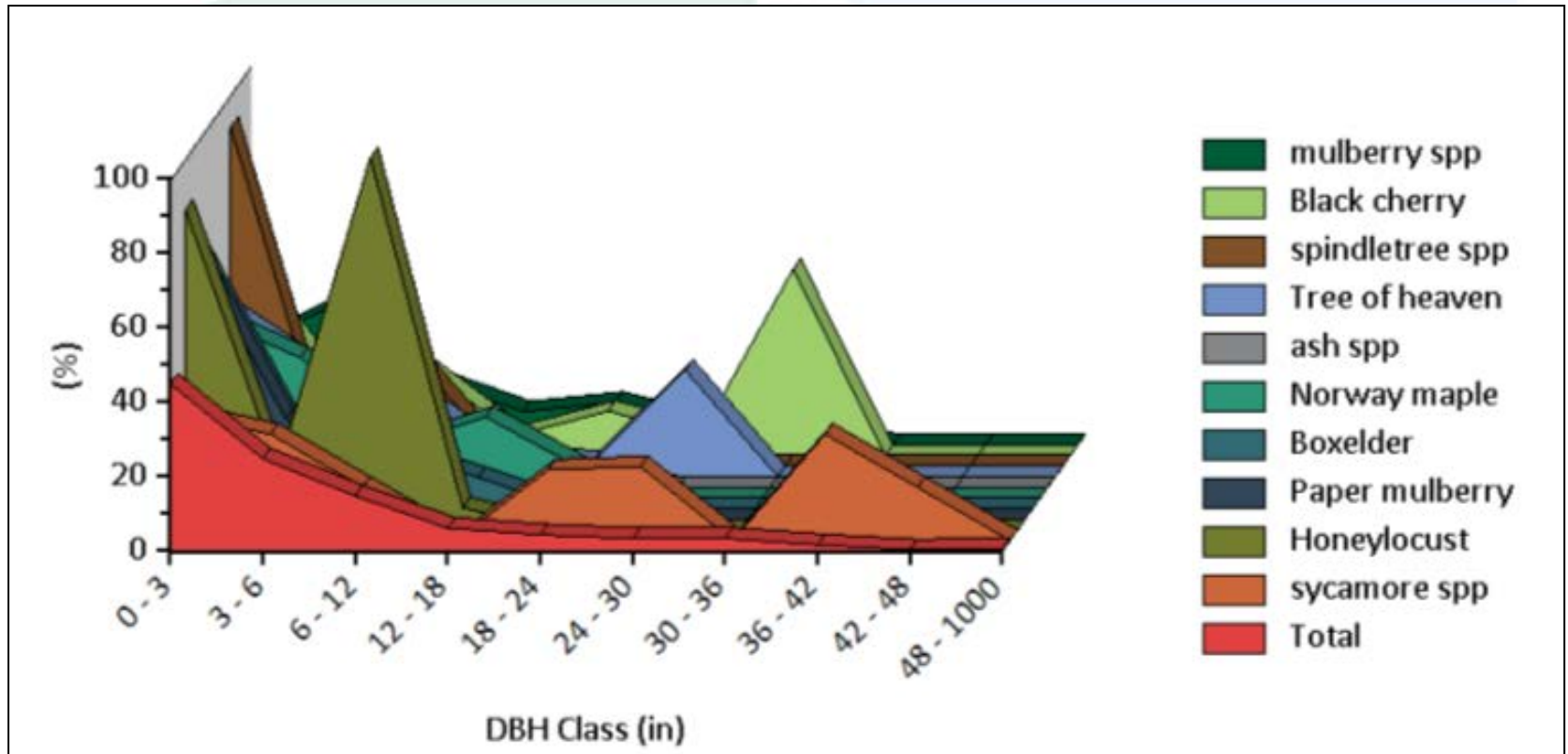
reports from



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New reports



Individual tree reporting

Structure and benefits of any tree you measured

- Report benefits of a single tree
- With GPS data map benefit locations
- Find tree providing the greatest benefits

Avoided Runoff by Individual Tree

Location: Hartland, Waukesha, Wisconsin, United States of America

Project: Hartland, Series: Inventory data, Year: 2012

Generated: 8/27/2015

Tree ID	Species Name	DBH (in)	Height (ft)	Tree Condition	Leaf Area (ft ²)	Avoided Runoff (ft ³)
1	American elm	39.0	82.0	Good	13,592.8	73.7
2	American elm	30.5	74.0	Good	14,037.1	76.1
3	American elm	27.0	70.0	Excellent	11,613.1	63.0
4	Ginkgo	9.0	38.0	Excellent	2,751.3	14.9
5	Ginkgo	9.0	44.0	Excellent	3,834.8	20.8
6	American elm	25.0	77.0	Good	13,840.1	75.1
7	Autumn purple ash	8.0	29.0	Excellent	2,309.2	12.5
8	Swamp white oak	10.0	29.0	Excellent	2,333.4	12.7
9	River birch	10.4	42.0	Excellent	4,661.6	25.3



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i-Tree Forecast - What is it?

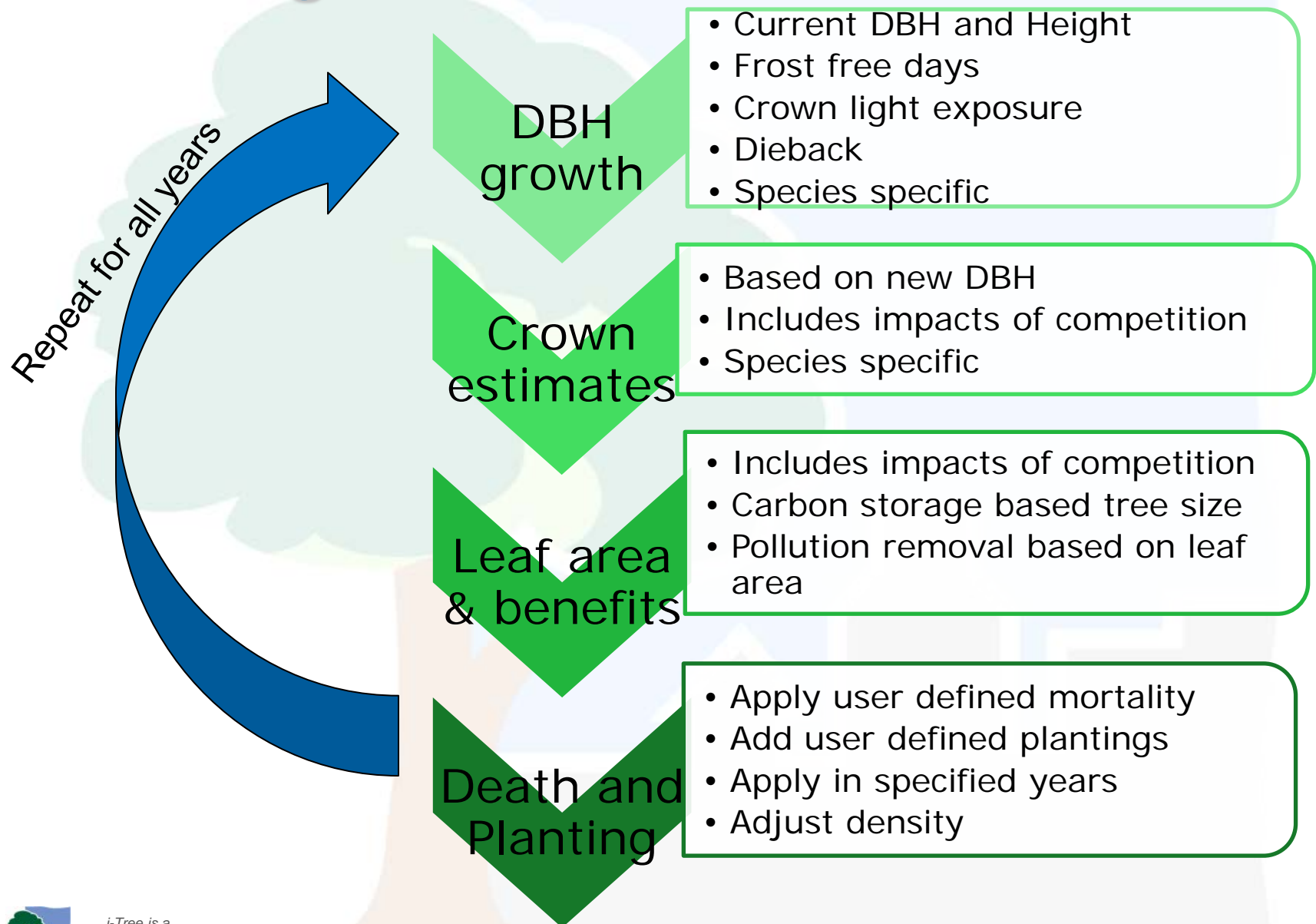
- A new module within i-Tree Eco 2015
- Project tree growth over time
- Include population modeling
- User guided planting and mortality
- Projects changes in selected tree benefits



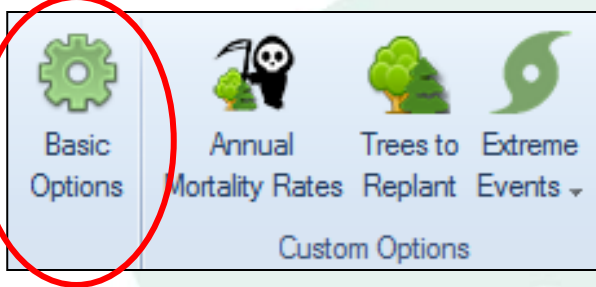
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Forecasting: How it works



Forecasting: Basic Options



- Set-up forecast duration, 1-100 years
- Estimate days of the year without frost (localized defaults provided)
- Set up base/background mortality rates for different tree conditions
- These options impact all trees

Forecast > Basic Options

Duration of the forecast

Years:

Days of the year without frost

Days:

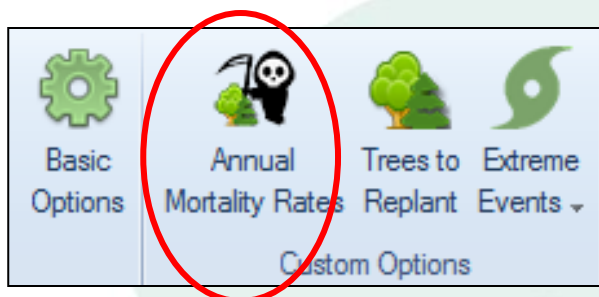
Base annual mortality rates (%)

Healthy Trees (0-49% Dieback):

Sick Trees (50-74% Dieback):

Dying Trees (75-99% Dieback):

Forecasting: Customize annual mortality



Specify mortality rates for a

- genus
- health category
- user-defined stratum

Forecast > Custom Options > Annual Mortality Rates

Mortality type: Genus (dropdown) ailanthus spp (Ailanthus) (dropdown)

Annual mortality rate (%): 40.0 (spinner)

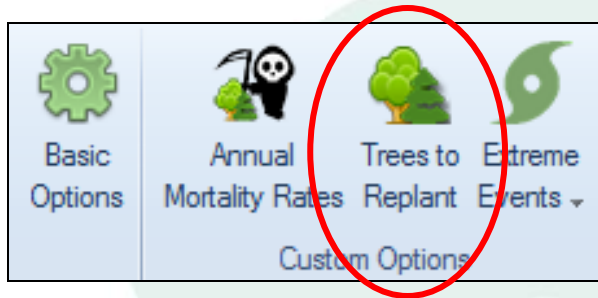
Percent of Starting Population? ☐

Add Clear



Type	Value	Annual Rate (%)	Percent of Starting Population?
Stratum	Transportation	20.0	<input type="checkbox"/>
Stratum	Vacant	20.0	<input type="checkbox"/>
Genus	mulberry spp (Morus)	40.0	<input type="checkbox"/>

Forecasting: Customize tree planting



Plant trees in existing proportions

- Apply to whole study area or a single stratum
- Define start and end dates

Forecast > Custom Options > Trees to Replant

Applies to stratum

Set DBH of new trees to Inches

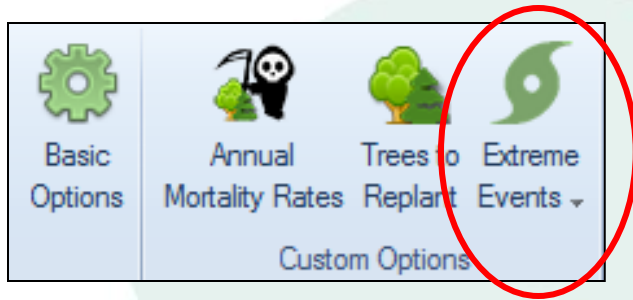
Trees to replant annually

Start replanting in year For how many years?

⏮ ⏪ ⏩ ⏭

	Stratum	DBH (Inches)	Number	Start Year	Duration (years)
▶	Commercial	2.0	100	1	30
	Recreation	1.0	100	1	30

Forecasting: Pest Outbreaks



- Preloaded with 36 common pests
- All host species impacted
- Flexible start and end
- Flexible mortality rates

Forecast > Custom Options > Extreme Events > Pest Outbreaks

Pest Species:

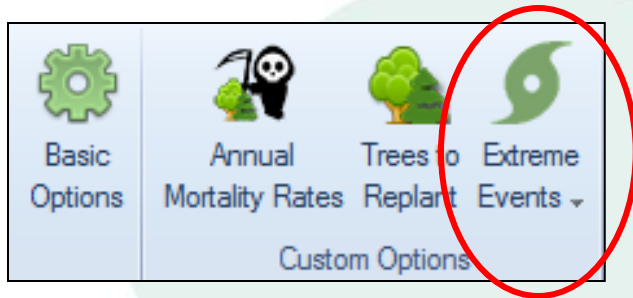
Outbreak occurs in year: Lasts how many years?:

Resulting annual mortality (%):

Plant host trees during event? ☐

Pest Species	Start Year	Duration (years)	Annual Mortality Rate (%)
Emerald Ash Borer (Agnilus pl...	2	10	10.0

Forecasting: Extreme weather



- Default storm categories provided
- All trees impacted
- Mortality and year of occurrence are flexible
- Repeat storms possible, e.g. 5 year storm events

Forecast > Custom Options > Extreme Events > Weather Events

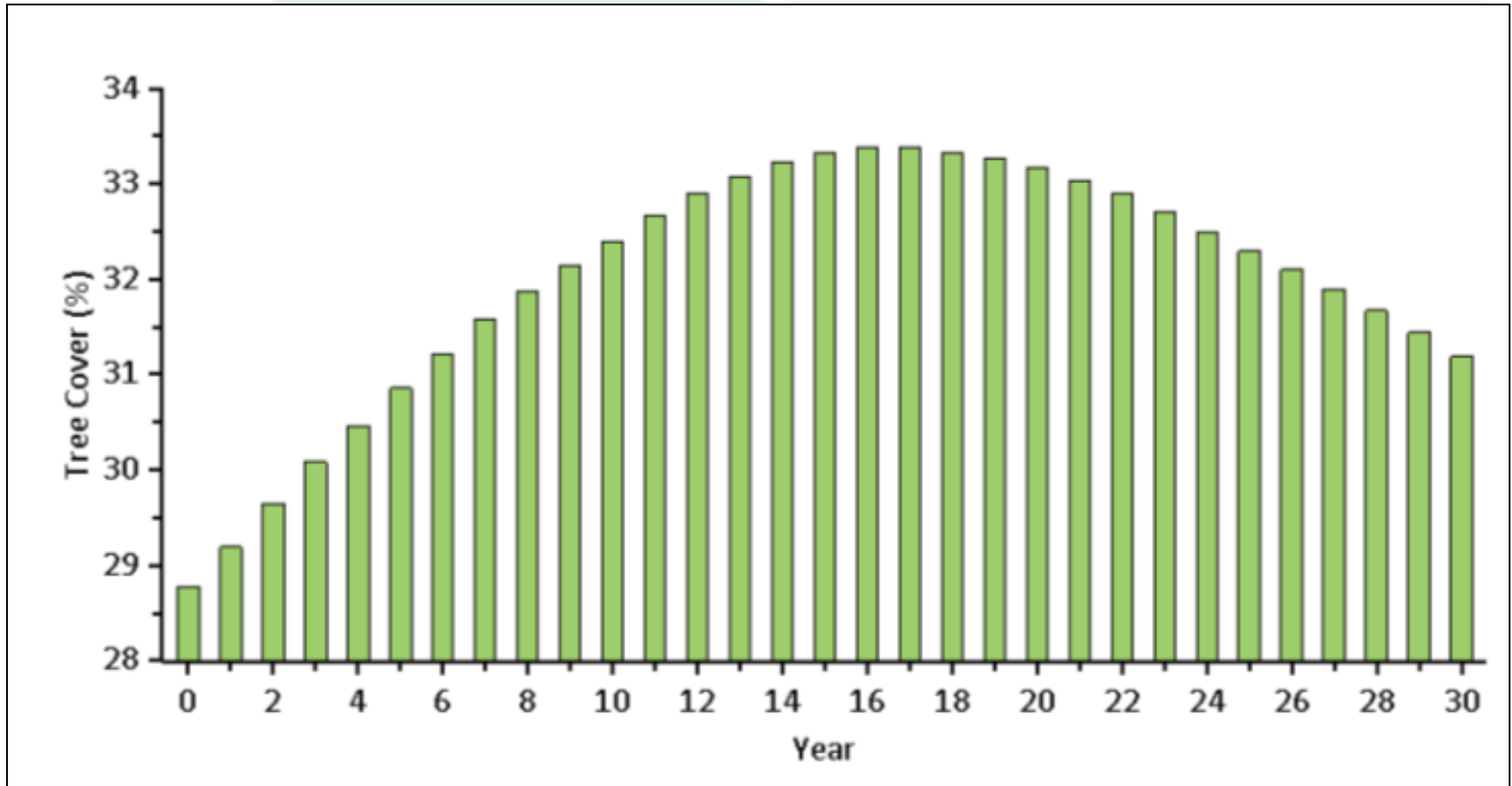
Weather type

Weather occurs in year

Resulting annual mortality (%)

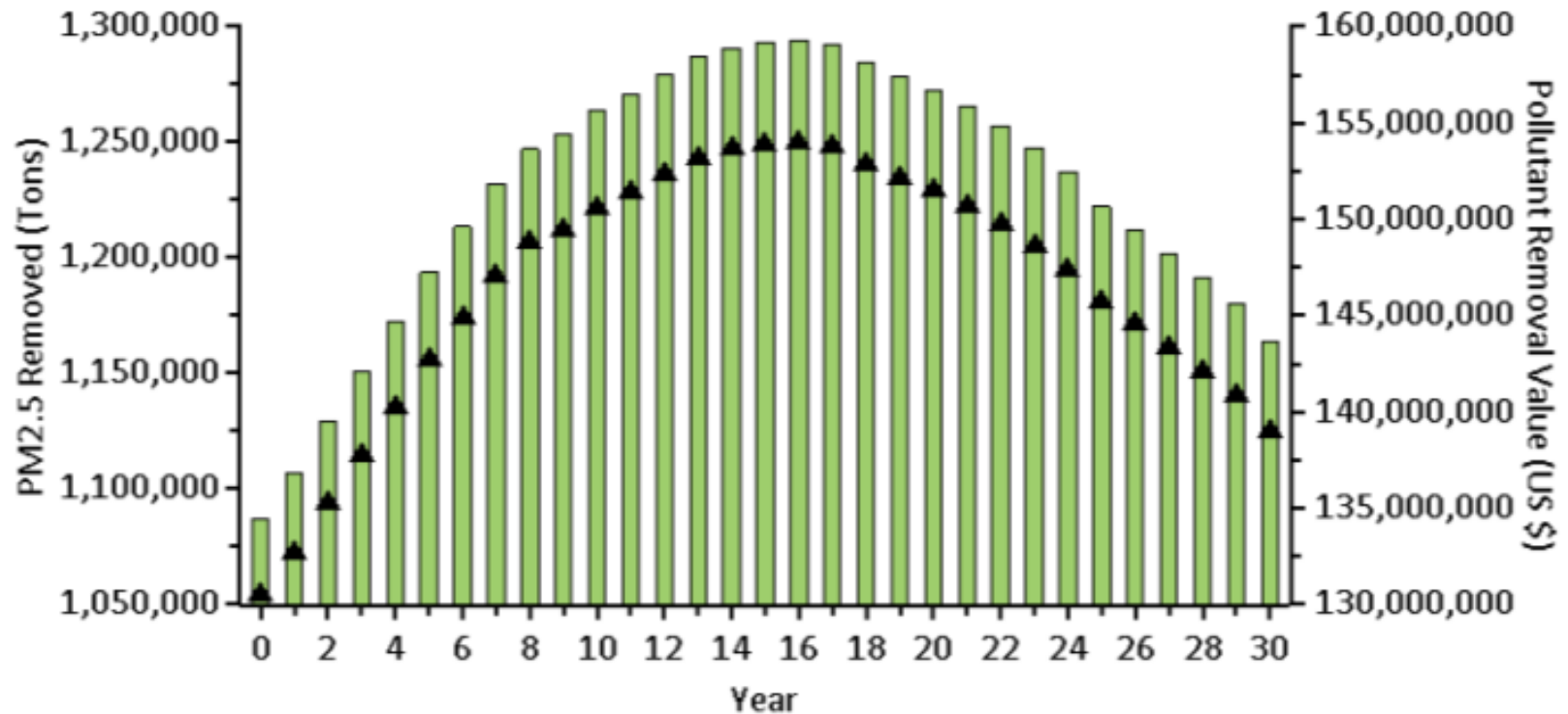
Weather Type	Start Year	Duration (years)
Tropical Storm	1	1
▶ Class 2 Hurricane	5	1

Forecasting Results: Change in structure



Forecasting Results: Change in benefits

Removal of Fine Particulate Matter (PM2.5) over Time



Walkthrough Example

Chester, Pennsylvania

- We know EAB is coming
- We know background mortality rate is a little higher than average
- We know the Pennsylvania Horticultural Society gives away 2,000 yard trees per year and plants another 500 on public property



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Potential Applications

- Model different scenarios
 - Species mixes
 - Climate change impacts
 - Size/type of planting stock
- Planting
 - How many trees will you need to plant to maintain current stocking, offset known losses, achieve canopy goals
- Maintenance
 - What benefits will be lost if lack of maintenance leads to higher mortality
- Lots of flexibility



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Discussion and Questions

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