CITY green

What is it?
How does it work?
CITYgreen

- Developed by American Forests
- Software module for ArcGIS software
- Initially released in 1996.
What does it do?

CITYgreen calculates dollar benefits based on your specific site conditions.

CITYgreen analyzes:

- Stormwater Runoff
- Air Quality
- Summer Energy Savings
- Carbon Storage and Avoidance
- Tree Growth
How does it work?

- High-resolution multispectral satellite imagery.
- Landcover type classification.
  - Tree canopy
  - Impervious surface
  - Grass
  - Water
  - Etc.
- CITYgreen uses classification information to calculate data.
Analysis Report

Charlotte, NC 1994 Landcover

Charlotte, NC 2003 Landcover

Air Quality Results

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>1994</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Monoxide</td>
<td>234,817</td>
<td>118,738</td>
</tr>
<tr>
<td>Nitrogen Dioxide</td>
<td>361,271</td>
<td>247,972</td>
</tr>
<tr>
<td>Sulfur Dioxide</td>
<td>2,200,308</td>
<td>1,537,937</td>
</tr>
<tr>
<td>Particulate Matter</td>
<td>1,083,982</td>
<td>890,881</td>
</tr>
<tr>
<td>Total</td>
<td>5,311,098</td>
<td>2,811,123</td>
</tr>
</tbody>
</table>

Stormwater Results

Green Event Hydrograph

- % Reduction in Recharge

<table>
<thead>
<tr>
<th>Stormwater Volume Change</th>
<th>1994</th>
<th>2003</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2yr, 24hr Rainfall: 3.31 in.</td>
<td>3.31 in.</td>
<td>3.31 in.</td>
<td>3.31 in.</td>
</tr>
<tr>
<td>Name Matter reflecting conditions in 1994:</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name Matter reflecting conditions in 2003:</td>
<td>84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional storage volume of stormwater generated due to change in landcover from 1994 to 2003</td>
<td>266,532,592 cu. ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of construction flood correction facility per acre, $/acre</td>
<td>2,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of the construction of retention facilities to store stormwater</td>
<td>$1,987,149,104</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Benefit Summary

Landcover Change (acres)

<table>
<thead>
<tr>
<th>Landcover</th>
<th>1994</th>
<th>2003</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>62,953</td>
<td>33,214</td>
<td>-27,789</td>
</tr>
<tr>
<td>Water, Forest &amp; Open Areas</td>
<td>43,703</td>
<td>20,063</td>
<td>-23,640</td>
</tr>
<tr>
<td>Urban</td>
<td>41,313</td>
<td>92,116</td>
<td>50,803</td>
</tr>
<tr>
<td>Waste</td>
<td>3,918</td>
<td>823</td>
<td>-3,095</td>
</tr>
<tr>
<td>Total</td>
<td>51,520</td>
<td>115,115</td>
<td>63,595</td>
</tr>
</tbody>
</table>

Air Pollution Benefits

<table>
<thead>
<tr>
<th>Pollutant Removed (lb)</th>
<th>1994</th>
<th>2003</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>5,311,098</td>
<td>2,811,123</td>
<td>-2,500,005</td>
</tr>
<tr>
<td>T. Acre (t)</td>
<td>2,200,308</td>
<td>1,537,937</td>
<td>-662,371</td>
</tr>
<tr>
<td>Carbon Stored (t)</td>
<td>2,700,052</td>
<td>1,433,332</td>
<td>-1,266,720</td>
</tr>
<tr>
<td>Carbon Emitted (t)</td>
<td>2,000</td>
<td>1,000</td>
<td>-1,000</td>
</tr>
</tbody>
</table>

Stormwater Benefits

- Additional storage volume needed: 276,604,037
- Cost of Retaining Additional Volume of Water: $1,987,149,104

Water Quality (Continued)

| Percent Change in Contaminant Loadings from 1994 to 2003 due to land cover change |
|--------------------------|------------------|-----------------|-----------------|-----------------|
| Biologically Oligotrophic | Chemically Oligotrophic | Chemically Nutrient | Chemically N-N | Chemically P-P |
| Sulfate | Chloride | Nitrate | Nitrogen | Phosphorus |
| 59% | 41% | 2% | 2% | 2% |
| 59% | 41% | 2% | 2% | 2% |

Note: The stormwater calculations are based on process models which are under development by the USGS to represent the potential for stormwater runoff to reach the Chesapeake Bay. Stormwater runoff from 30% of 1994. The higher the score, the more severe the stormwater runoff. The change in score considers the impact of the change in the volume of stormwater runoff.
Cost Analysis Related to Local Air and Water Issues

How CityGreen can provide a baseline for local decision-making in the future
Triad Operating Under an EAC for Ozone (EAC = Early Action Compact)
“Bad” Ozone is produced in the lower atmosphere on hot days when nitrogen oxides (NOx) and volatile organic compounds (VOCs) react with oxygen in the presence of sunlight.

This photochemical reaction creates Ozone.
“AQM11. ....... Thus, destruction of trees in urban and suburban areas increased total VOC emissions. Conversely, urban planning and construction practices that modulate the intensity of urban heat islands (for example, through placement of "green spaces" within the urban core of cities and use of high-reflectivity building materials) aided in ozone pollution abatement by decreasing air temperatures in urban and suburban areas (Cardelino and Chameides, 1990; Meagher et al., 1998).”

http://www.ncsu.edu/sos/pubs/SOSNYCUC.pdf
NOx Reduction Estimates

- Study Area = urban park @ 523 acres
- FC = 410 sq. miles (x 640 acres/sq.mile) = 262,400 acres
  - NOx reduction (523 acres @ 9lbs/day)
  - 4,515 lbs NOx per day in FC x 365 days
  - 1,647,975 lbs/year (823 tons) – at similar density

Every 1% reduction in tree cover is roughly equivalent to an extra 8.2 Tons of NOx emissions in FC
Industry’s Cost for NOx Control (in an attainment or EAC area)

- New Company X – Best Available Control Technology (BACT) for NOx = Selective Catalytic Reduction (SCR).
- Cost/ton/year = $2000 - $10,000
- Every 1% tree cover loss ~= 8.2 tons/year
- @$6000/ton/year = $49,200/yr worth of AQ service compared to the Industrial permittees.
If FC became non-attainment for Ozone.

- If (when?) FC becomes non-attainment – then - LAER (Lowest Achievable Emission Rate)
- Eg. Catalytic Oxidation/Absorption @ $6145 - $48,663 cost/ton/year
- @ $48,663 /ton/yr x 8.2 tons (per 1% tree loss) = $399,680/ yr AQ service compared to Industrial and/or mobile source Community (and citizens)
- + offsets
- CityGreen may provide options – eg. Commit to increased % tree coverage
Triad is approaching non-attainment for Fine Particulate Matter
PM Reduction Estimates

- 48 lbs particulate / 523 acres
- 4390 tons yr / FC
- Every 1% reduction in tree cover is roughly equivalent to an extra 43.9 tons of particulate matter available to be monitored in FC
- Atlanta and other areas are using CityGreen along with TO as implementation strategies to achieve attainment.
Stormwater Control

- **TMDL** (Total Maximum Daily Load) – LID growth techniques can facilitate TMDL development and the long-term implementation of TMDL load allocations and wasteload allocations by better controlling stormwater discharges, reducing the quantity and peak flow of stormwater, and retaining more land in open space and buffers. Moreover, allocations for future growth provide a mechanism to evaluate the patterns of development that will protect water quality and those that will not.

- **Linking Stormwater Fees to the Size of Impervious Surfaces.** Local systems could assess fees based on the amount of impervious surface on a property and provide discounts for properties where stormwater is managed effectively on site.

- Phase II – Post Construction – LID could be used as a tool to eliminate costly maintenance issues and make the property more cost-friendly to consumers. Any lot that is part of a bigger project exceeding one acre will require post-construction BMPs.

  CityGreen – useful down to the acre level for site planning
Summary

- CityGreen can be a valuable resource to future action strategies to avoid draconian EPA measures for non-attainment areas.
- CityGreen can benefit local planning and strategy initiatives to meet CWA requirements (TMDLs, etc.)
- CityGreen can be used by Developers to offset traditional infrastructure costs.
- It would be an invaluable tool for future assessment of current planning initiatives.
- It would give elected officials necessary data to make more informed planning decisions in FC.
- Concern – staffing and resources; usefulness is in future evaluations.