TREES AND STORMWATER
A PERFECT PAIR

Carrie Tauscher
State Community and Urban Forestry Coordinator
Indiana DNR
ctauscher@dnr.IN.gov

Jeroen Everaert of Rotterdam, Netherlands, came up with the idea of planting trees on the water.

This Afternoon

- Define Urban Forestry
- Discuss Management Overlap
- Review Tree Morphology/ Physiology
- Data/Resources
- Modeling tools you should get to know

Taking the long View

- Think in the context of **the life of a forest**
- A healthy forest **system** has the potential to continue infinitely. (human scale/context)
  - Disturbance can and will impact the system
  - "Permanent" VS "Temporary"
  - Forest Resilience

Painting by S.P. Goodman


One Acre opening Cut
1983


2013
05/24/2013 08:28

Soooo, not like that here:

What is the Urban Forest?

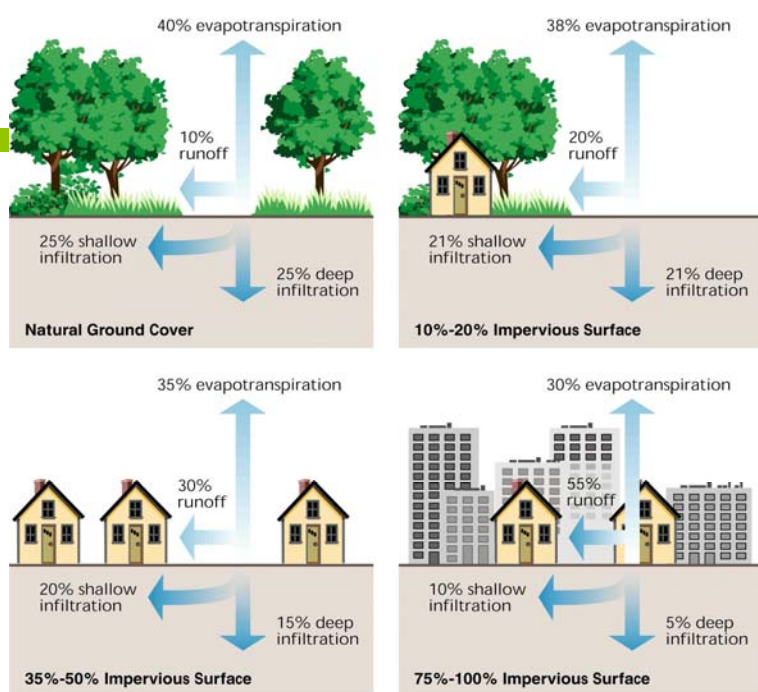
Objective; the cultivation and management of trees for their present and potential contributions to the physiological, sociological, and economic well-being of urban society.

Where's the overlap?

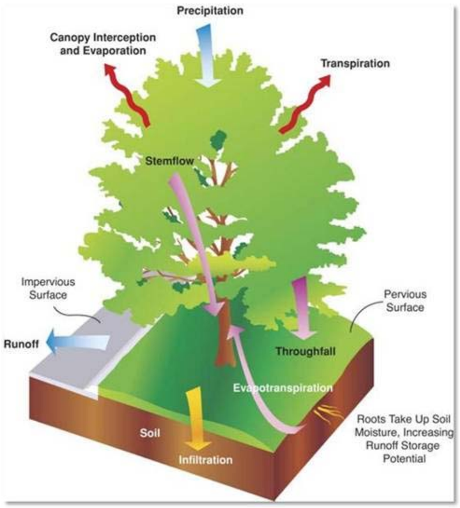
- Urban foresters manage public trees in ROW and Parks.
- So Who really manages the urban forest?
  - 70-80% private landowners
- Where do we build most parks?
  - Where land is donated
  - Where it is not suitable to develop
  - IN THE FLOOD PLAIN

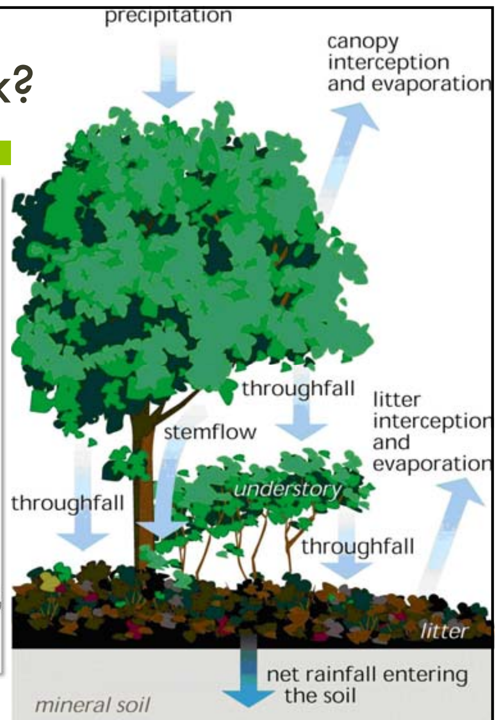
Community Trees

- **Green** Infrastructure
  - Designed Systems
    - Plantings designed with a specific intent to slow, hold, treat, or mange stormwater.
  - "Natural" Systems
    - Sites that inherently help manage and mitigate the effects of high volume precipitation events.



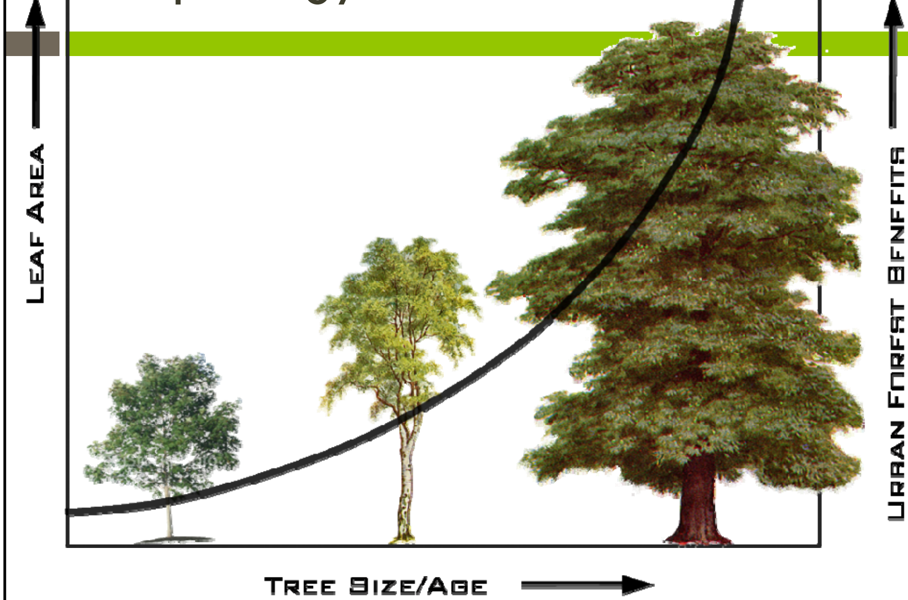
How does it work?





Physiology- One BIG Water Pump

Morphology- Size Matters

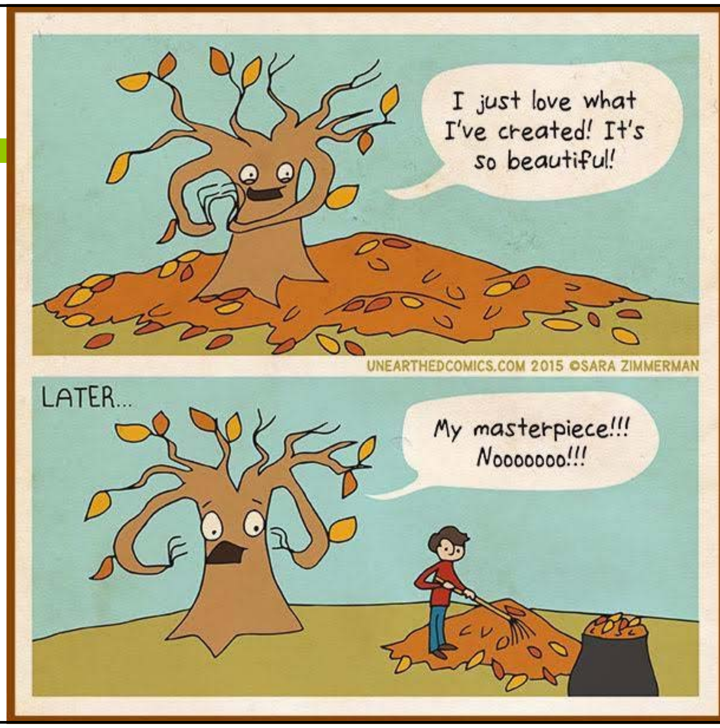


Morphology- Stem Texture

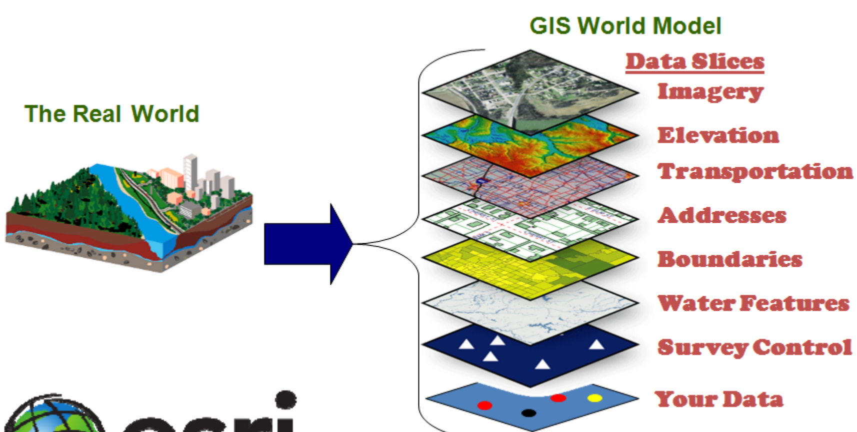
Morphology - Stem Texture

- Not all tree parts are created equal

Morphology - Foliage Timing and Surface Area



Technology



esri

National Tree benefits Calculator

- 14" Pin Oak
- Annual Value $58
- 3,508 gal stormwater
- 641lbs or $CO2$

Inventory & Analysis

Complete a Municipal Tree Inventory

- Know what you have to manage
  - Species, DBH, location, condition, conflicts, risk assessment, plantable spaces.
- Calculate benefits based on initial inventory data
  - i-Tree analysis
  - Benchmark and set goals

Example Inventory Data Attica, IN

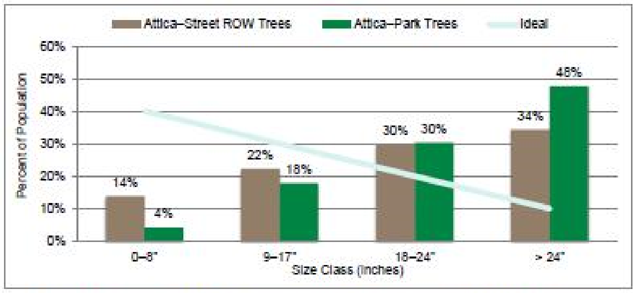


Figure 5. Comparison of diameter size class distribution to the ideal distribution.

Attica Metrics

- Total trees: 1,611 trees
- Total benefits: $245,862
- *Stormwater:* 4,605,279 gallons @ $124,803

Example Inventory Data Attica, IN

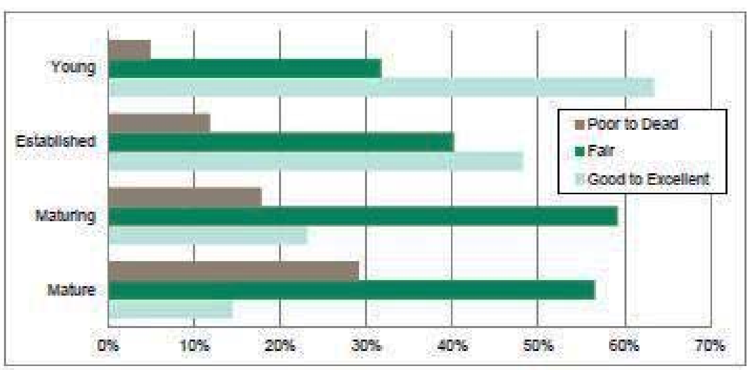


Figure 7. Tree condition by relative age in the 2013 inventory.

Example Inventory Data Attica, IN

	white oak	sugar maple	black walnut	pignut hickory	American sycamore
Attica	20%	14%	14%	11%	7%
10% Rule	10%	10%	10%	10%	10%

Figure 4. Five most abundant species for park trees in the 2013 inventory.

Example Inventory Data Attica, IN

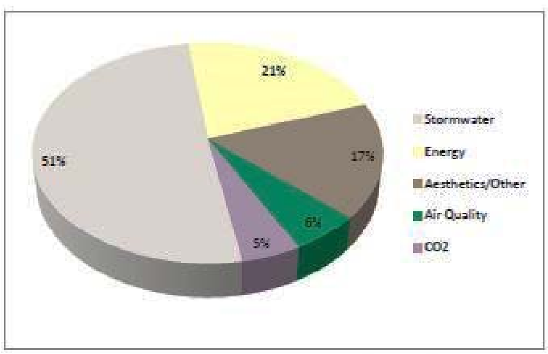
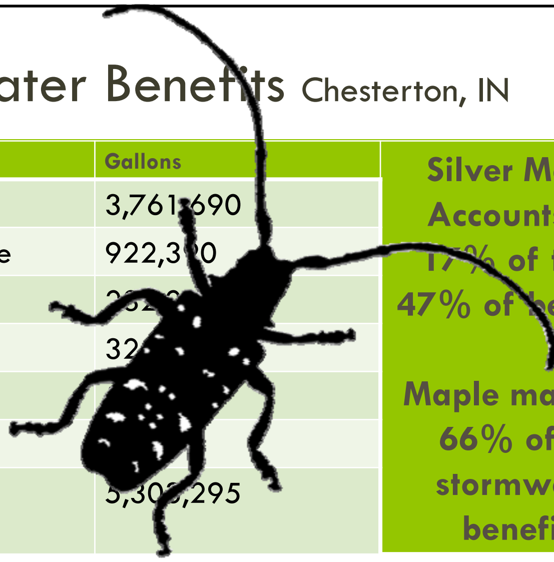


Figure 9. Annual environmental and economic benefits valuated by i-Tree Streets.

52% of overall benefit is Stormwater

Time for a big ?

Stormwater Benefits Chesterton, IN



Species	Gallons
Silver Maple	3,761,690
Norway Maple	922,3[illegible]0
Red Maple	[illegible]
Sugar Maple	32[illegible]
Boxelder	[illegible]
	5,30[illegible],295

Silver Maple Accounts for 17% of trees 47% of benefits

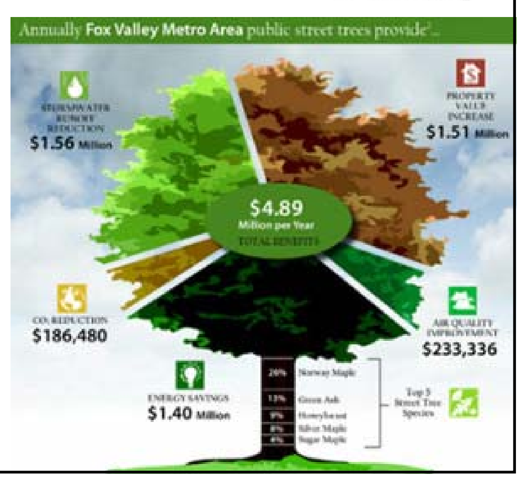
Maple make up 66% of all stormwater benefits

Ash: 151,855gal

Total Stormwater benefit: 8,001,278 gal Value: $216,835

i-Tree

- Streets /Eco
- Hydro
- Landscape
- Design
  - DEMO?
  - Webinars available



i-Tree design

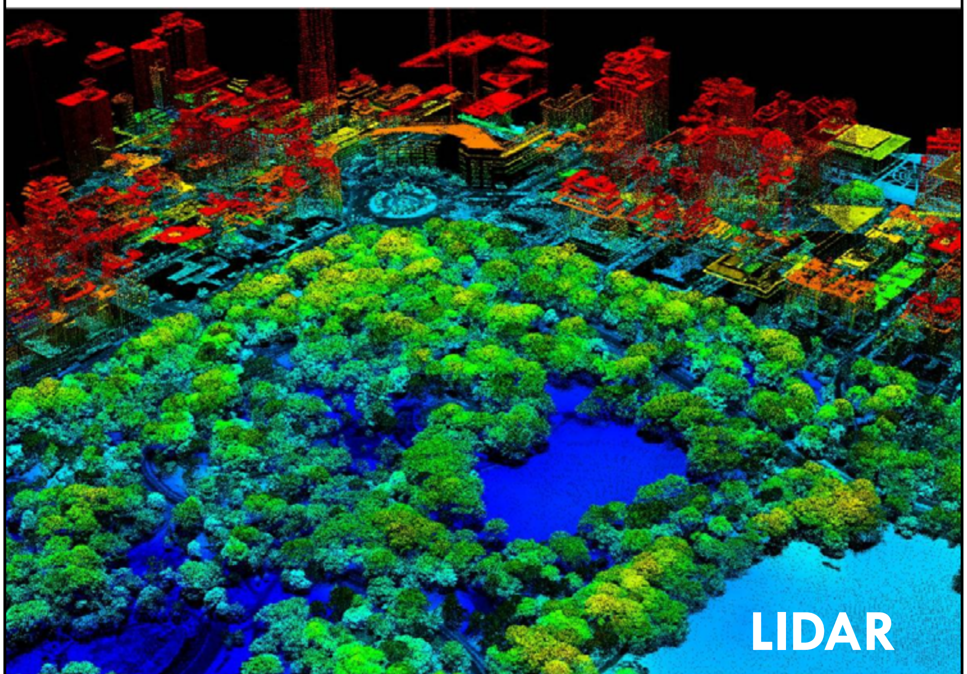
- Calculations and model Demonstration Belterra Site
- https://www.itreetools.org/design.php

	Current Value	+ 50 Value	Current Gal	+ 50 Gal
2016	$2,189	$ 2,381	160,232	186,515
2036	$3,641	$ 4,860	311,756	439,571
2016-36	$59,429	$ 71,163	4,696,209	6,132,414
Difference		**$18,734**		**1.4mil**

Estimated Initial Investment $14,000

UTC- Urban Tree Canopy

- A measure of the tree canopy over and urban area
- Correlates to all small sample urban forest benefit calculations
- Provides larger view of the urban forest



Take THIS Home

Planning

- Diversity
- Species Adaptability
- Canopy Goals
- Future Development/ Re-development
  - Green Infrastructure
- Environmental Justice
- Politics
- Resources

Minimum Soil Volume

Soil volume is a limiting factor

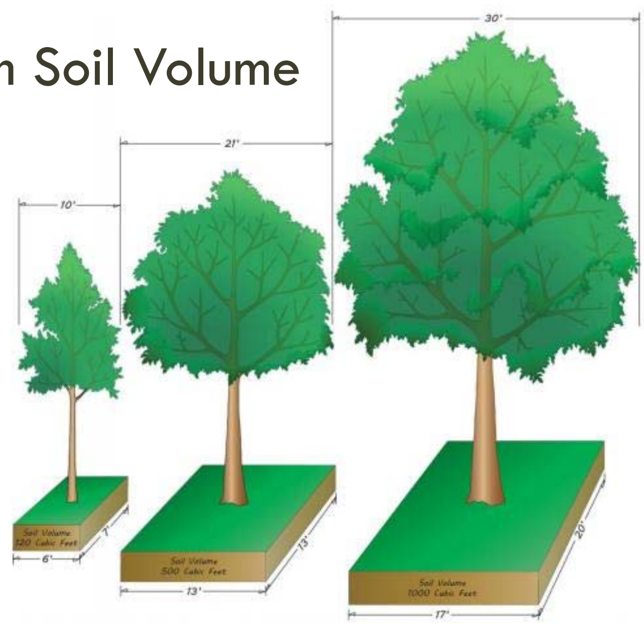
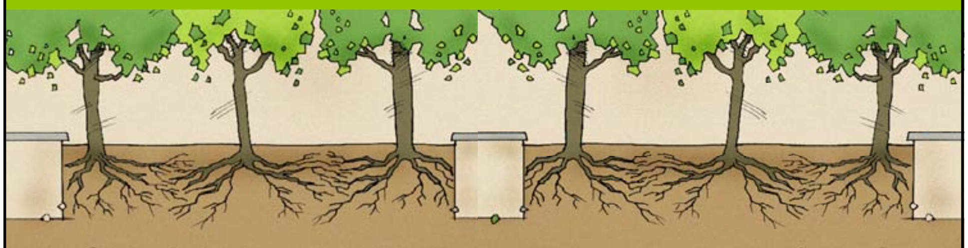


Figure 3. Tree growth is limited by soil volume. To grow big trees, large amounts of uncompacted soil are needed. For a mature tree with a canopy spread of approximately 30 feet, 1,000 cubic feet of soil is needed. Illustration from Casey Trees, 2008.

Soil

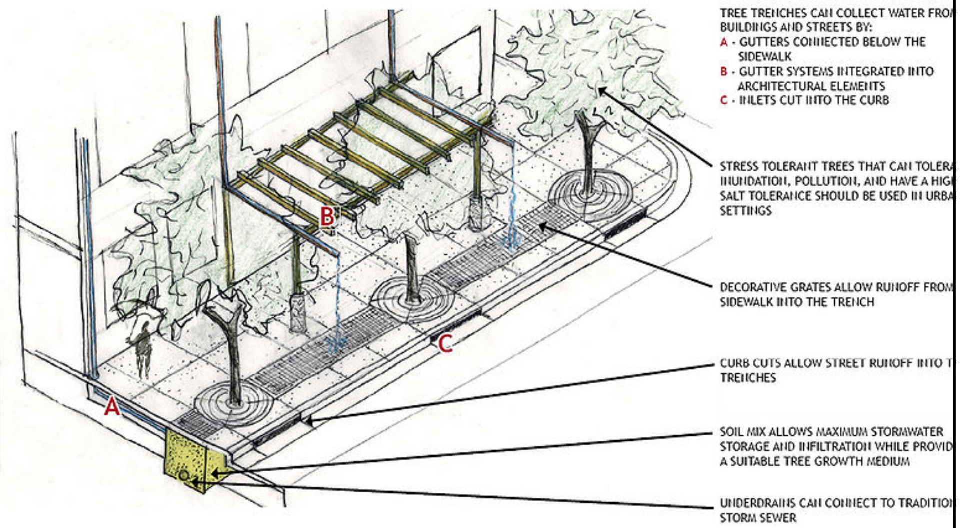
If you can not provide adequate soil volume or quality. You can't expect an adequate tree.



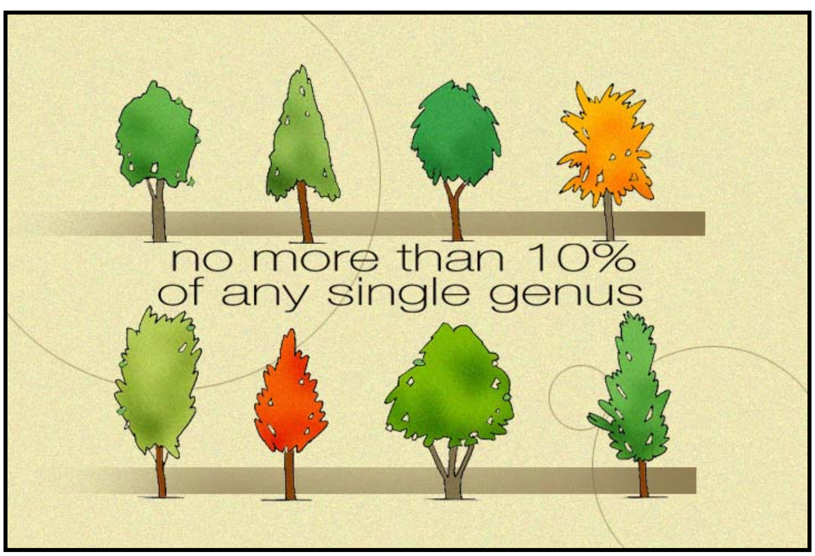
Minimum 1,200 cuft of soil space

Soil

Be Aware in Your Designs



AVOID MONOCULTURES



DETERMINE Plantable Space

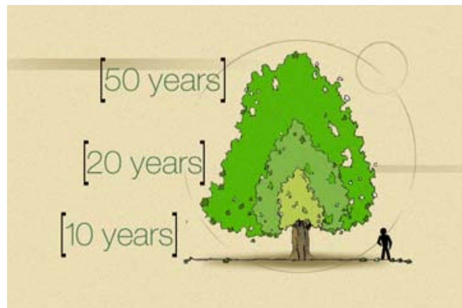
Decide which "size" tree will fit in space

WHEN FULL GROWN.

Small ?

Medium?

Large?



Space

Goal setting

Give metrics and need metrics

- Increase canopy cover by 5%
- Develop contiguous multi level canopy
- Tree plating focused on water quality improvement
- 30% planting budget used in under served areas
- Reduced tree failure

Consensus

- Need **Diverse** plantings
- Need **High** quality tree stock
- Need **Ample** resources for post plating tree establishment
  - Water, pruning, monitoring,
  - **Indiana ROI 1 : 1.77**


CITY
PARK

WATERSHED FORESTRY RESOURCE GUIDE
HTTP://FORESTSFORWATERSHEDS.ORG/REDUCE-STORMWATER/

US EPA STORMWATER TO STREET TREES
HTTP://WWW.DAVEY.COM/MEDIA/183712/STORMWATER_TO_STREET_TREES.PDF

PENN STATE GREEN INFRASTRUCTURE WEBINAR SERIES
HTTP://EXTENSION.PSU.EDU/NATURAL-RESOURCES/FORESTS/COURSES/GREEN-INFRASTRUCTURE-WEBINAR-SERIES

DEEPROOT HTTP://WWW.DEEPROOT.COM/BLOG/

URBAN TREE CANOPY ASSESSMENT (UTC) HTTP://WWW.NRS.FS.FED.US/URBAN/UTC/

FOR MORE INFORMATION ON I-TREE CONTACT SCOTT MACO SMACO@DAVEY.COM

I-TREE HYDRO FACT SHEET: HTTPS://WWW.ITREETOOLS.ORG/RESOURCES/CONTENT/HYDRO_FACTSHEET.PDF

I-TREE LANDSCAPE FACT SHEET: HTTP://WWW.DAVEY.COM/MEDIA/984350/ITL_SELLSHEET_05202015-1.PDF

Resources

Contact Information

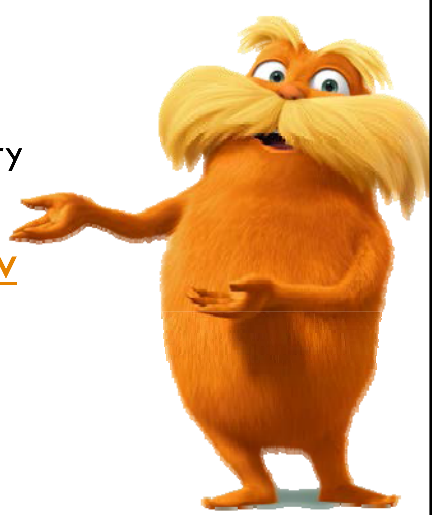
Carrie Tauscher

Indiana DNR Forestry,

Community and Urban Forestry Coordinator

Ctauscher@dnr.IN.gov

317-234-4386



- **Abstract Summary**
- A look at how our management of trees, or lack of, impact stormwater quality and volume in urban areas.
-
-
- **Abstract**
- Those charged with the protection, conservation, and management of water understand the critical role vegetation plays in creating healthy systems able to manage and mitigate the impacts of human practices and development.
- We sometimes overlook the impact our local tree management practices have on water.
- Through years of research we now have tools that can calculate the stormwater benefits community's trees provide.
- Using the case study of tree canopy loss due to the Emerald Ash borer; take a look at the real impact urban forest management has on both water quality and quantity in our communities.

i-Tree Hydro Executive Summary

Project Location: Syracuse, New York
Project Time Span: 01/01/2012 - 12/30/2012

Model Parameters

Watershed Area *square kilometers*	Rainfall *millimeters*	Total Runoff *cubic meters*	Stream Gage	Weather Station
26.24	813.05	6,006,586.24	04240100	725190-14771

Land Cover	*Base*	*Alternative*		*Base*	*Alternative*	LC beneath Tree Cover	*Base*	*Alternative*
Tree Cover %	39.2	42.0	Tree LAI	5.0	5.0	Soil Cover %	95.4	95.4
Shrub Cover %	33.5	33.5	Shrub LAI	2.0	2.0	Impervious Cover %	4.6	4.6
Herbaceous Cover %	15.0	15.0	Herbaceous LAI	2.0	2.0			
Water Cover %	2.0	2.0						
Impervious Cover %	10.3	7.5	Directly Connected Impervious Cover (%)	100.0	100.0			
Soil Cover %	0.0	0.0						

Streamflow Predictions

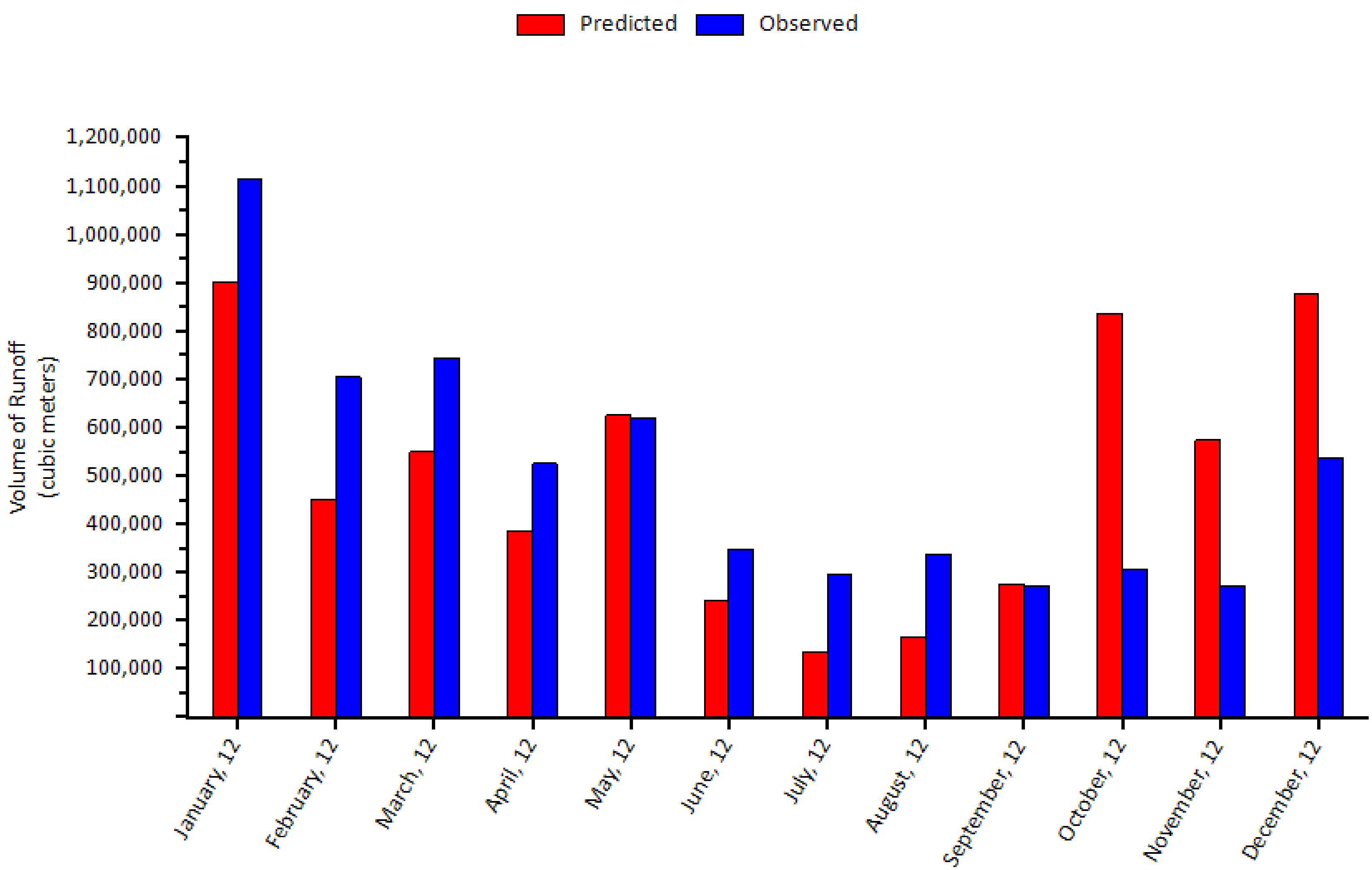
	Total Runoff		Baseflow		Pervious Flow		Impervious Flow	
	Base	*Alternative*	*Base*	*Alternative*	*Base*	*Alternative*	*Base*	*Alternative*
Total Flow (cubic meters)	6,006,586.2	5,783,460.5	4,172,666.0	4,304,124.9	10,053.5	10,459.8	1,823,866.8	1,468,875.9
Highest Flow (cubic meters / hour)	15,080.6	13,412.9	1,205.5	1,243.0	4,018.9	4,181.4	13,365.8	10,775.4
Lowest Flow (cubic meters / hour)	23.7	24.4	23.6	24.3	0.0	0.0	0.0	0.0
Highest Flow Date	01/13/12	01/13/12	01/01/12	01/01/12	01/13/12	01/13/12	08/10/12	08/10/12
Lowest Flow Date	09/18/12	09/18/12	09/18/12	09/18/12	01/01/12	01/01/12	01/01/12	01/01/12
Median Flow (cubic meters / hour)	503.8	511.0	436.1	449.9	0.0	0.0	0.2	0.2
Number of flow events ABOVE median flow	46.0	48.0	11.0	11.0	1.0	1.0	47.0	48.0
Average length of flow events with flow ABOVE median (hours)	83.7	80.1	376.6	376.6	78.0	78.0	94.4	92.4
High Flow: Number of flow events ABOVE 1 standard deviation	37.0	36.0	5.0	5.0	1.0	1.0	41.0	41.0
Average length of flow events ABOVE 1 standard deviation (hours)	103.8	106.7	887.5	887.5	78.0	78.0	100.0	99.0
Number of flow events BELOW median flow	45.0	47.0	10.0	10.0	0.0	0.0	47.0	48.0
Average length of events BELOW median (hours)	97.1	92.9	436.8	436.8	0.0	0.0	92.9	91.0

i-Tree Hydro Executive Summary

Project Location: Syracuse, New York
Project Time Span: 01/01/2012 - 12/30/2012

Water Volume: Observed Streamflow vs. Predicted Streamflow

(Predicted is 1% lower than Observed)



i-Tree Hydro Executive Summary

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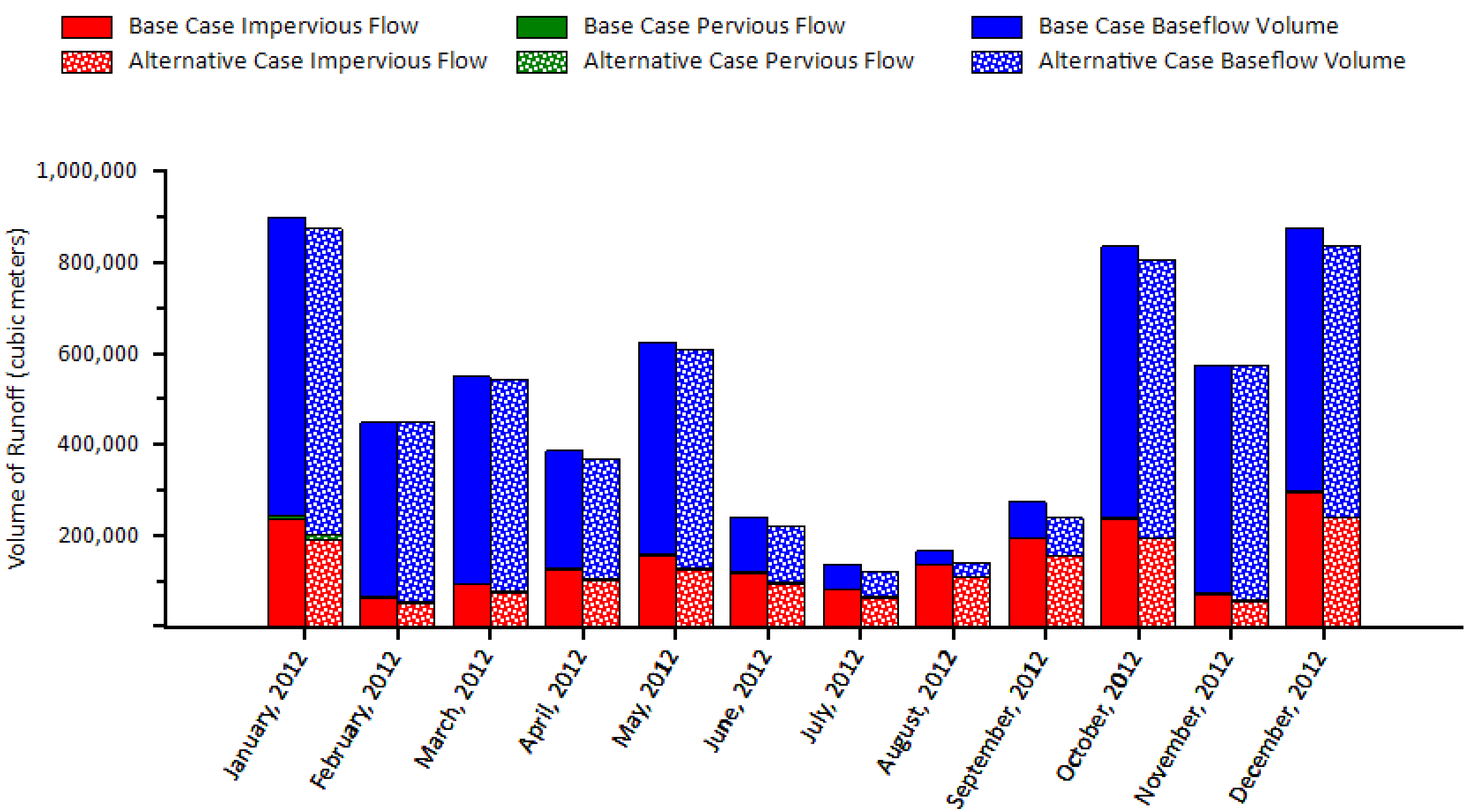
Base Case vs. Alternative Case Predicted Streamflow Components

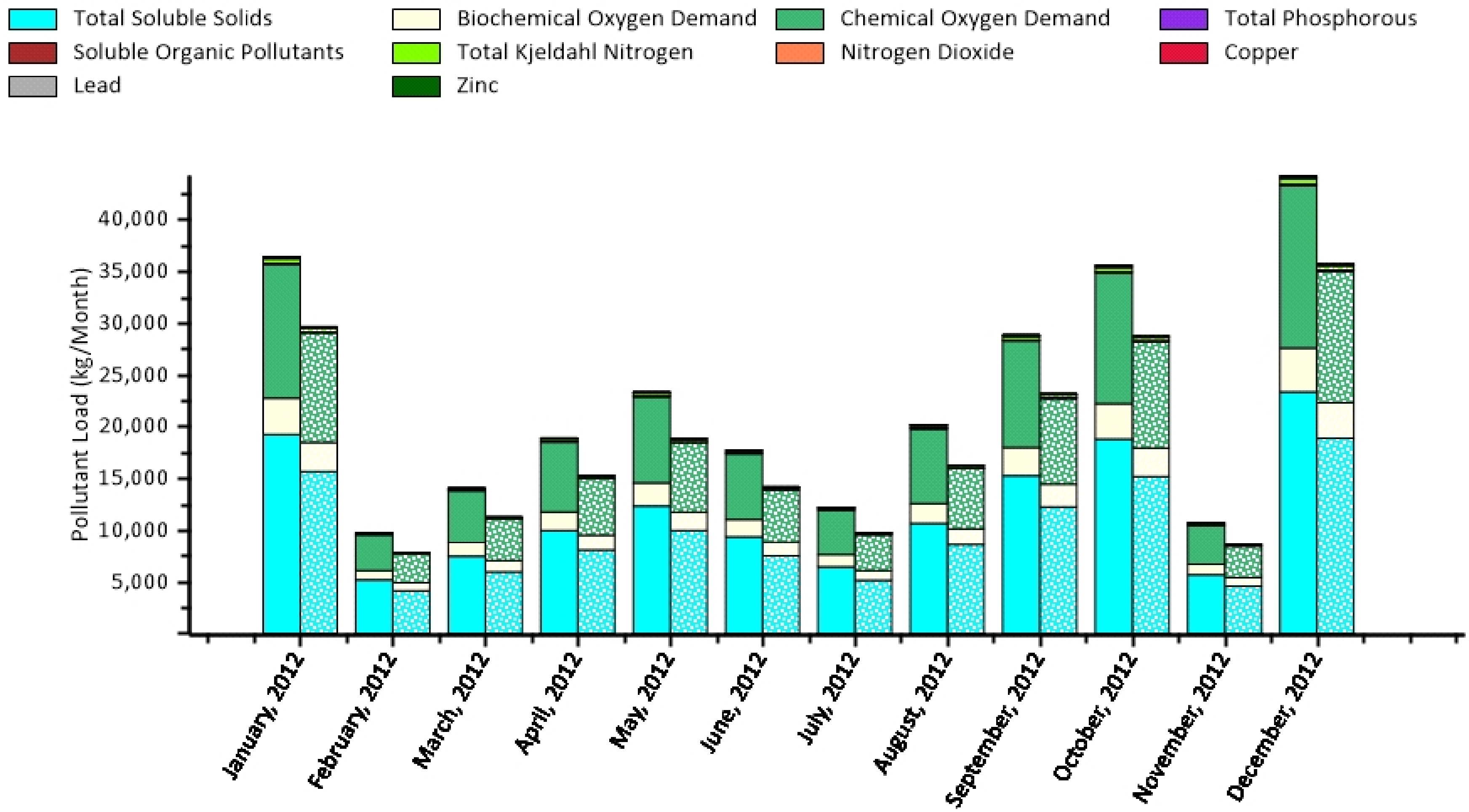


Note: Solid colors represent Base Case values while the hatched pattern indicates Alternative Case values

i-Tree Hydro Executive Summary

Project Location: Syracuse, New York
Project Time Span: 01/01/2012 - 12/30/2012

Pollutants: Base Case vs. Alternative Case Event Mean Concentration



Note: Solid colors represent Base Case values while the hatched pattern indicates Alternative Case values

Glossary of Key Terms

Base Case – The original modeled scenario defined by the initial land cover values (e.g. tree cover, herbaceous cover, impervious cover, etc.).

Alternative Case – The modeled scenario contrasted with the base case. It is defined by changes in the initial land cover values representing an increase in development (e.g. increase in impervious cover or decrease in vegetative cover) or an increase in vegetative cover (e.g. increase in tree cover or herbaceous cover).

Baseflow – The stream flow from groundwater and no recent storm runoff. Baseflow is generated from the saturated soil zone within i-Tree Hydro.

Impervious Flow – The predicted overland surface runoff generated from impervious cover areas, which may be impervious cover with or without vegetative canopies. The model first checks that impervious cover specific depression storage is filled and evaporation from this storage is accounted for, before generating impervious flow. Impervious flow either passes directly to the outlet through directly connected impervious cover area (DCIA) or runs on to neighboring pervious cover areas where infiltration may occur.

Pervious Flow – The predicted overland surface runoff generated from pervious cover areas, which include bare soil and soil areas under herbaceous cover and vegetative canopies. The model uses first checks that pervious cover specific depression storage is filled and evaporation from this storage is accounted for, then uses saturation excess and infiltration excess routines to calculate the total amount of pervious flow. Pervious cover surface runoff generates run-on to neighboring impervious areas, where DCIA transports a portion of the runoff to the outlet, or onto neighboring pervious cover areas where infiltration may occur.

Total Flow volume (cubic meters) – This is the total amount of streamflow (baseflow plus pervious and impervious surface runoff) for the modeled time period. To arrive at this number, the predicted total streamflow rate for each timestep (typically m/hr) is multiplied by the watershed area represented by each landcover type and the total number of modeled timesteps (typically hr).

Highest Flow rate (cubic meters / hour) – The largest predicted peak streamflow rate during the modeled period.

Lowest Flow rate (cubic meters / hour) – The lowest predicted peak streamflow rate during the modeled period.

Highest Flow Date – The date of the largest predicted peak streamflow rate.

Lowest Flow Date – The date of the lowest predicted peak streamflow rate.

Average Flow rate (cubic meters/hour) – The average predicted streamflow rate during the modeled period.

Number of flow events ABOVE average flow – The number of continuous periods (timesteps) where the predicted streamflow rate is above the average streamflow rate.

Average length of flow events ABOVE average (hours) – The average length in hours of the continuous periods (timesteps) where the predicted streamflow rate is above the average streamflow rate.

i-Tree Hydro in 2016

State-of-the-Art, Peer-Reviewed, Public-Domain

Process-Based Hydrological Model

Assessing How Changes in **Tree and Impervious Cover** Affect **Water Quantity & Quality**

Based on *Cutting-Edge U.S. Forest Service Science*

What Hydro Can Inform Us About

- How management practices & urbanization affect water resources.
- How land cover changes impact **water quality** & **quantity** in **watersheds, municipalities, and user-defined places nation-wide.**
- **Hourly & total results** available in **tabular & graphical form**, including an automatically-generated **Executive Summary report**.

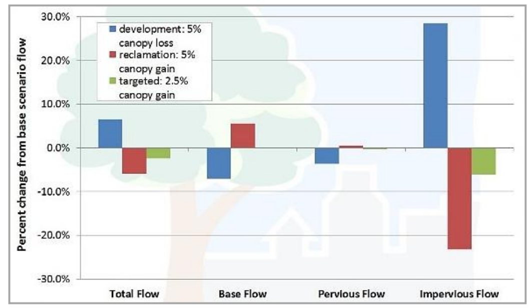


Figure 1: i-Tree Hydro simulation of alternative management scenarios as compared to initial conditions

How It Works

- Data needs: location; topography; weather; optional stream flow for calibration; land cover for initial case & optional alternatives.
- Users input: location, simulation period, and land cover information derived from i-Tree Canopy, NLCD data, and/or local knowledge.
- Topography, weather data, and hydrological parameters becoming increasingly automated & pre-loaded with vast coverage for the U.S.

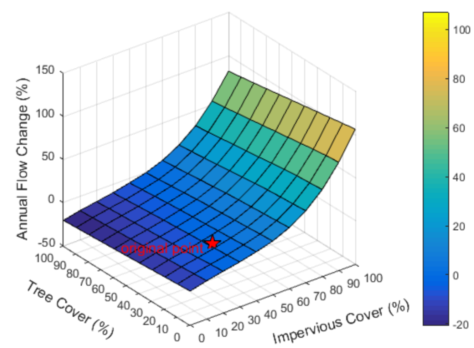


Figure 2: i-Tree Hydro simulated effects of incremental changes to Tree Cover and Impervious Cover in 161km²
Rock Creek watershed near Washington, DC.

What's New This Year

- **Green infrastructure modeling** of tree pits; rain barrels; green roofs; rain gardens; and pervious pavement – each uniquely parameterized.
- **Design Rain tool** for simulating storms using regional NOAA data and Intensity-Duration-Frequency (IDF) curves for the U.S.
- **Curve Number tool** for simple runoff prediction using the empirical NRCS TR-55 method based on small-catchment hydrology studies.
- Increased **functionality** & **accessibility**, e.g. 4 scenarios can be paired with different parameter sets & canopy properties in a single project.

How Can Hydro Help

- **By supporting decision-making** to **reduce stormwater damage** and improve urban forests, environmental quality, and human health.

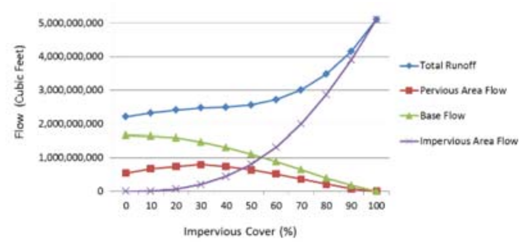


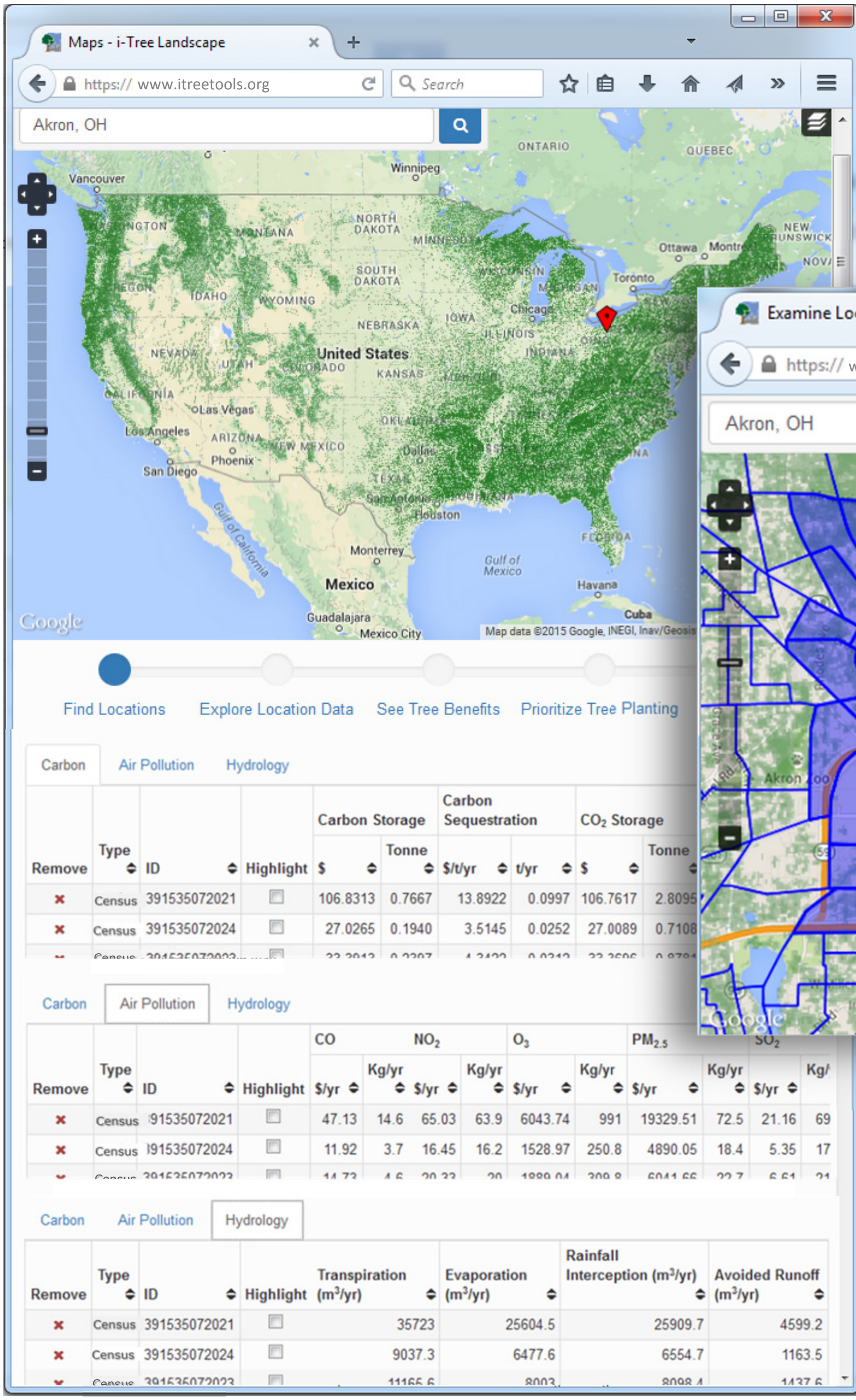
Figure 3: i-Tree Hydro simulation scaling Impervious Cover, with constant Tree Cover, in Rock Creek watershed near Washington, DC.

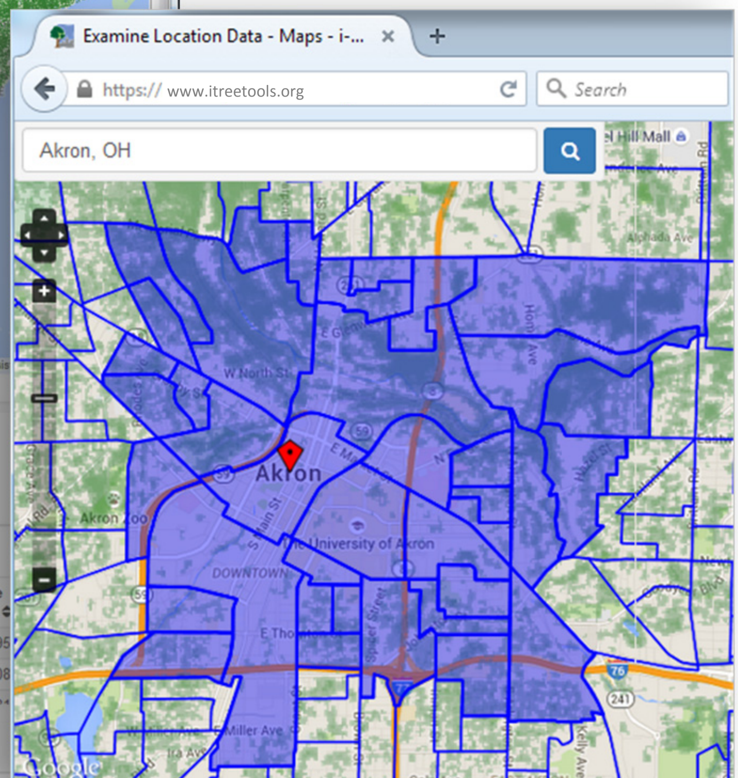
What's on the Horizon – Projects, Partnerships, and Research

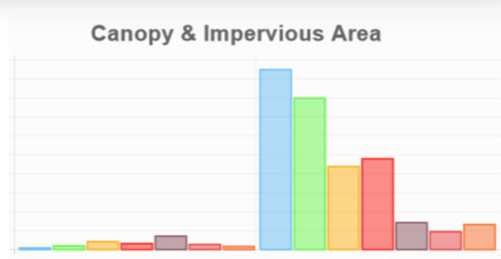
- **Nation-wide simulations** to assess hydrological effects of changes in tree cover and impervious cover across the United States.
- **Improved water quality modeling**, including pollution build-up & buffering hotspot identification and land cover specific effects.
- Simulating land cover changes in **climate change scenarios** using USGS weather stations and 25-year past & future data from the international, high-resolution NARCCAP model.
- NRCS SSURGO database will inform **localized soil & hydrology parameters** for users all over the U.S.
- Spatially-distributed version of model, providing more specific and localized land use decision-making support.

i-Tree Landscape

Tree & Forest Benefits
at your fingertips!
in 5 easy steps…







5 Steps:

1) Find your Location – Census areas, Cities, Counties, Watersheds, and more
2) Explore Location Data – Canopy & Impervious amounts, Census information…
3) See Tree Benefits – Carbon storage & Sequestration, Air Pollution Removal…
4) Prioritize Tree Planting – Adjust location parameters to focus tree planting efforts
5) Generate Results – To share with others and promote the benefits of trees!

i-Tree Landscape

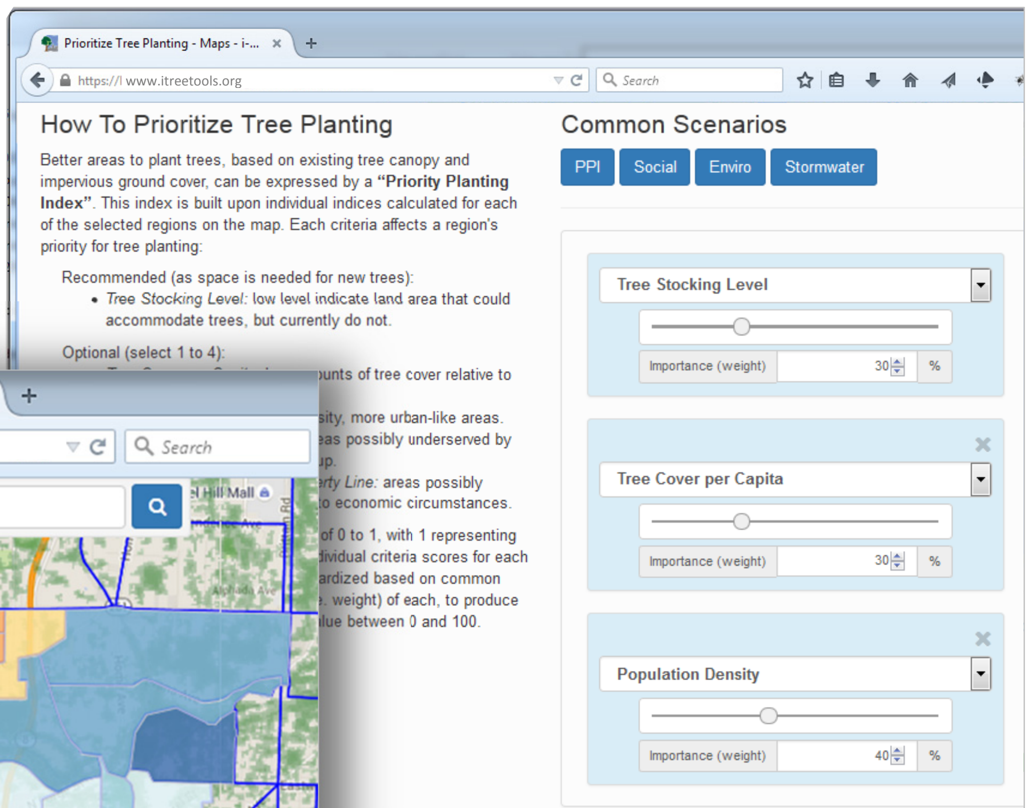
How it works:

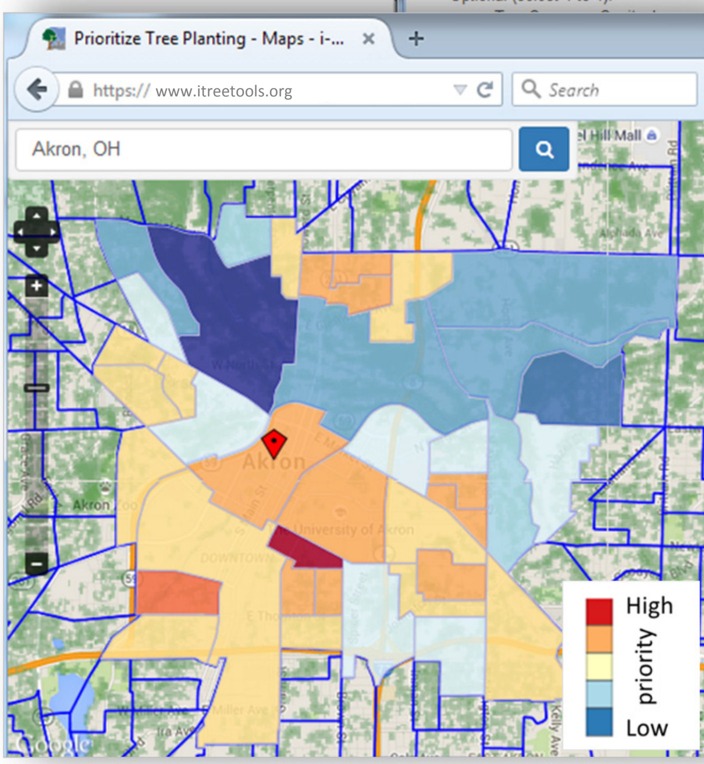
i-Tree Landscape is a web browser application that uses tree cover maps and other data to spatially estimate ecosystem services of trees. It can help map optimal locations to plant or protect trees in order to sustain these services based on user-specified parameters related to forest and tree stocking and Census data.

- Census Block Groups & Places
- Counties, States, Congressional Districts
- State/National Forests & National Parks,
- Tree Canopy, Impervious Cover, Land Cover:
  - UTC where available & NLCD 2011
- Base Maps:
  - Google, Bing, Open Street Map

… and more to come!

Quickly and Easily focus your Tree Planting and Forest Stewardship efforts.





i-Tree Landscape will be available in Fall of 2015.

Check out www.itreetools.org for more information.