

Snowball ~~Lightning~~ Talk

Comparison of CITYgreen and i-Tree Carbon Sequestration Software

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Executive Order 13514

issued by President Obama on October 5, 2009

“to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of greenhouse gas emissions a priority for Federal agencies”.

“...Federal agencies shall increase energy efficiency; measure, report, and reduce their greenhouse gas emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and stormwater management; eliminate waste, recycle, and prevent pollution”.

In the Ring : i-Tree vs. CITYgreen

i-Tree

Produced by: USDA Forest Service

Cost: public domain, no cost

Website: <http://www.itreetools.org/index.php>

CITYgreen for ArcGIS

Produced by: American Forests

Cost: Single license, government rate \$895

Website: <http://www.americanforests.org>

This is an ArcGIS extension

What do we expect these cost-benefit applications to do?

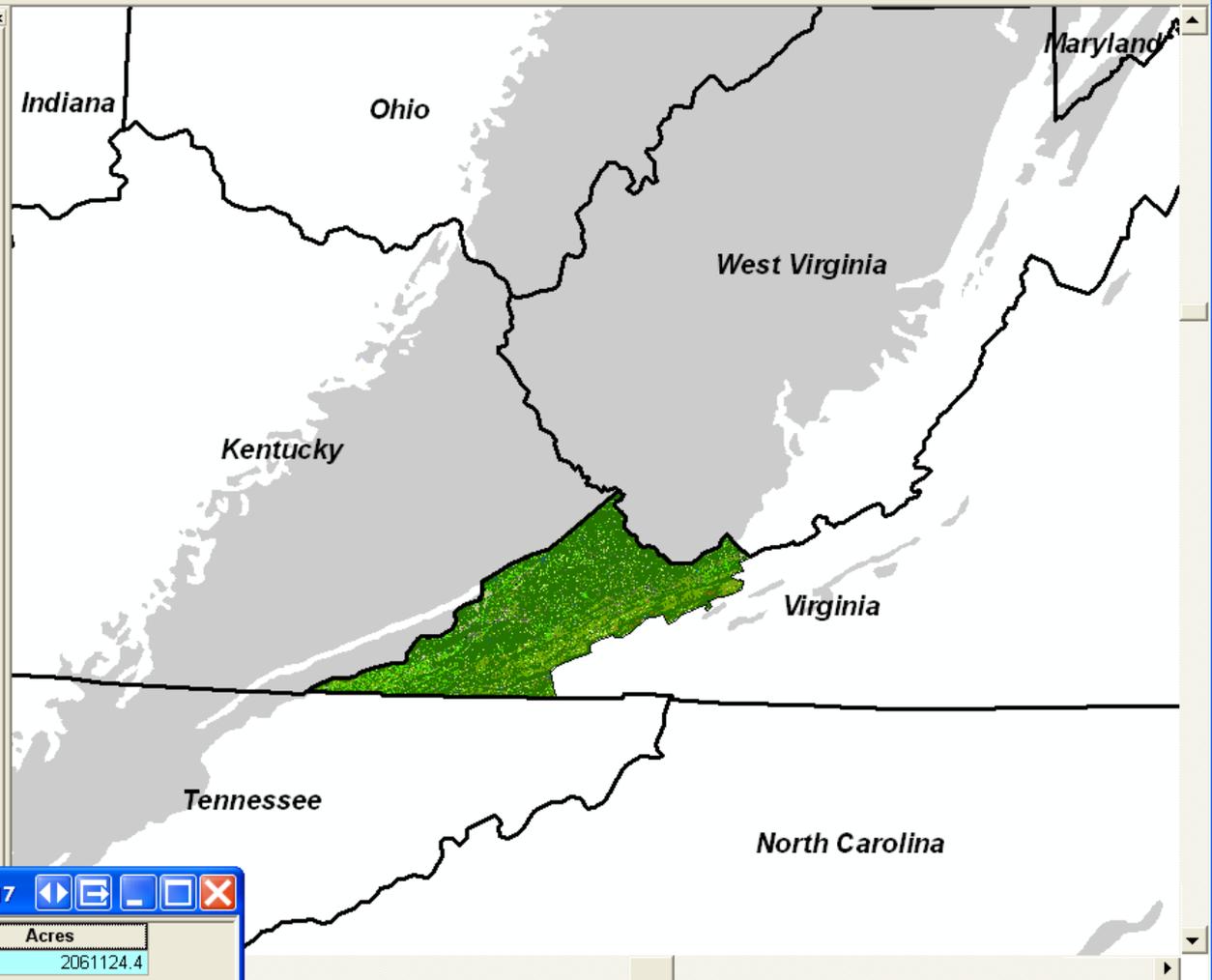
- Carbon storage and sequestration metrics
- Change scenario modeling
- Stormwater runoff mitigation metrics
- Air and water pollution removal metrics

Two Types of Analysis

- General NLCD land cover based
Coarse estimates based on regional averages
- Detailed customized land cover inventories
Precise estimates based on local data

CITYgreen for ArcGIS

- Layers
 - USA Base Map
 - Coal_counties_Dissolve_utm17
 -
 - VA_NLCD_Ic_CG
 - CGFEATURE
 - Bare Ground
 - Herbaceous Meadow
 - Open Space - Grass 50 - 75% cover
 - Open Space - Grass >75% cover
 - Pasture/Range >75% cover
 - Row Crops
 - Shrub 50 - 75% cover
 - Trees - forest litter understory adequate soil
 - Trees: Forest litter understory
 - Urban: Commercial/Business
 - Urban: Residential: 0.25ac Lots
 - Urban: Residential: 2.0ac Lots
 - Water Area
 - nlcd_ic_6cos
 - AllCoalFields



Attributes of Coal_counties_Dissolve_utm17

FID	Shape *	STATE	StudyArea	Acres
0	Polygon	VA	Va_6cos	2061124.4

Record: 0 Show: All Selected Records

Analysis Report for Va 6cos



Land cover type	Land cover in acres	Percentage
Bare Ground	18,601.8	0.9%
Herbaceous Meadow	0.9	0.0%
Open Space - Grass >75% cover	133,637.4	6.5%
Open Space - Grass 50 -75% cover	89,817.2	4.4%
Pasture/Range >75% cover	313,376.4	15.2%
Row Crops	4,169.8	0.2%
Shrub 50 - 75% cover	8,289.7	0.4%
Trees - forest litter understory adequate soilcover	1,435,894.1	69.7%
Trees: Forest litter understory	45.4	0.0%
Urban: Commercial/Business	1,544.9	0.1%
Urban: Residential: 0.25ac Lots	13,498.2	0.7%
Urban: Residential: 2.0ac Lots	37,610.5	1.8%
Water Area	4,172.2	0.2%
Total:	2,060,658.4	100.0%

Tree Canopy: 1,435,939.4 acres (69.7%)

Air Pollution Removal

Nearest air quality reference city: *Phoenix*

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr.</u>
Carbon Monoxide:	11,520,093	\$5,853,762
Ozone:	55,040,444	\$194,460,680
Nitrogen Dioxide:	29,440,238	\$104,013,852
Particulate Matter:	92,160,744	\$217,393,168
Sulfur Dioxide:	2,560,021	\$2,209,378
Totals:	190,721,539	\$523,730,840

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Tons Stored (Total):	58,292,809
Tons Sequestered (Annually):	1,921,741

Stormwater Management

Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	2.75
Curve Number reflecting existing conditions:	66
Curve Number of replacement land cover:	89
Dominant Soil Type:	C
Replacement land cover type: (existing condition)	
Impervious Surfaces: Buildings/ structures	
Additional cu. ft. storage needed:	9,289,945,574
Construction cost per cu. ft.:	\$2.00

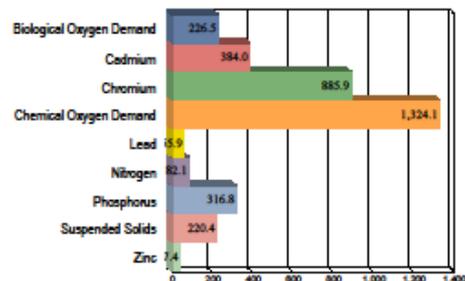
Total Stormwater Value: \$18,579,891,148

Annual Stormwater Value: \$1,619,879,578

(based on 20-year financing at 6% interest)

Water Quality (Contaminant Loading)

Percent change in contaminant loadings



Carbon Sequestration

Entire region.

(Carbon Sequestration * Tree Canopy) note: all estimates are rounded

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Image Area

2,061,124.0 acres

Impervious Cover

27,294.1 acres

1.3 %

Tree Canopy

1,280,483.6 acres

62.3 %

Carbon Sequestration: 1,615,549.6 short tons; \$33,415,725.0 @ \$20.68 per short ton

CO2 Equivalent Sequestration: 5,922,605.0 short tons; \$33,415,725.0 @ \$5.64 per short ton

NLCD Developed

Developed, All

142,493.7 acres

6.9 %

Impervious Cover: 27086.7 acres; or 19 %

Tree Canopy: 53801.8 acres; or 37.8 %

Carbon Sequestration: 720.0 short tons; \$14,892.6 @ \$20.68 per short ton

CO2 Equivalent Sequestration: 2,639.6 short tons; \$14,892.6 @ \$5.64 per short ton

Developed, Open Space

Developed, Low Intensity

Developed, Medium Intensity

Developed, High Intensity

NLCD Forest

Forest, All

1,444,134.7 acres

70.1 %

Impervious Cover: 30.9 acres; or 0 %

Tree Canopy: 1183724.8 acres; or 82 %

Carbon Sequestration: 1,584,141.8 short tons; \$32,766,090.8 @ \$20.68 per short ton

CO2 Equivalent Sequestration: 5,807,463.8 short tons; \$32,766,090.8 @ \$5.64 per short ton

Deciduous

Evergreen

Mixed

Shrub/Scrub

NLCD Wetlands

Wetlands, All

475.0 acres

0 %

Impervious Cover: 0 acres; or 0 %

Tree Canopy: 354.9 acres; or 74.7 %

Carbon Sequestration: 474.9 short tons; \$9,822.9 @ \$20.68 per short ton

CO2 Equivalent Sequestration: 1,741.0 short tons; \$9,822.9 @ \$5.64 per short ton

Woody Wetlands

Va_6cos: 10 Percent More Trees

Land cover in acres and percentages

■ Cropland: Row Crops: Straight Row (SR): Conditions encourage infiltration, tend to decrease runoff	4,121.3	0.2%
■ Impervious Surfaces: Unpaved: Dirt	18,545.9	0.9%
■ Open Space - Grass/Scattered Trees: Grass cover < 50%	0.1	0.0%
■ Open Space - Grass/Scattered Trees: Grass cover > 75%	133,942.8	6.5%
■ Open Space - Grass/Scattered Trees: Grass cover 50% - 75%	90,669.0	4.4%
■ Pasture/Range (Continuous forage for grazing): Ground cover > 75%	105,093.6	5.1%
■ Shrub: Ground cover 50% - 75%	8,242.6	0.4%
■ Trees: Forest litter understory: No grazing, forest litter and brush adequately cover soil	1,642,344.7	79.7%
■ Urban: Commercial/Business	2,060.7	0.1%
■ Urban: Residential: 0.25ac Lots	14,424.6	0.7%
■ Urban: Residential: 2.0ac Lots	37,091.9	1.8%
■ Water	4,121.3	0.2%
Total:	2,060,658.4	100.0%

Tree Canopy: 1,642,344.7 acres (79.7%)

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO₂), sulfur dioxide (SO₂), ozone (O₃), carbon monoxide (CO), and particulate matter less than 10 microns (PM₁₀), trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for these five pollutants based on research conducted by David Nowak, PhD, of the U.S. Forest Service. Economists use "externality" costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue to determine the dollar value of air pollutant removal. The externality costs used in CITYgreen are set by each state's Public Services Commission.

Nearest Air Quality Reference City: **Charleston**

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr</u>
Carbon Monoxide:	1,464,002	718,494
Ozone:	39,528,053	\$139,654,617
Nitrogen Dioxide:	13,176,018	\$46,551,539
Particulate Matter:	27,816,038	\$65,613,799
Sulfur Dioxide:	14,640,020	\$12,634,795
Totals:	96,624,130	265,173,244

Dollar values are based on 2009 dollars

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree's dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and sequestration rates of trees within a defined study area. The carbon storage and sequestration model was developed using research conducted by David Nowak, E. Gregory McPherson, and Rowan Rowntree of the U.S. Forest Service.

Tons Stored (Total):	70,672,527
Tons Sequestered (Annually):	550,204

Va_6cos: 10 Percent More Trees

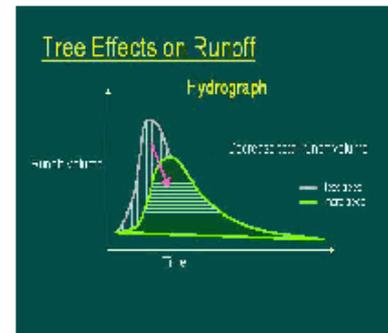
Stormwater Management

Water Quantity (Runoff Volume)

Trees decrease total runoff volume, helping cities to decrease their stormwater management costs. CITYgreen calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained if all trees were removed. To do this, CITYgreen uses a model developed by the Natural Resources Conservation Service (NRCS) called TR-55, based on a system of curve numbers. Curve numbers are an index of potential runoff within a specified drainage area. Curve numbers range from 30 to 100, with a higher number indicating greater runoff potential.

CITYgreen calculates two curve numbers for the stormwater analysis: one reflecting existing land cover conditions and the other reflecting the replacement of tree canopy in the study area by a user-defined replacement land cover (specified in the CITYgreen Preferences.) The difference in curve numbers and local rainfall determine the change in storage volume between the two different land cover scenarios (with and without trees). To determine the dollar amount of stormwater-related savings resulting from tree canopy, this calculated volume is then multiplied by the user-specified local construction cost.

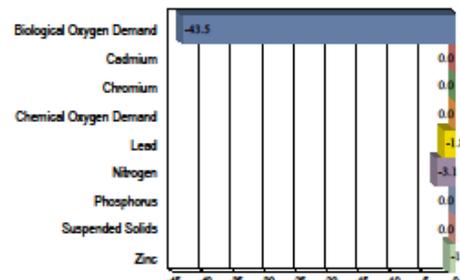
2-yr, 24-hr Rainfall in inches:	2.75
Curve Number reflecting existing conditions:	58
Curve Number of replacement land cover:	57
Dominant soil type:	B
Replacement land cover type: (existing condition)	
Open Space - Grass/Scattered Trees: Grass cover < 5%	
Additional cu. ft. storage needed:	-99,833,397
Construction cost per cu. ft.:	\$2.00
Total Stormwater Value:	-\$199,666,793
Annual Stormwater Value:	\$17,407,861
<small>(based on 20-year financing at 6% interest)</small>	



Water Quality (Contaminant Loading)

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. American Forests developed the CITYgreen water quality model using data from the US Environmental Protection Agency (EPA) and Purdue University's L-Thia spreadsheet water quality model. The water quality model estimates the change in the concentration of pollutants in runoff during a typical storm event, by replacing the tree canopy in a specified study area with the user-defined replacement land cover (specified in the CITYgreen Preferences) and comparing the results. The model estimates the event mean concentrations of nitrogen, phosphorus, suspended solids, zinc, lead, cadmium, chromium, chemical oxygen demand (COD), and biological oxygen demand (BOD).

Percent change in contaminant loadings



Metric

i-Tree

CITYgreen

Carbon Storage and Sequestration
Air Pollution Removal
Stormwater Runoff
Water Quality
Modeled Scenarios
Detailed Cost-Benefit Tons/\$ Figures
Detailed Tree Canopy Information
Incorporates Soil Characteristics
NLCD-Based Analysis
Customized Analysis Using Polygons
Direct Integration with GIS, GPS
Ease of Use
Overall Level of Detail
Crash Index
Front End Labor Load

Yes

Yes

Soon

Soon

Yes

Yes

Yes

No

Yes

No

No

Difficult

High

Fragile

High

Yes

Yes

Yes

Yes

Yes

No

No

Yes

Yes

Yes

Yes

Easy

Low

Solid

Low

Conclusions

CITYgreen offers an easy to use ArcGIS extension that provides rapid, general regional or local analytical results to determine carbon storage and sequestration, as well as other ecological benefits. Price is reasonable.

i-Tree is a detail-oriented and complex standalone that is well suited for very precise measurements of carbon storage and sequestration. It is somewhat cumbersome to operate, and requires substantial effort to gather and process all of the data required to run an analysis. However, results are expected to be far more precise. No cost – public domain software.

Questions?

Choose CGFeature



Choose the corresponding CGFeature to assign to the selected record. If no CGFeature is selected, the CGFeature and CN_Code will be replaced by the default land cover.

OK

- Please select one from the following list
- Arid & Semi-Arid Rangeland
- Cropland
- Farmsteads (Buildings, lanes, driveways and surrounding lots)
- Impervious Surfaces
 -
 - Bioretention / Rain Gardens
 - Green Roofs
 - Porous Pavement - Not Properly Maintained
 - Porous Pavement - Properly Maintained
 - Vegetated Buffers - Grass
 - Vegetated Swales - Grass
- Low Impact Development
- Meadow (Continuous grass, generally mowed, not grazed)
- Open Space - Grass/Scattered Trees
 - Grass cover < 50%
 - Grass cover > 75%
 - Grass cover 50% - 75%
- Pasture/Range (Continuous forage for grazing)
 - Ground cover < 50%
 - Ground cover > 75%
 - Ground cover 50% - 75%
- Shrub
 - Ground cover < 50%
 - Ground cover > 75%
 - Ground cover 50% - 75%
- Trees
 - Forest litter understory
 - Forest litter and brush destroyed by grazing or burning
 - Grazed but not burned, some forest litter
 - No grazing, forest litter and brush adequately cover soil
 - Grass/turf understory
 - Ground cover < 50%
 - Ground cover > 75%
 - Ground cover 50% - 75%
 - Impervious understory
- Tropical
- Unclassified
- Urban
 - Bare
 - Commercial/Business
 - Residential