Characterizing Changes in Urban Green Space Over Two Decades

Vegetation in Charlotte, North Carolina, 1986-2005

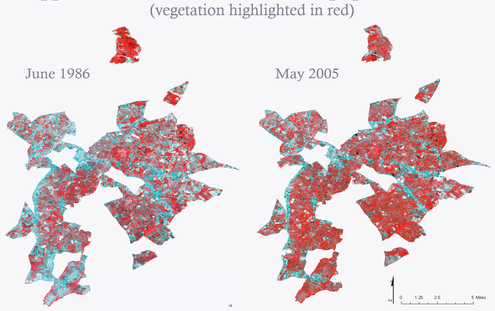
Nanda Chassot. Tufts University, CEE Department, May 2010

Introduction

Charlotte, NC (35°13′37″ N, 80°50′36″ W) is the largest city in North Carolina and has received attention by being named on several "best places" lists in the past several years. In 2008, Charlotte launched an initiative to increase public green spaces and parks . The City's 2015 Plan calls for increased attention to attractive urban space design in the downtown and surrounding areas.

I applied Landsat TM and U.S. Census Bureau Tiger files and Census 2000 information toward investigating how vegetation in Charlotte has changed in recent history and if green spaces were available equally to neighborhoods in Charlotte.

False Color Image of Charlotte, NC from Landsat TM images cropped to U.S. Census tracts with population >2500
(vegetation highlighted in red)



Methodology

While researchers have looked at classification of urban vegetation before, there were some specific challenges in this project: 1) all "ground truthing" would need to be done via Google Earth imagery, as vegetation maps, independent historical imagery, and actual ground knowledge is unavailable; 2) the method needed to be simple, and account for all vegetation within the region of interest, including vegetation only present at the sub-pixel scale.

I used multiple methods for initial classification of a May 2005 image of Charlotte into categories for "forest," "mixed vegetation," "low vegetation," and "none." These attempts were compared with 100 points representing each of the categories (T=400) located on historical 2005 imagery in Google Earth. The only method with an accuracy >70% was via NDVI density slices, and I then applied this method to images from June 1986, and also May 1995.

Classification Methodology

Classification of urban vegetation was attempted via

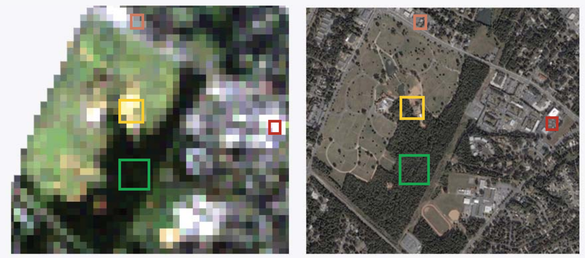
- Supervised (500+ pixels for each class in >8 polygons)
- Unsupervised using original image (K-means, 20 classes)
- Unsupervised using PCA (K-means,20 classes)
- Unsupervised using PCA Bands 1, 2, and NDVI (K-means,20 classes)
- NDVI calculation and density slices

Each classified image was simplified to four classes by combining classes through visual comparison with Google Earth imagery. These attempts were compared with 100 points representing each of the categories (T=400) located on historical 2005 imagery in Google Earth. The only method with an accuracy >70% was via NDVI density slices,

Accuracy Asssessment Table for
NDVI Density Slice Classification

	high	*mixed*	*low*	*none*
high	**100**	7	0	0
mixed	0	**93**	4	0
low	0	0	**96**	0
none	0	0	0	**100**

Urban Vegetation and Landsat Imagery

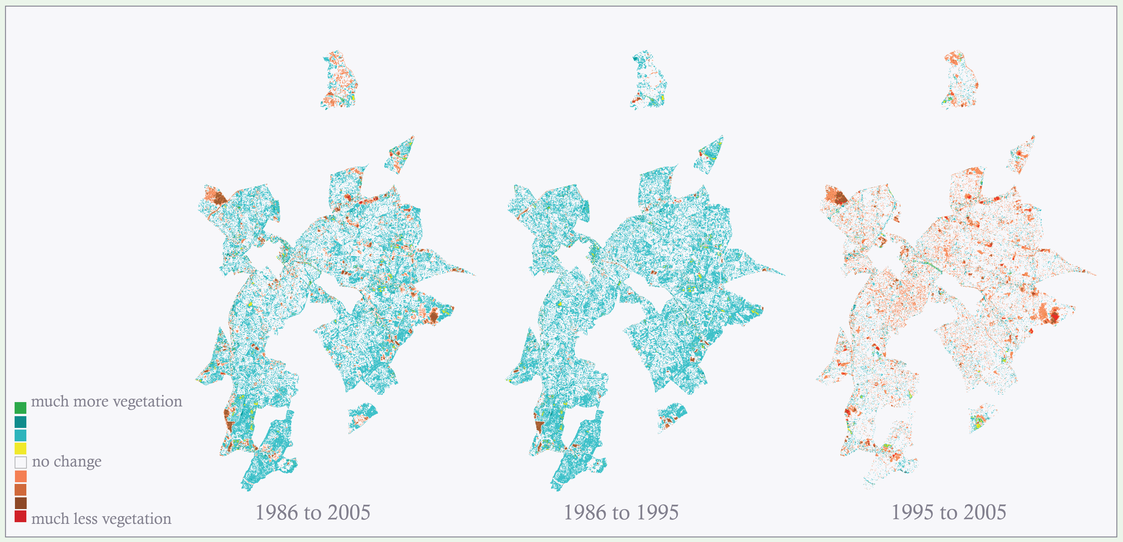


Landsat TM Image | Google Earth Image

Investigating vegetation in urban areas using Landsat TM poses challenges because vegetation presence is often at the sub-pixel scale, and surrounding areas (pavement, soil, gravel, buildings, etc) are largely heterogeneous. Additionally, vegetation in urban areas varies between gardens, fields, highway buffer, forests, etc. Examples featured above include: Forest (■)
Mixed vegetation – grass with patches or overlapping pathways (■)
Low Vegetation – vegetation located within a parking lot (■)
None – buildings, paved lots (■)

Sources: TIGER Shapefiles and Demographic Data: U.S. Census Bureau (census.gov) – Landsat TM Imagery: NASA (landsat.gsfc.nasa.gov) – Charlotte City Plans and Initiatives: Charlotte-Mecklenberg website (charmeck.gov) and the Charlotte Observer (www.charlotteobserver.com)

Results, Implications, Future Directions



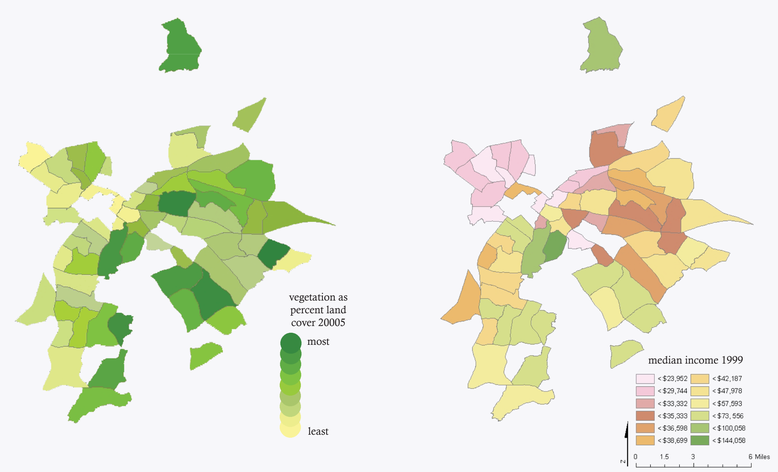
While an increase of vegetation is seen between 1986 and 2005, most occurs between 1986 and 1995, largely due to maturation of vegetation in areas developed during the 1970s and 1980s. Areas under heavy development during 1986 to 1995 and 1995 to 2005 see large losses in vegetation. Losses of vegetation occur generally during the 1995 to 2005. The reaction to these losses is reflected in city plans and initiatives created during the 2000s to increase green space in Charlotte.

Between resources available from Mecklenberg County and North Carolina's state GIS office, one could compile a useful set of map layers including roads, parks, land-use types, and even accurate building footprints for certain areas within Charlotte. While compiling and organizing these layers would require additional time, knowledge of this information could be combined with NDVI to create more accurate and useful vegetation classification.

Vegetation on ball fields had similar visual characteristics to vegetation near highways and construction sites: but each has a different value to the respective neighborhood. Additionally, green spaces in an urban environment are linked to other characteristics of the urban environment such as economy and the values held by the population, and in order to explore these relationships, more detail on the nature of spaces is needed.

For future studies, I would like to incorporate land use type, building and roadway footprints, and other physical characteristics of the urban landscape in the classification of urban vegetation to create highly detailed classification schemes that can differentiate the relative value of the vegetation to the residents of Charlotte.

Visual Comparison of Vegetation and
Income Characteristics by Census Tract



Pearson correlation coefficients calculated with land area classified as high or mixed vegetation and median income in 1995 show significant positive relationships ($p < 0.01$) for 1995 and 2005 images (1995, 0.50; 2005, 0.36). This suggests that statistical investigation of vegetation relationships to urban demographics may yield interesting results that could influence city planning or environmental justice concerns. I suggest further investigation using more detailed vegetation classification.