Assessing the Potential for Developing Urban Forest Carbon Offset Projects in the US South

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Overview

- State of forest carbon markets
  - Market trends
  - Market development issues
- Why urban forest carbon?
  - Quality
  - Supply & demand
- Southern urban forest carbon assessment
  - Methods & results
- Policy implications

Past Federal Cap-and-Trade Legislation in the US

- American Clean Energy and Security Act of 2009
  - a.k.a. The Waxman-Markey Bill
  - CBO → Deficit Neutral
- Reduce GHG emissions by 17% by 2020 (base 2005)
- Reduce GHG emissions by 83% by 2050 (base 2005)
- 20% of electricity from renewable sources by 2020
- Scheduled to begin in 2012
- Estimated price of tCO_2e $13
- Provisions for forest carbon offsets

Carbon Market Issues in the US

- Failure of federal carbon regulation
  - No cap on carbon emissions
- Public support for climate action is waning as economic worries prevail
- The Environmental Protection Agency (EPA) now legally required to act on CO_2 emissions
  - Modest progress
  - Renewable energy
  - No funds for improvements
- Carbon tax still a possibility

Forest Carbon Markets

- Voluntary carbon markets
  - Chicago Climate Exchange (CCX) – voluntary, legally binding GHG reduction and trading system (recently ceased most operations)
  - Over the Counter (OTC) markets – transactions outside CCX
- Voluntary carbon markets account for most forest carbon transactions
  - 95% of volume
  - Prices ranging from $0.65 to $50 per tCO_2
  - CCX accounted for 26% of trade volume
- Most forest carbon credits originated from North America
  - 7.2 million tCO_2 or 42% of trade volume
  - Average price $5 per tCO_2

Why Forest Carbon Sequestration?

- Environmentally friendly
- Socially acceptable
- Known technology
- Cost effective
- Large abatement potential
  - 25% of the potential global abatement at a cost of up to €40 per metric ton
- Reality
  - Forest carbon represents less than 0.005% of the global carbon trade

Kyoto Protocol

- Article 3.3
  - The net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced ***land-use change and forestry activities***, limited to afforestation, reforestation and deforestation since 1990, measured as verifiable changes in carbon stocks in each commitment period, shall be ***used to meet the commitments*** under this Article of each Party included in Annex I.

A Few Complexities

- Additionality
  - Greater carbon sequestration than would have occurred assuming "**business-as-usual**" practices
- Leakage
  - When a mitigation activity in **place A reduces** net production of a product which is compensated for in **place B**
- Permanence
  - How long will your sequestered carbon be around
- Baseline

What Lies Ahead?

- Voluntary markets will continue to dominate forest carbon transactions in near future
  - Hundreds of organizations
  - Numerous standards
- Improvements in forest carbon measurement and monitoring
- Increasing role of carbon standards
- Political recognition that forests are important carbon sinks
  - Particularly in developing countries (REDD)
  - What about North American forest resources and practices?
- Lack of comprehensive climate legislation
- Lack of economic incentives
- Forest carbon market is as challenging as ever

Why Urban Forest Carbon Offsets?

- Lack of wood production orientation
- Additionality easy to establish
- Permanence (site context) easy to establish
- Range of environmental co-benefits
- Cities have capacity and interest in developing urban forest carbon projects
- Buyers have interest in acquiring urban forest carbon offsets, some willing to offer price premium
- Ability to generate high quality credits

Study Area

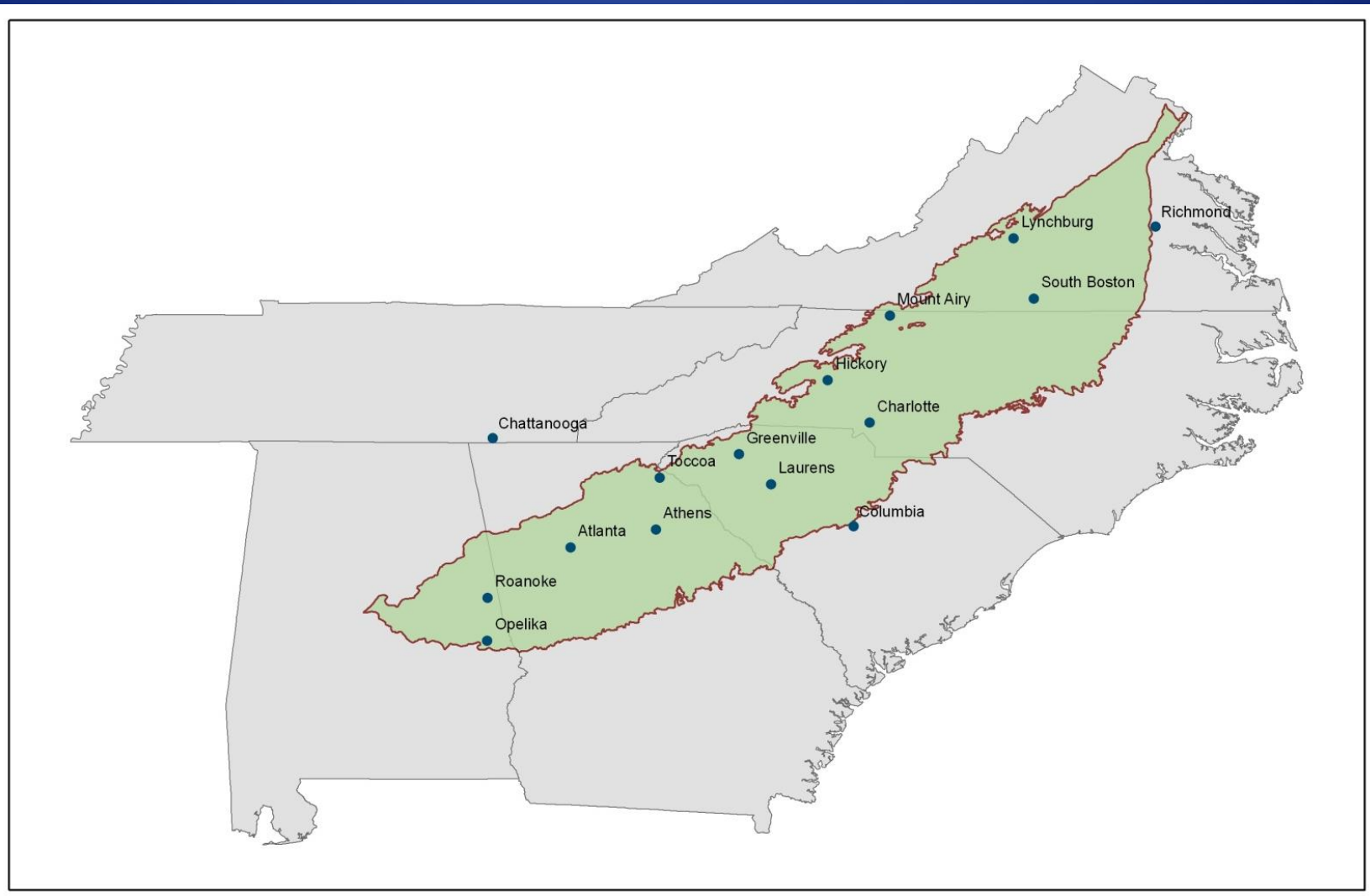
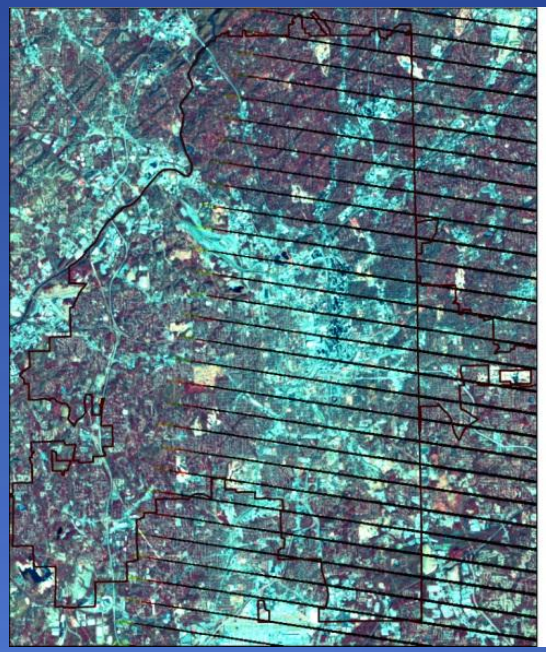

Lynchburg
Richmond
South Boston
Mount Airy
Hickory
Charlotte
Chattanooga
Greenville
Toccoa
Laurens
Athens
Columbia
Atlanta
Roanoke
Opelika

Image Acquisition & Processing

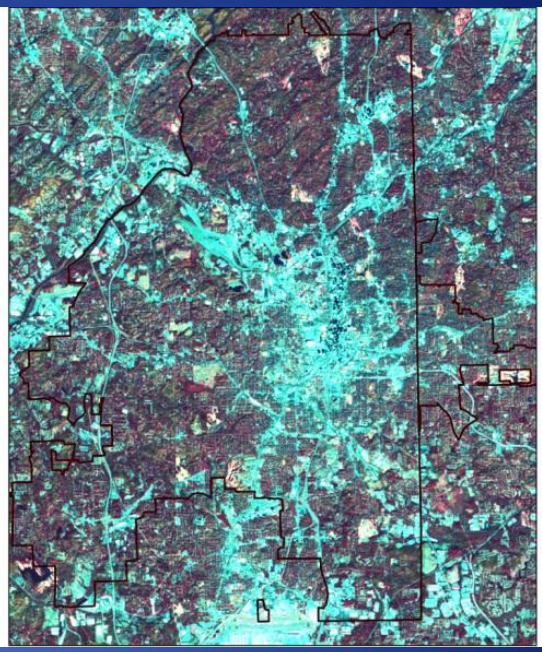
- Landsat 7 ETM+ imagery was obtained from the U.S. Geological Survey (USGS)
- This imagery is free, easily obtained, and available as recently as 2011 for some areas of the conterminous US
- Landsat 7 ETM+ imagery has already been orthorectified, which reduces the amount of pre-analysis processing required
- However, any imagery captured by Landsat 7 after 2003 has data gaps across the images, resulting in striping (failure of the scan line corrector [SLC] within the satellite)

Image Processing

- Striping is more prevalent toward the edges of a scene
- A simple histogram matching technique was used for the gap-filling process
- This process uses two images, (a) the reference image to be analyzed and (b) a secondary image to populate the missing raster data cells with data values



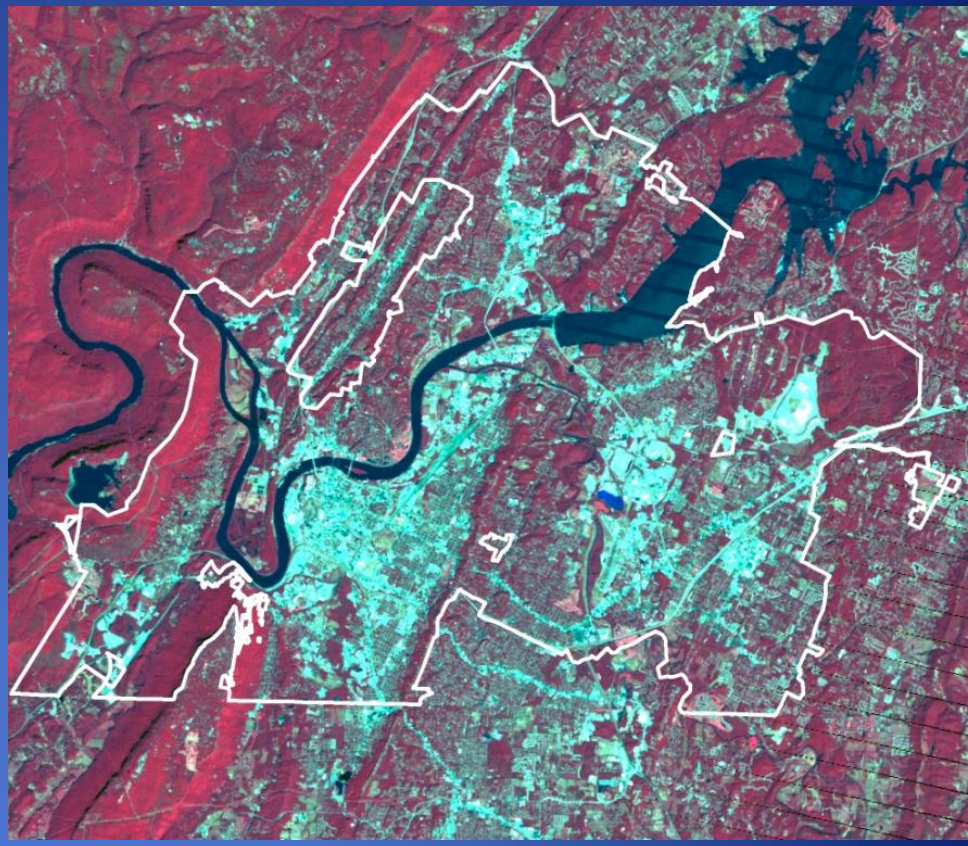
Atlanta area - striped



Atlanta area - de-striped

Image Processing

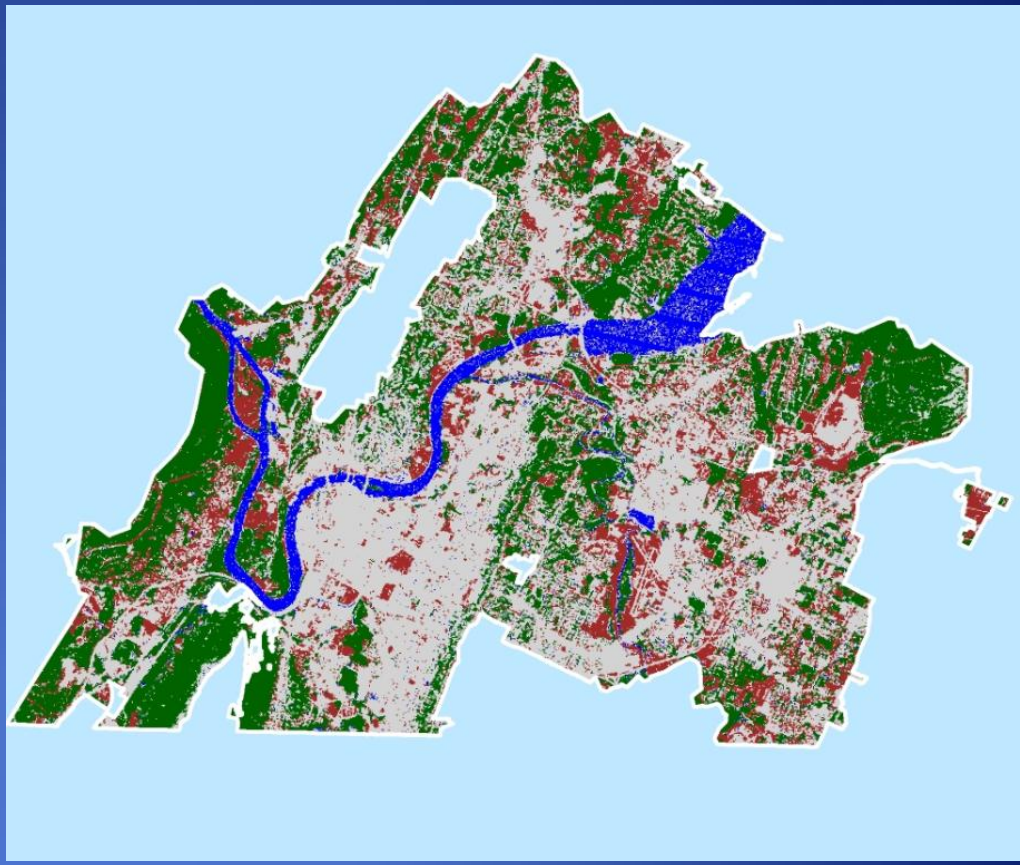
- Landsat data was radiometrically corrected to convert the raw Landsat data from digital numbers (DN) to spectral reflectance values
- All bands were “stacked” into one image and then the image was clipped to the extent of each city using the U.S. Census Bureau’s "designated places" datasets



Chattanooga - prior to clipping and classification

Image Classification

- A supervised classification process with a maximum likelihood classifier was chosen
- Four land cover classes were developed: water, developed, forest, and open.
- Fifty training sites for each class, in each city, were used

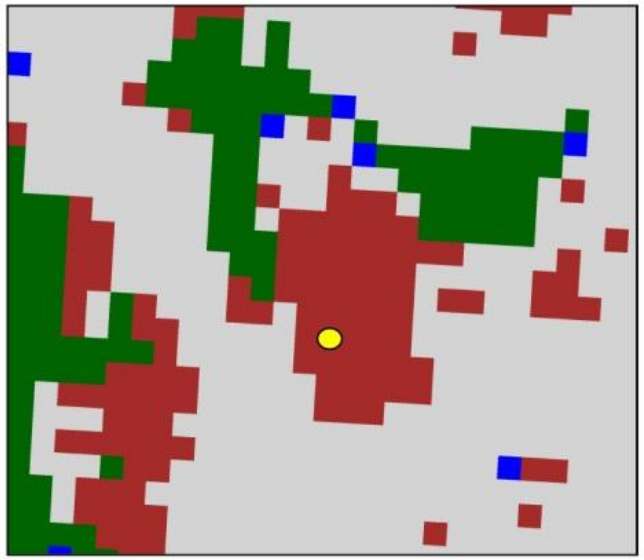


Chattanooga - after clipping and classification

Classification Accuracy Assessment

- A random sample for each class, developed within city
- Assessed actual status of 50 sample points per cover class
- Error matrices/commission tables developed

Forest
Open
Developed
Water
Sample point



Chattanooga - classified image

Chattanooga - air photo

Image Classification Results

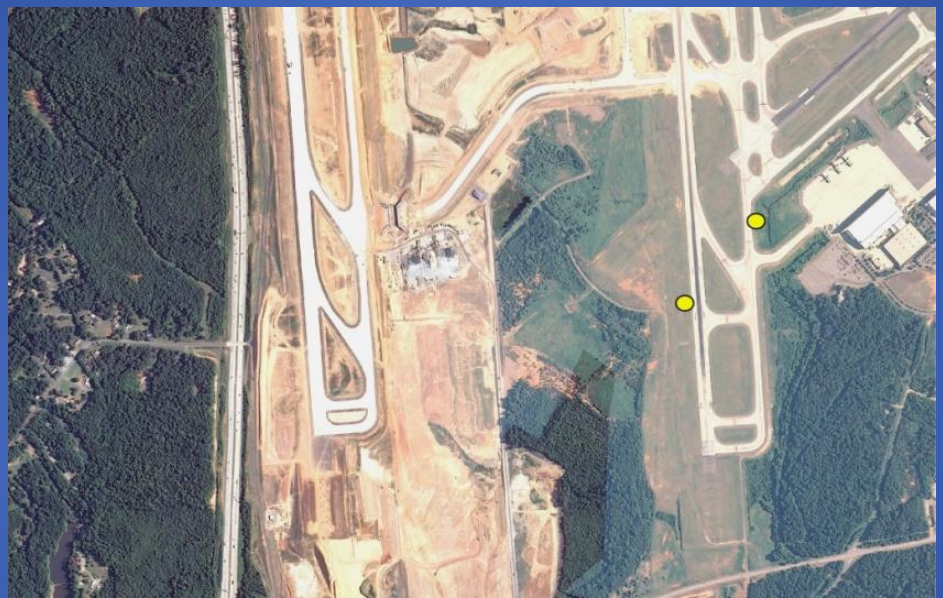
City	Overall accuracy (%)	Just the "open" class: Producer's accuracy (%)	Just the "open" class: User's accuracy (%)
Athens, GA	77.9	80.8	98.3
Atlanta, GA	84.2	86.4	63.3
Auburn, AL	68.7	79.0	81.7
Charlotte, NC	68.8	74.0	90.0
Chattanooga, TN	94.6	96.6	93.3
Columbia, SC	70.4	87.0	78.3
Greenville, SC	78.3	86.8	55.0
Hickory, NC	84.6	86.2	83.3
Laurens, SC	85.4	90.6	70.7
Lynchburg, VA	86.7	79.4	83.3
Mount Airy, NC	71.3	50.5	86.7
Richmond, VA	81.3	76.3	75.0
Roanoke, AL	74.2	54.6	73.5
South Boston, VA	82.1	69.1	96.7
Toccoa, GA	88.3	89.4	70.0

User's accuracy:
Error of commission.
Proportion pixels that are what they should be

Producer's accuracy:
Error of omission.
Proportion of a given class that is correctly labeled that class

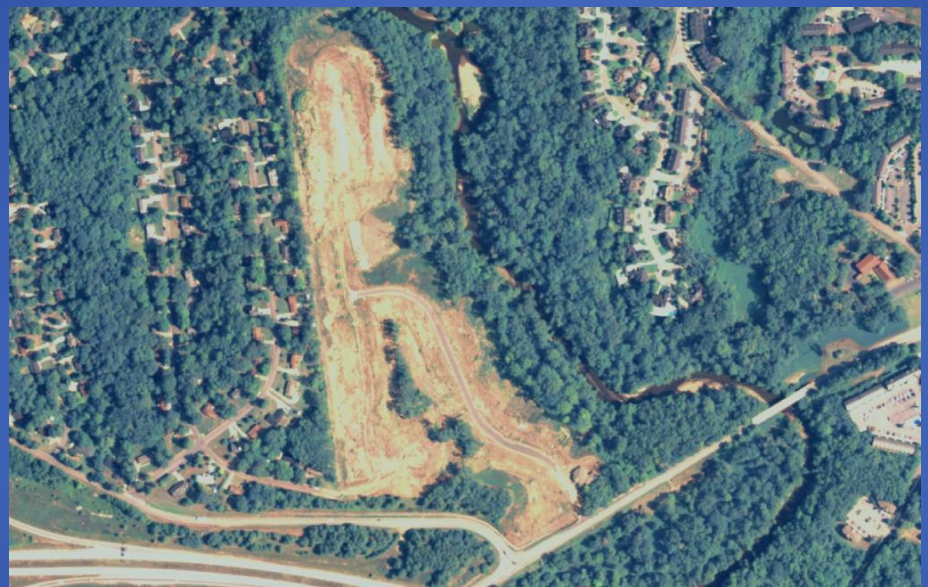
Assessment of the “Open Class”

- 100 independent points within the “open” class randomly sampled and classified as being either truly plantable or non-plantable
- Those points that were within residential lots, powerline cuts and right-of-ways, inside highway on/off ramps, farmland, edges of roadways that followed existing vegetation patterns, and forest clearings were all classified as plantable
- Areas around airports, sports facilities like baseball fields and golf courses, cemeteries, and public areas with a specific purpose were classified as non-plantable. Additionally, points that were misclassified as “open” were classified as non-plantable.



Assessment of the “Open Class”

- The classification process is fairly good and provides us with an estimate of **land cover**, but **not land use**
  - We can make assumptions about whether an area is plantable, but we are unaware of local or organizational policies regarding specific land uses
- In many of the cities, abandoned residential developments were identified within the "open" class as plantable
  - Debatable, given future intentions for these lands



Assessment of the "Open Class"

City	Total open area (ac)	Amount of city area (%)	Amount of open area plantable (%)	Plantable area in the city (ac)
Athens, GA	11,947	3.5	90	10,752
Atlanta, GA	26,981	7.0	64	17,268
Auburn, AL	19,073	7.0	74	14,114
Charlotte, NC	16,748	2.4	52	8,709
Chattanooga, TN	16,125	3.9	82	13,223
Columbia, SC	22,063	5.9	65	14,341
Greenville, SC	7,983	10.4	73	5,828
Hickory, NC	3,838	4.9	68	2,610
Laurens, SC	2,386	20.2	72	1,718
Lynchburg, VA	10,733	7.4	72	7,728
Mount Airy, NC	1,383	5.5	92	1,272
Richmond, VA	5,427	3.0	75	4,070
Roanoke, AL	2,538	4.6	84	2,132
South Boston, VA	1,750	4.9	82	1,435
Toccoa, GA	1,834	7.0	53	972
	150,809			106,171

About 70% of the open areas are plantable

About 3.4% of the total city area is plantable

Urban Forest Carbon Potential

- Cities account for about 4.6% of land area in the US South
- Total plantable area amounts to 840 thousand acres
- Assuming 100% planting rate, target storage of 100 tons of CO_2 per acre, and price of $20 per ton of CO_2, market size would amount to $1.7 billion in the US South
  - How much of plantable area can realistically be/will used to developed carbon projects?
  - How about other regions of the US?
  - How about the rest of the world?

Urban Forest Carbon Potential

- Plantable land ownership
  - Mostly private (90%+)
  - Need to develop targeted policies, incentives & technical assistance
  - City ordinances
- Develop one high-quality, consistent carbon offset standard for all urban forest carbon projects
- Develop dedicated trading platform for urban forest carbon offsets

Further Research

- Improve assessment accuracy
  - GIS (data sources and processes)
  - Plantable land
  - Portion of plantable land with actual potential for developing carbon projects
    - Regulations
    - Policy factors
    - Market factors
- Policy research
  - Develop effective tools facilitating carbon project development

Thank You

Forest Carbon Offset Standards

- CCX Standard
- American Carbon Registry (ACR) Forest Project Standard
  - Available for A/R, IFM and REDD projects in the US or non-Annex I countries
- Climate Action Reserve (CAR)
  - California Climate Action Registry (CCAR)
  - Available for R, REDD, IFM
  - Requires a 100-year crediting period
- Voluntary Carbon Standard (VCS)
  - ARR, ALM, REDD
- Climate, Community, Biodiversity (BCC) Standards

Assessment of the "Open Class"

- Higher spatial resolution imagery might lead to an increase in the accuracy of classification
  - These may not be freely available
- Lower levels of accuracy in the classification process may also be a result striping effect in Landsat images and the histogram matching process.
  - The data used to adjust the image may lead to a misclassifications