Two Decades of Change in New York City Greenspace
1990 - 2010

New York City's Urban Forest

This research project is part of a larger National Science Foundation-funded program for exploratory cross-disciplinary research in Urban Long-Term Research Areas (ULTRA-Ex). The NYC-ULTRA-Ex program focuses on interactions between spatial ecology, ecosystem services and stewardship in New York City's urban forest.

To quantify the spatial and temporal changes in NYC's urban forest we use a combination of satellite and airborne imagery in conjunction with field observations collected by NYC Parks staff. Optical sensors on the LANDSAT satellites have imaged NYC hundreds of times in the past two decades. The sensors measure the brightness of reflected sunlight at both visible and infrared wavelengths in much the same way digital cameras do for visible light. Vegetation is distinguished from other materials by its extreme brightness at Near-Infrared wavelengths and by the absorption of visible red and blue light by chlorophyll. In order to quantify changes in vegetation cover it is necessary to calibrate the LANDSAT images through time and validate the accuracy of the vegetation abundance estimates with high resolution imagery and field observations.

The vegetation abundance in each LANDSAT pixel is estimated by unmixing the color of the vegetation from the colors of other materials in the area imaged by the pixel. Each 30x30 m pixel imaged by LANDSAT is a spatial average of many illuminated surfaces + shadow. Even though LANDSAT cannot resolve individual trees, every illuminated tree contributes to the aggregate reflected radiance imaged by LANDSAT. Every illuminated leaf contributes to the measured signal. At 30 m resolution, almost all urban pixels imaged by LANDSAT are spectral mixtures.

Time As Color

Multispectral satellite images have several spectral bands that can be shown in many combinations using an RGB composite renderer, depending on what landscape feature needs to be highlighted. Some band combinations produce an image very similar to what humans see called a natural color image. False color composite images, however, display information outside of the visible color spectrum by assigning "false colors" to wavelengths that the human eye can't see.

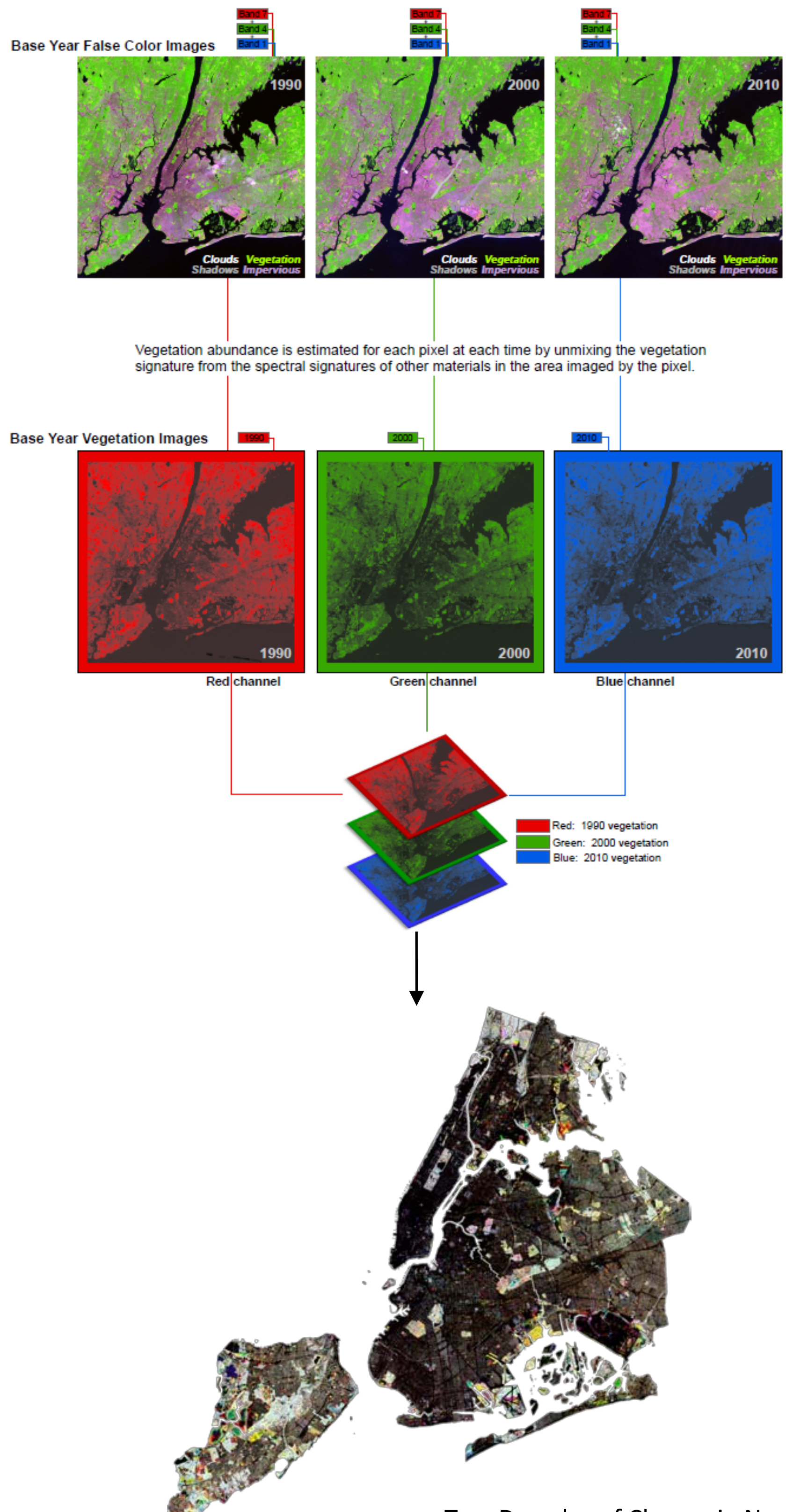
Band 1 detects visible blue light useful for imaging water clarity and thin clouds. Band 4 detects Near infrared light useful for discriminating vegetation from other dark materials. Band 7 detects Shortwave infrared light useful for detecting leaf water content and soil moisture.

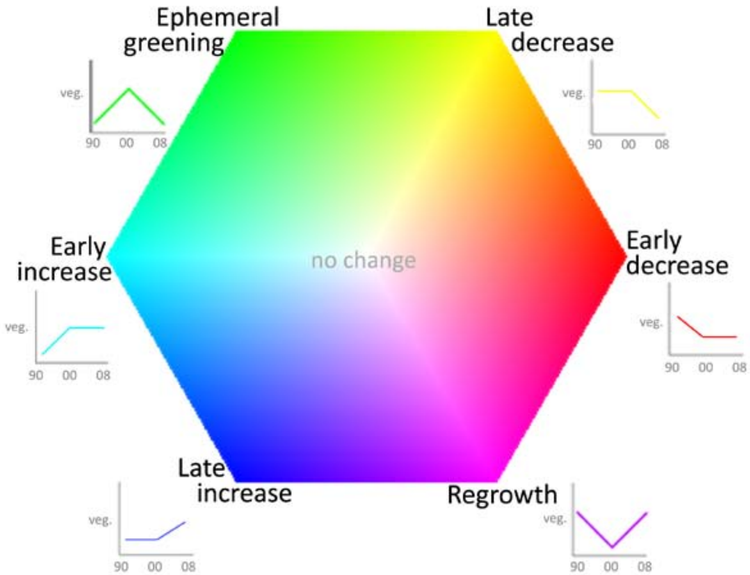
In the Base Year False Color Images below, band 7 is assigned to the red channel, band 4 to the green channel, and band 1 to the blue channel. This band combination was chosen because it clearly differentiates between vegetation, soil, building materials and water. Vegetation appears as varying shades of green; grassy areas are brighter green while forested areas are darker green. Impervious surfaces such as buildings and roads appear as pink or gray.

Vegetation abundance is estimated for each pixel at each time by unmixing the vegetation signature from the spectral signatures of other materials in the area imaged by the pixel. Other materials can include water, rock, buildings, shadows and bare ground.

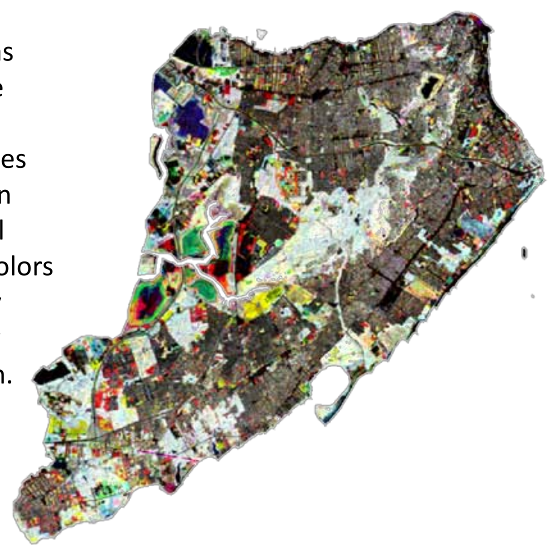
Small, Lu and Braden, October 2010

Instead of displaying three bands from a single image, we are combining three different satellite images into one tritemporal composite image by displaying a different image on each RGB channel. The resulting tri-temporal image represents the abundance of vegetation at each time as red, green or blue brightness. The relative brightnesses of red, green and blue are then superimposed in a single image.





When primary colors (red, green and blue) are mixed in equal proportions the result is a shade of gray between black and white. Equal proportions of vegetation through time imply little change. Areas where vegetation has not changed significantly over three decades are therefore gray. The brightness of the gray shade indicates the abundance of vegetation. When primary colors are mixed in unequal proportions, the result is a color. Colors imply change. Brighter colors imply greater change. Darker colors imply change in areas with less vegetation.



For further information:
http://www.ldeo.columbia.edu/~small/NYCveg.html
http://www.nsf.gov/pubs/2009/nsf09551/nsf09551.htm

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