

# Urban Tree Canopy Assessment for Miami-Dade County: A Regional Approach

Adam R. Benjamin<sup>1</sup>, Hartwig H. Hochmair<sup>1</sup>, Daniel Gann<sup>2</sup>, Zhaohui Jennifer Fu<sup>2</sup>



<sup>1</sup> – University of Florida Geomatics Program, Fort Lauderdale Research & Education Center, Fort Lauderdale, FL - <http://flrec.ifas.ufl.edu/geomatics/>  
<sup>2</sup> – Florida International University GIS Center, Miami, FL - <http://maps.fiu.edu/gis/>



## Abstract

The University of Florida (UF) and Florida International University (FIU) collaborated in assessing urban tree canopy (UTC) within the Urban Development Boundary of Miami-Dade County, as defined by the Miami-Dade Metropolitan Planning Organization (MPO). The analysis estimated the area with current tree canopy (existing UTC), the area of potential tree canopy (possible UTC), and the area currently unsuitable for tree canopy, based on various other land cover categories. The study uses multispectral satellite imagery together with selected vector feature layers for analysis and classification of land cover data. Based on the generated land cover classification map, a Geographic Information System (GIS) was used to estimate the existing and possible UTC for predefined areal units (e.g., census places, census block groups, property parcels, zip codes) and by land use type. Percent of existing UTC was related to socioeconomic and health variables at various spatial aggregation levels. Furthermore, the study used satellite imagery (Landsat ETM) to generate a surface heat map and to relate surface temperatures to the mix of land cover categories.

## Objectives

- Estimate areal extent of existing and possible urban tree canopy within the Urban Development Boundary of Miami-Dade County using land cover classification
- Assess relationship between land cover types (e.g., existing UTC) and environmental/socioeconomic variables (e.g., land use, surface temperature)

## Study Area

Excluding intracoastal water areas, the Urban Development Boundary for Miami Dade County (Fig. 1) encompasses approximately 1150 km<sup>2</sup> (444 mi<sup>2</sup>).

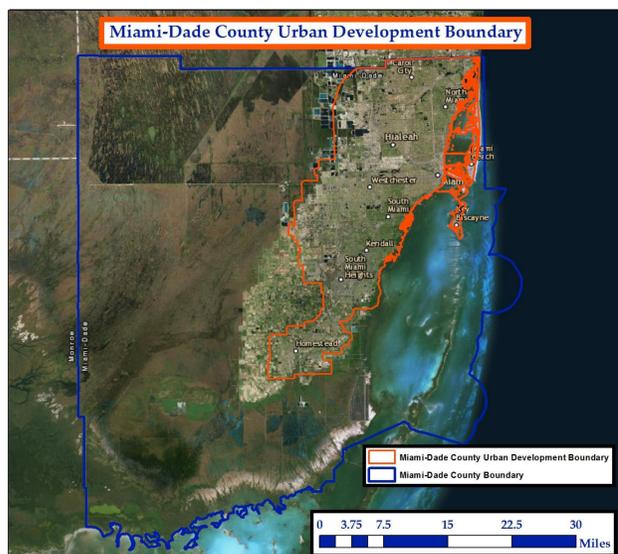


Fig. 1 – Urban Development Boundary for Miami-Dade County

## Land Cover Classification

A land cover classification map (Fig. 4) was generated using WorldView-2 satellite imagery data acquired between 2011 and 2014. The final 9 class land cover classification map has a bias adjusted accuracy of 90%. The initial land cover detection was based on a random forest classification algorithm (Liaw & Wiener, 2002; Svetnik et al., 2003) in the caret R-package (Kuhn & Team, 2014), which used the WV2 spectral information (8 band spectral resolution, 2m spatial resolution).

Various vector data layers (Fig. 2), provided by Miami-Dade County, were incorporated into the map generation process for quality enhancement after the initial classification.

Land cover class distribution (Fig. 3) shows existing tree canopy (including shrubs) covers 19.9% (~88 mi<sup>2</sup>). Possible tree canopy, which includes grass, bare ground, and impervious surfaces (e.g. parking lots, but not buildings, streets, or railroads) covers an additional 44.2% (~196 mi<sup>2</sup>).

Fig. 2 – Vector data layers used in classification

VECTOR LAYER	LAYER TYPE
Large Buildings	Polygons
Small Buildings	Points buffered with 5m radius
Edge of Pavement	Polylines converted to polygons
Railroads	Polylines buffered with 3m distance
Water Bodies	Polygons
Agricultural Areas	Polygons

Fig. 3 – Land cover class distribution

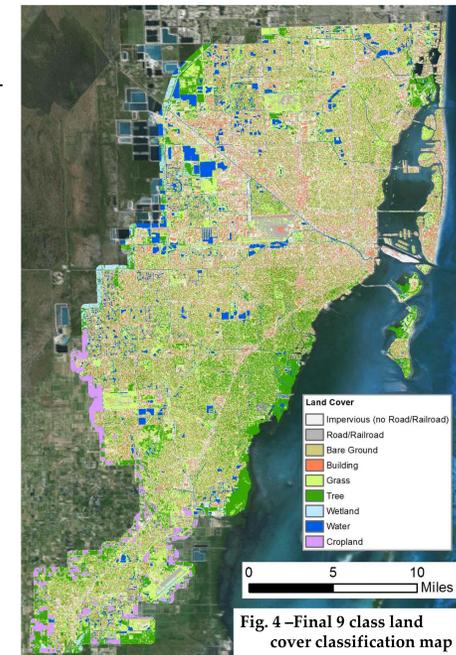
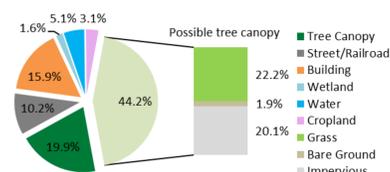


Fig. 4 – Final 9 class land cover classification map

## Surface Temperature Analysis

A surface temperature map (Fig. 5) was derived from the Landsat Enhanced Thematic Mapper (ETM) thermal band acquired November 2011 to determine the relationship between land cover mix and surface temperature (Fig. 6). Hot spots occur primarily in areas with sparse tree canopy and large buildings surrounded by parking lots. Cool spots are in areas around water bodies and with higher UTC density and grass land (e.g., golf courses).

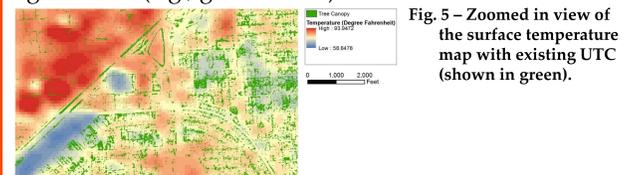
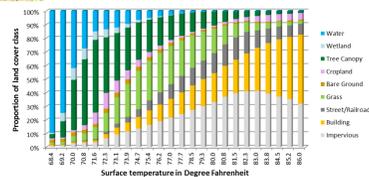


Fig. 5 – Zoomed in view of the surface temperature map with existing UTC (shown in green).

Fig. 6 – The relationship between land cover mix and surface temperature shows the cooling effect of water and trees is evident at lower surface temperatures.



## Land Use Pattern Analysis

To investigate the tree canopy/ land use relationship, the 9 land cover classes were reclassified based on UTC type:

UTC TYPE	LAND COVER CLASS
Existing UTC	Trees/shrubs
Possible UTC – Vegetation	Grass, bare ground
Possible UTC – Impervious	Impervious surface (e.g. asphalt) excluding streets/railroads & buildings
Not Suitable	Streets/railroads, buildings, wetland, water, cropland

UTC types were summarized by land use category (Fig. 7) based on selected land use categories from the FDOT 2014 land use classification map.

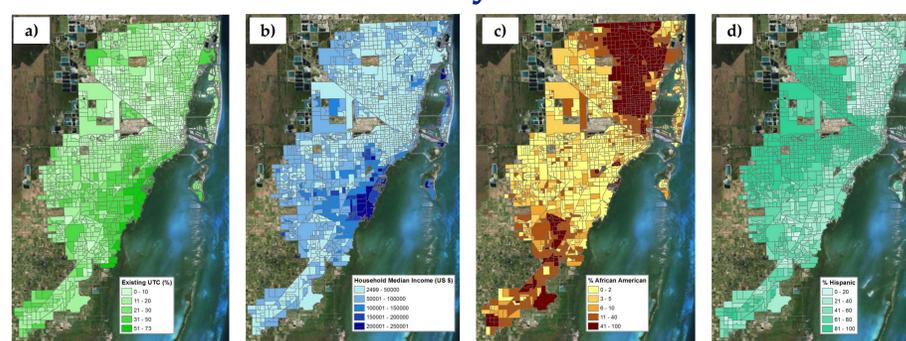
Land use	EXISTING UTC			POSSIBLE UTC - VEGETATION			POSSIBLE UTC - IMPERVIOUS		
	% Land	% Category	% UTC Type	% Land	% Category	% UTC Type	% Land	% Category	% UTC Type
Industrial	0%	5%	1%	1%	11%	2%	2%	44%	9%
Institutional	1%	17%	3%	1%	34%	5%	1%	31%	6%
Office/Business	0%	12%	1%	0%	11%	0%	0%	47%	2%
Public Schools	0%	9%	1%	0%	36%	2%	0%	22%	2%
Recreation	1%	30%	7%	2%	51%	8%	1%	12%	2%
Res. - Multiple Family	1%	12%	3%	1%	14%	3%	2%	38%	8%
Res. - Single Family	7%	26%	37%	8%	26%	28%	6%	21%	27%
Res. - Townhouse	0%	15%	1%	0%	17%	1%	0%	28%	2%
Res. - Two Family (Duplex)	0%	17%	1%	0%	21%	1%	0%	28%	2%
Shopping Center	0%	5%	0%	0%	8%	0%	0%	51%	1%

Fig. 7 – For the 8 dominant land use types, UTC metrics were computed as a percentage of the total study area (% Land), as a percentage of the land area by land use category (% Category), and as a percentage of the area for the UTC type relative to the total study area (% UTC Type).

## Socioeconomic Data Analysis

Tree canopy distribution patterns among certain population groups were analyzed by using socioeconomic data (Fig. 8) from the America Community Survey 2010-2014 5-year estimate.

Fig. 8 – For 1,525 populated census tracts within the study area, these maps visualize the percent of existing tree canopy (a), mean annual household income in US \$ (b), percent African American population (c), and percent Hispanic population (d).



## Health Data Analysis

The relationship between asthma related hospitalization rates and the density of existing urban tree canopy was explored at the zip code level within the Urban Development Boundary in Fig. 9.

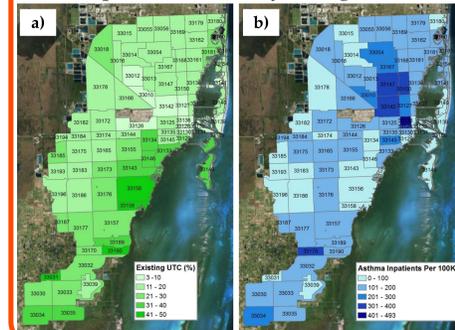


Fig. 9 – For 78 populated zip codes within the study area, these maps visualize the percent of existing tree canopy (a) and asthma inpatient rate per 100,000 residents (b).

## Conclusions

- Urban tree canopy (UTC) was 19.9% within Miami Dade County's Urban Development Boundary (UDB).
- Great potential for additional UTC within the UDB
  - Areas consist of both pervious surfaces (grass, bare ground) and impervious surfaces (asphalt)
- Residential housing represents 42% of existing UTC & 33% of potential UTC within the UDB.
- Tree canopy, grass, and water bodies are associated with lower surface temperatures.
- Tree canopy is positively correlated with median income, but negatively correlated with percentage of African American and Hispanic residents.
  - Strategically planting trees in minority & lower income communities can support environmental equity.
- Higher UTC is associated with both lower overall hospitalizations & lower asthma related hospitalizations.
  - Since UTC is positively correlated with income, this association can at least be partially attributed to higher income and the healthier lifestyle associated with higher income.
- This project does not study specific tree species. To catalog the species that comprise the UTC, ground surveys or higher spatial and spectral (hyperspectral) remotely sensed data sets are required.

## Acknowledgements

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