i-Tree Hydro

Water Resilient Cities conference

April 22, 2016

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Outline

1. Intro to the tool; modeling & management
2. Briefing on background, inputs & outputs
3. Summary of 3 real-world applications
4. Additional resources & next steps

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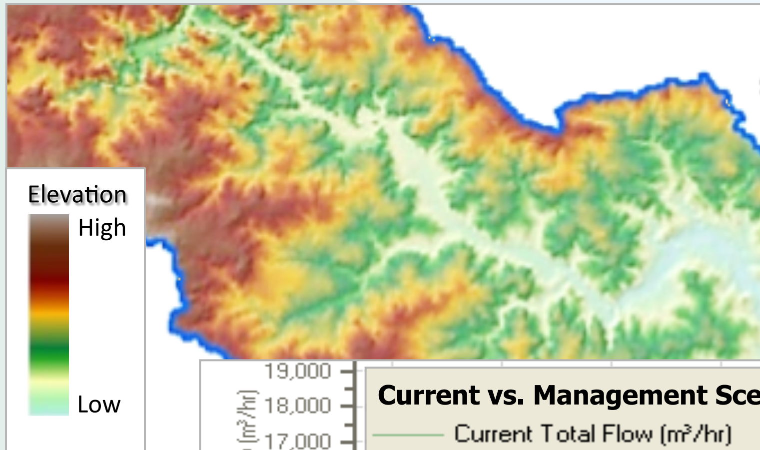
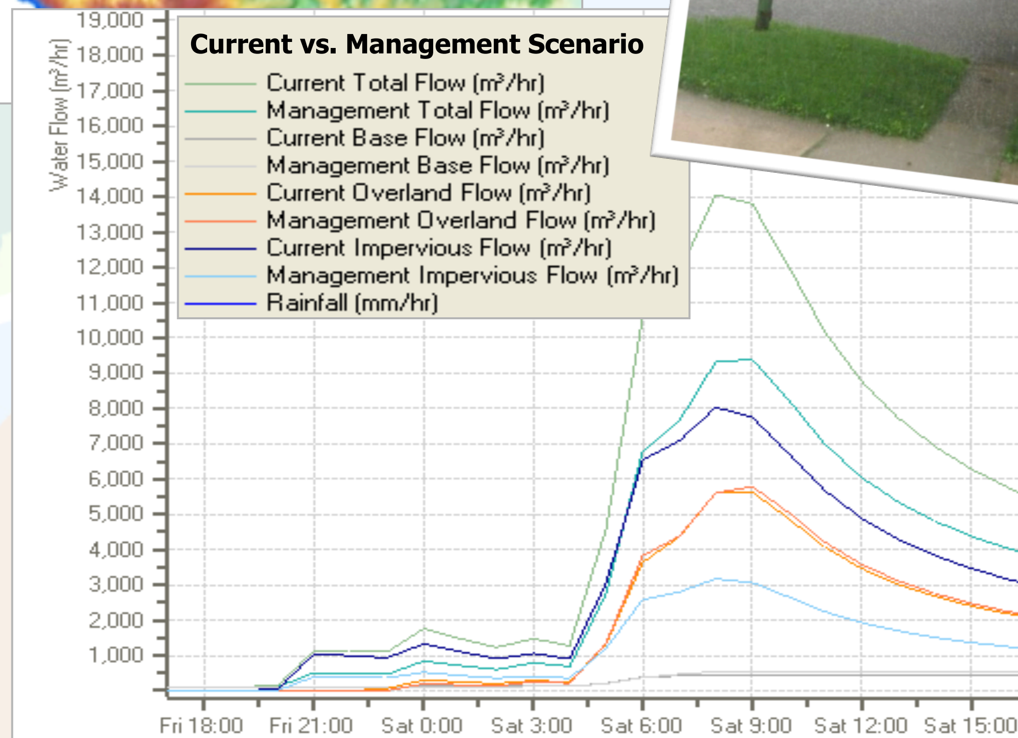
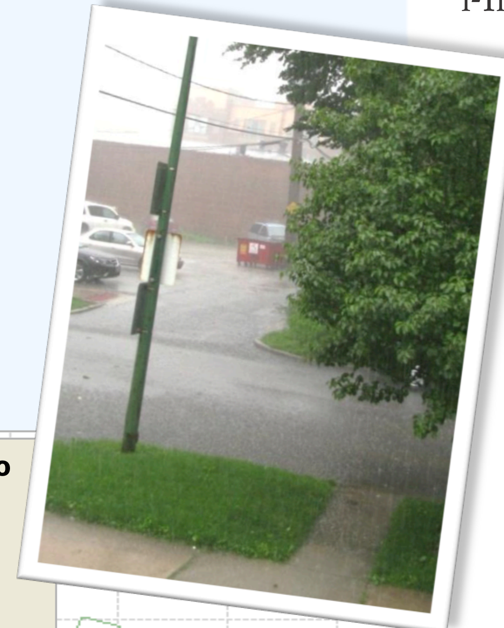
DAVEY · Arbor Day Foundation · sma Society of Municipal Arborists · ISA · Casey Trees · ESF State University of New York College of Environmental Science and Forestry

What is i-Tree Hydro?







Simulates effects of:

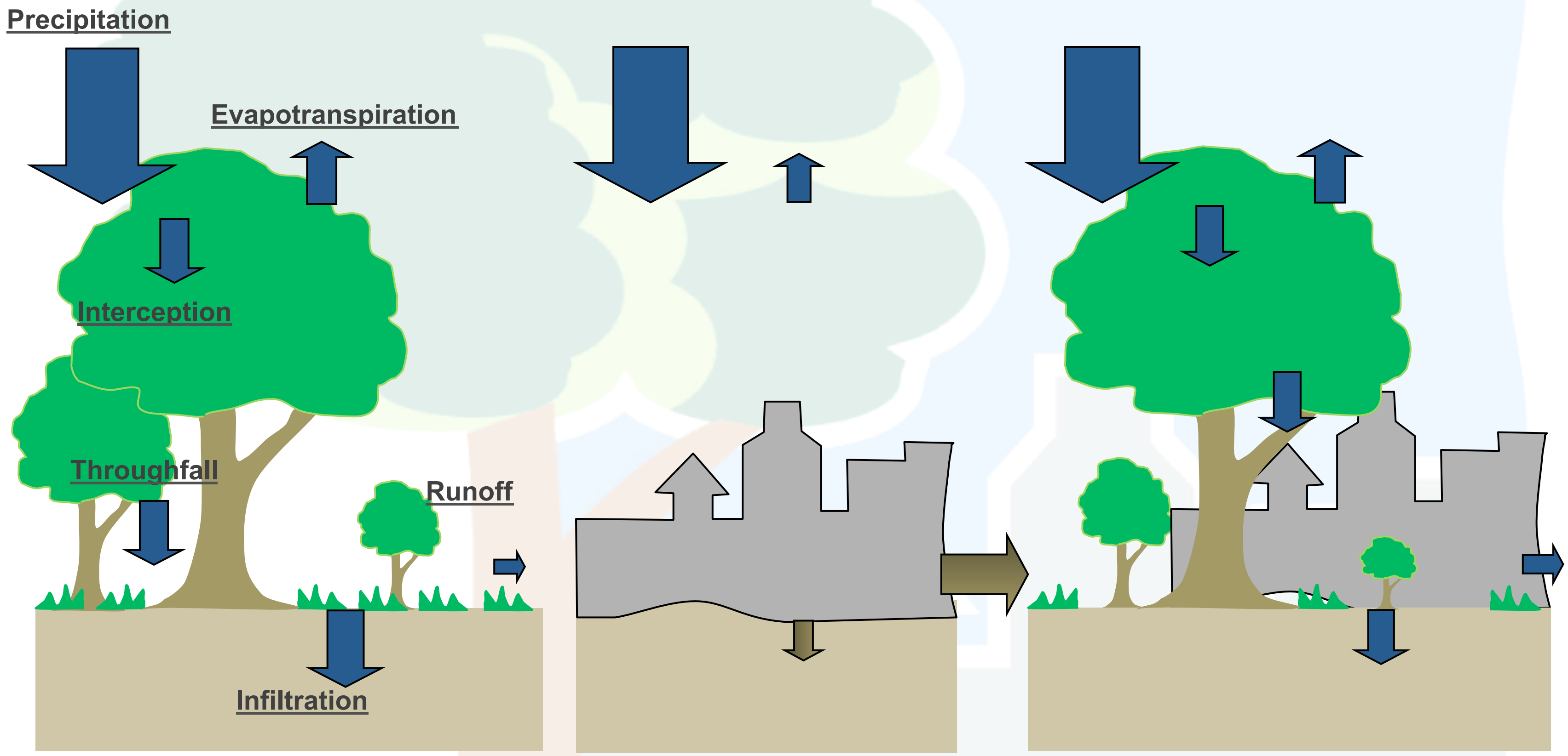
- Tree cover
- Impervious cover

on:

- Stream flow
- Water quality

How can i-Tree Hydro Help?

Modeling & Management



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i-Tree Hydro

Model Background

- Process-based, first-order Rainfall-runoff model
- Origins from discussions between Dr. Ted Endreny (SUNY-ESF) and Dr. David Nowak (USFS - NRS)
- Wanted to replace curve number based runoff models with a processed based hydrological model

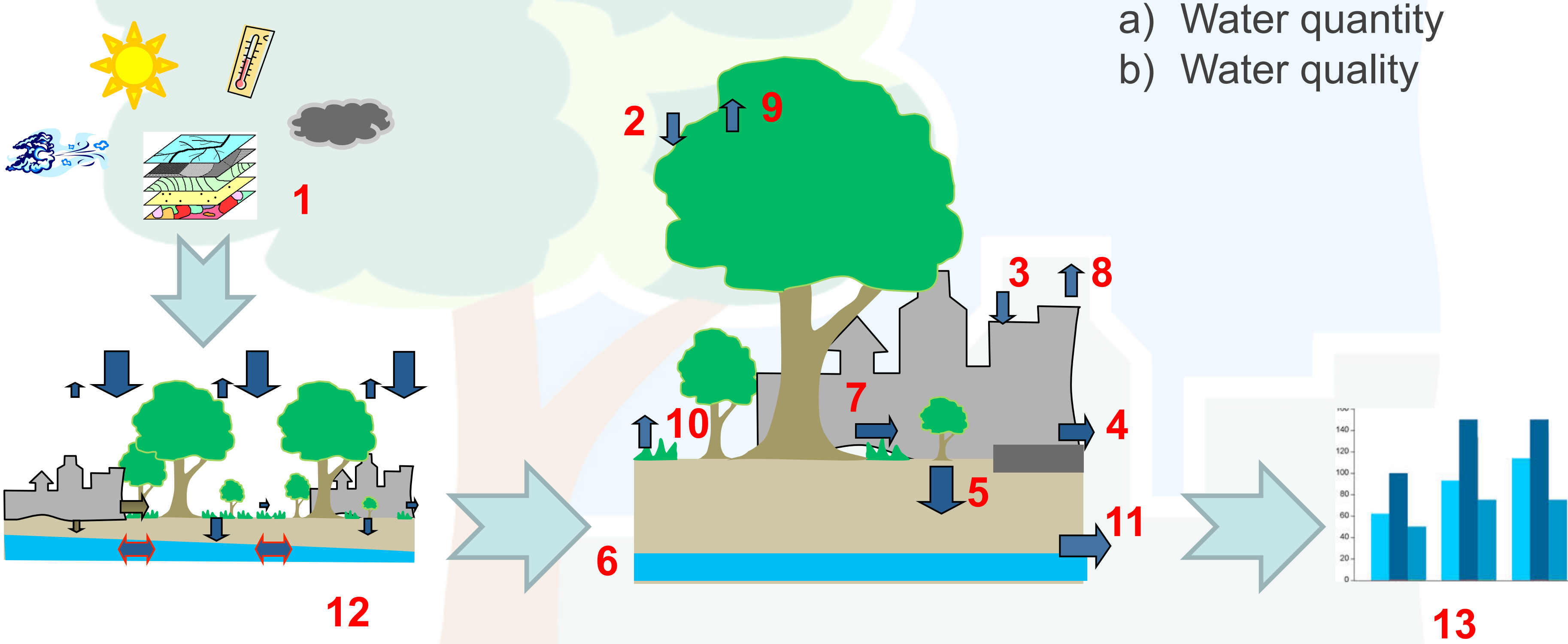
St. Elizabeth Hosp. D.C. 2006-2011
Casey Trees

Modeled Hydrologic Processes

1 Inputs
   a) Location
   b) Weather
   c) Land Cover
   d) Topography
   e) Hydrology & Soil

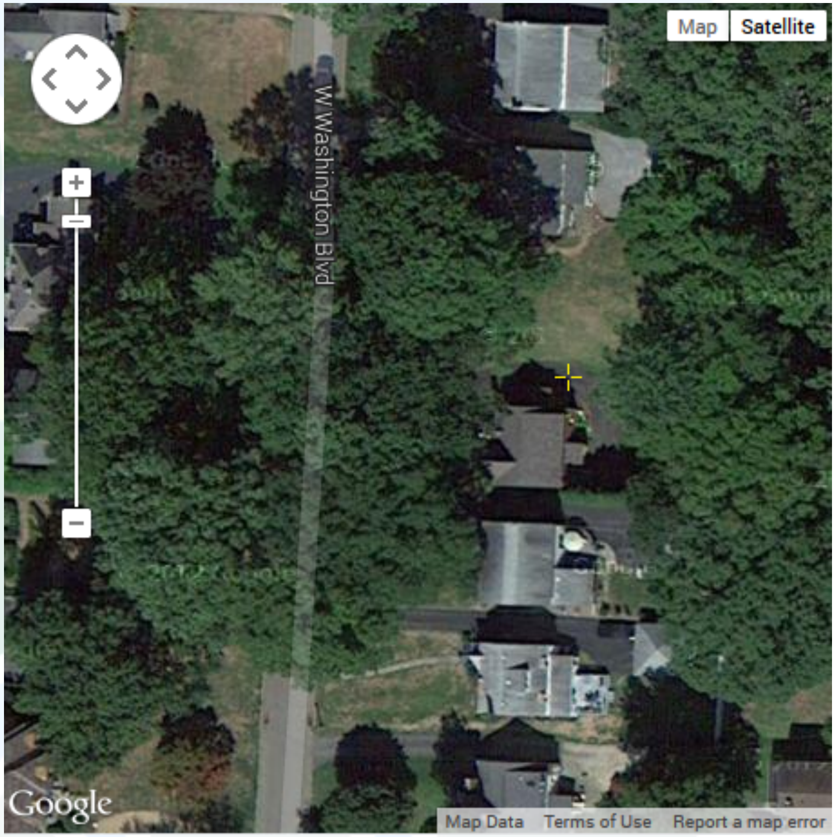
2 Canopy Interception
3 Depression Storage
4 Impervious Runoff
5 Infiltration
6 Soil Moisture
7 Pervious Runoff

8 Surface Evaporation
9 Veg Evaporation
10 Evapotranspiration
11 Subsurface Runoff
12 Semi-Spatial Distribution
13 Outputs
   a) Water quantity
   b) Water quality



Model Inputs

- Landcover
  - 5 main cover classes
    - Bare Soil
    - Shrub/Grass/Herbaceous (Short Vegetation)
    - Impervious Surface
    - Tree Cover over Impervious Area
    - Tree Cover over Pervious Area



i-Tree Canopy survey for photo-interpretation of i-Tree Hydro's land cover inputs

Model Calibration

- Calibration
  - Method:
    - Determining optimal model parameter set
      - Optimization algorithm - PEST
    - Repeated model runs

      Comparing predicted and observed values
    - Maximize goodness of fit metrics
  - Problems:
    - Equifinality – Different parameter sets, same optimum
    - Disagreement between field data and model parameters

Model Calibration

Parameter Calibration Results

Daily Model Calibration Results

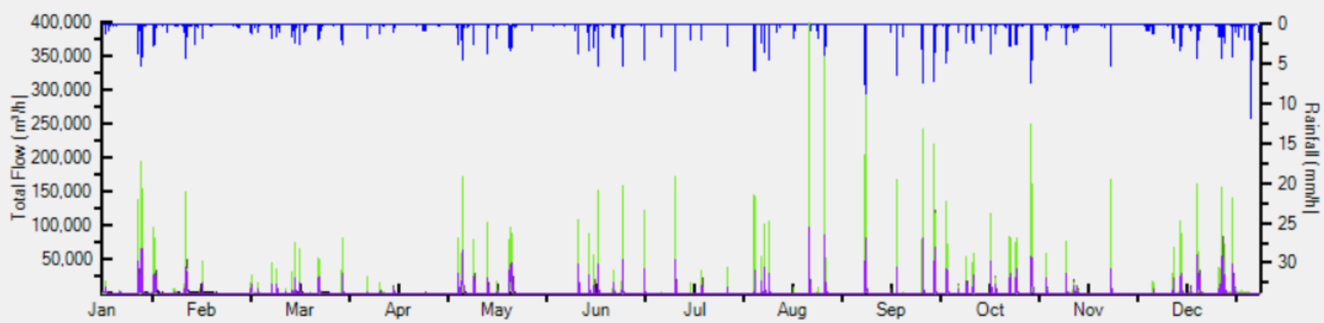
Enabled	Name	Volumetric Efficiency	Peak Flow Fit	Base Flow Fit	Balanced Flow Fit	Color
☑	Observed Discharge	N/A	N/A	N/A	N/A	Black
☑	Rainfall	N/A	N/A	N/A	N/A	Blue
☑	Suggested Default Values	-1.42625	-49.1535	-4.22019	-13.8412	Dark grey
☑	Values from file param.dat 1	-2.04194	-91.1213	-5.54488	-17.8398	Green
☑	AutoCalibrated Parameters	-0.980474	-29.0002	-3.26107	-10.8383	Purple

The Peak Flow, Base Flow, and Balanced Flow calibration metrics are a measure of how well the predicted flow matches the flow observed at the gaging station. These values range from negative infinity to 1.0. A value of 1.0 indicates a perfect match between the predicted and observed streamflow. A value of 0.0 indicates the predictions are no better at matching the observations than using the average observed streamflow. Negative values indicate the predictions are worse than using the average observed streamflow. Typically "good" calibration metrics range from 0.3 to 0.7, with higher values being better. Sources: Peak Flow Metric - Nash and Sutcliffe, 1970; Base Flow Metric - Ye et al., 1997; Balanced Flow

Show Graph

Export JPG

Calibration Comparison



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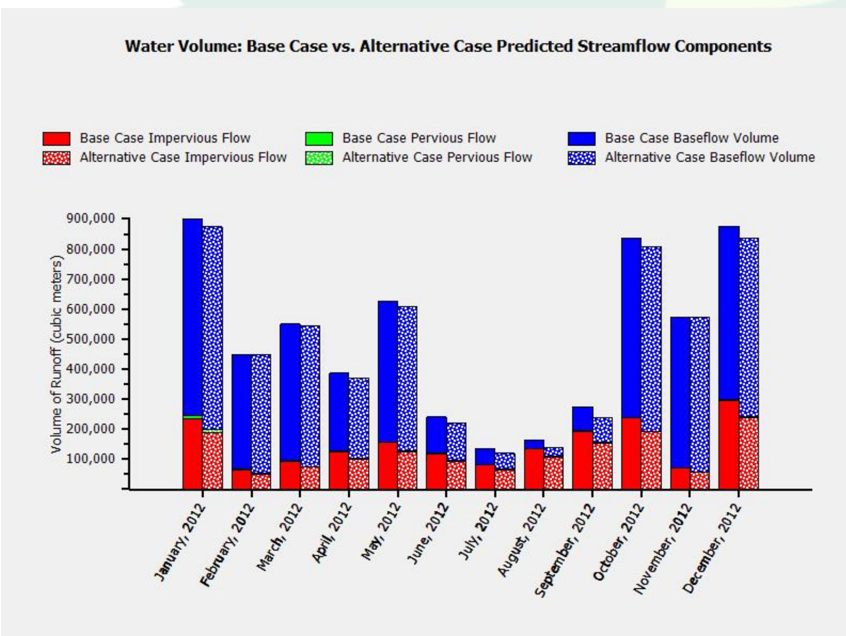
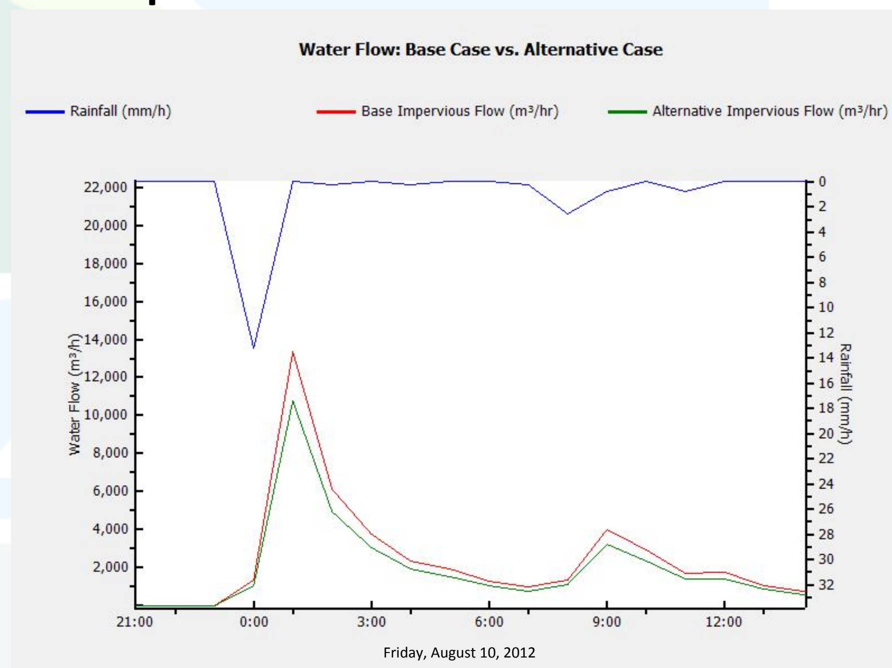
Outputs

- Water Quantity Outputs
  - Predicted streamflow vs. observed (if available)
  - Yearly, Monthly, Daily bar-graphs
  - Hourly time-series & Export options

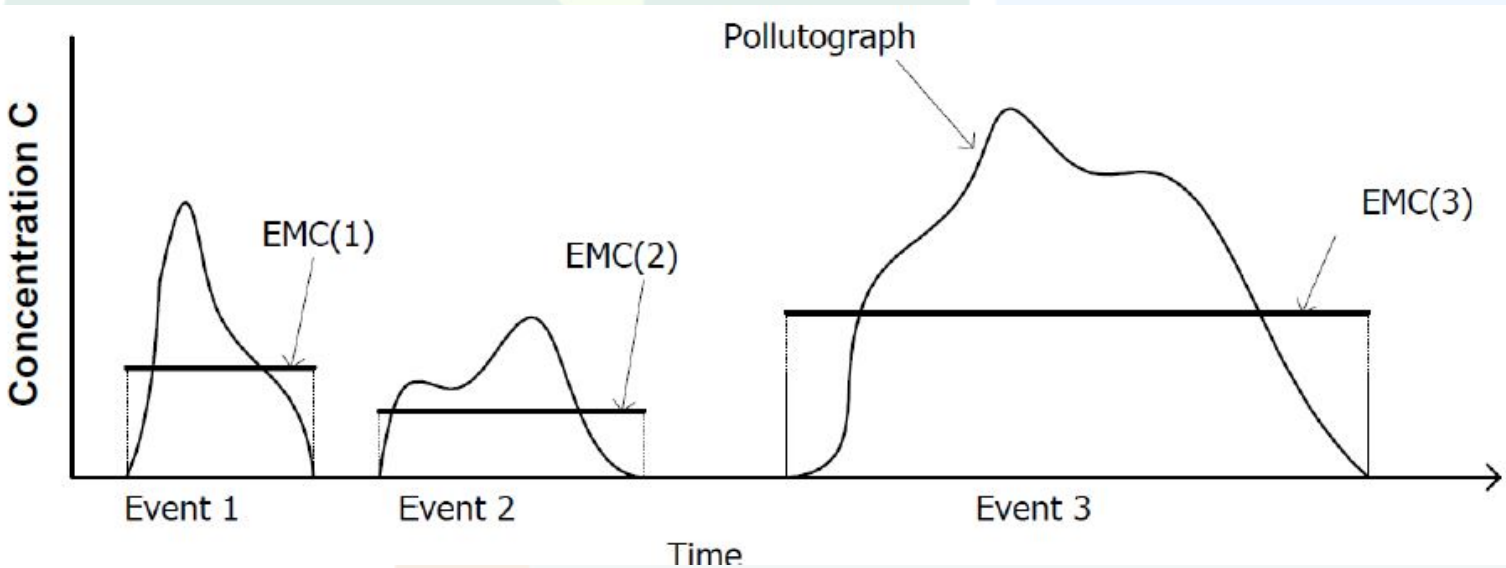




Exported Figures from i-Tree Hydro's Sample Project

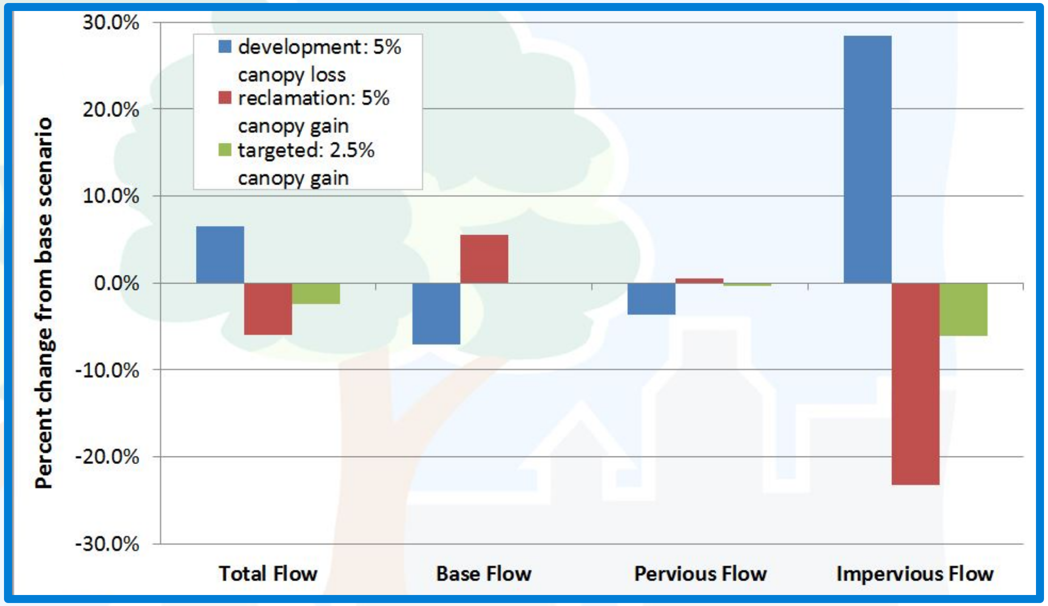
Outputs

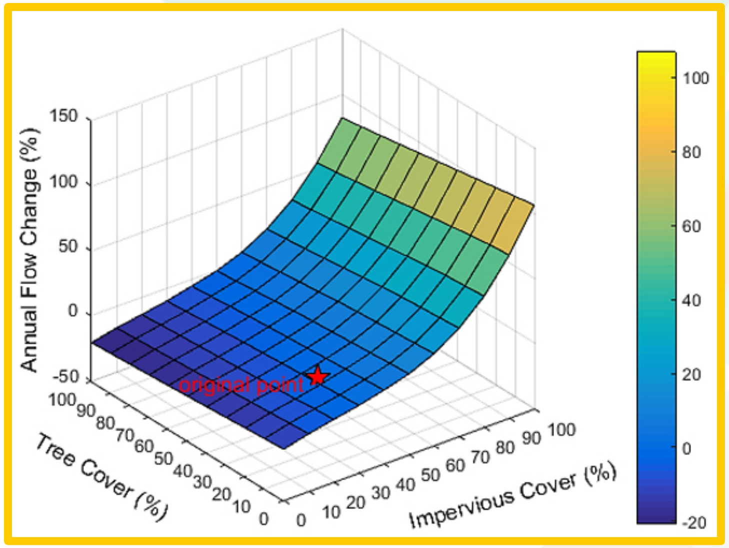
- Water Quality Outputs
  - Pollution – Loading estimates
    - Total pollutant mass
    - Based on EMC values – from EPA's NURP data
    - Available in same formats as water quantity outputs



Exported Outputs
& Examples of Additional Processing

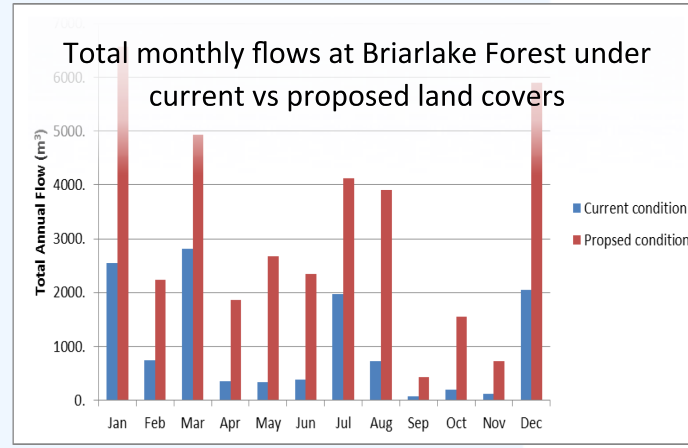
Site condition	Total flow (m^3)	Base flow (m^3)	Pervious flow (m^3)	Impervious flow (m^3)
Current	12,322	5,063	4,700	2,559
Post-development	37,277	6,488	14,327	16,462
Increased Gallons	6.6 million	376 K	2.5 million	3.7 million
Percent Increase	303%	28%	305%	643%





Additional Examples of i-Tree Hydro Modeling

Supporting Water Resilient Cities



- ***"Briarlake Forest Conversation Project** Using i-Tree Hydro"*

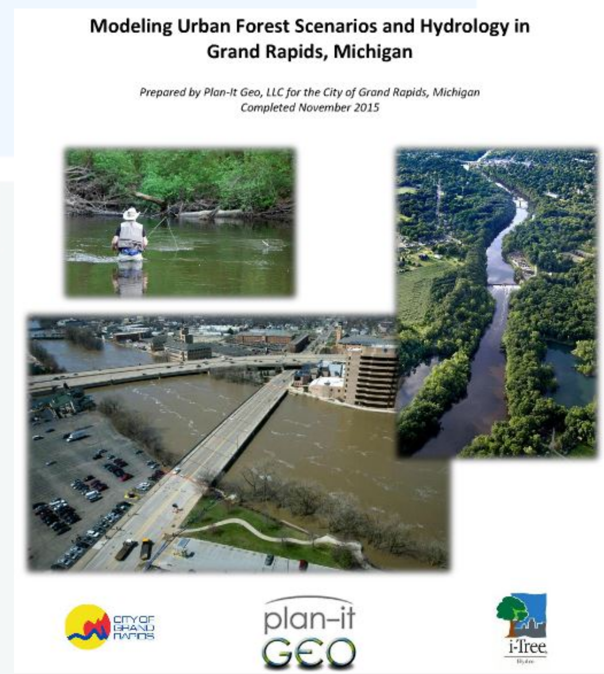
  by Eric Kuehler of the USDA Forest Service, 2015

  - Successful community forest conservation backed up by data from i-Tree Hydro

- ***"Modeling Urban Forest Scenarios and Hydrology in Grand Rapids, Michigan"***

  by Ian Hanou of Plan-It Geo, 2015

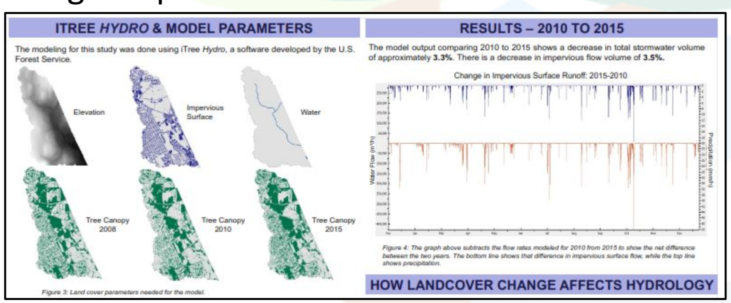
  - Value of urban forests reducing impervious runoff



- ***"Modeling Hydrological Ecosystem Services of Juvenile Trees in Worcester, Massachusetts"***

  by A. Filipovic & J. Rogan of Clark University, 2016

  - Hydrologic impact of deforestation due to ALB & reforestation



Excerpt from Poster on Worcester, MA i-Tree Hydro Study

- For more info on these projects, please visit: iTreeTools.org/Resources/Reports.php

Online Resources

- Download & more information - *itreetools.org*
- Support Forum - *forums.itreetools.org*
  - FAQs - *on Support Forum > Official i-Tree FAQs > Hydro*
- Email – *info@itreetools.org*

Upcoming Workshop

- WEFTEC2016, full-day hands-on workshop
  - September 25 in New Orleans

Subscribe for Updates on Events & Tools

- Sign up at *itreetools.org/news/subscriptions.php*

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