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Adam R. Benjamin
University of Florida

Hartwig H. Hochmair
University of Florida

Daniel Gann
GIS-RS Center, Florida International University, gannd@fiu.edu

Zhaohui Jennifer Fu
GIS-RS Center, Florida International University, Fujen@fiu.edu

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Adam R. Benjamin[1], Hartwig H. Hochmair[1], Daniel Gann[2], Zhaohui Jennifer Fu[2]

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

Abstract

Two of the Florida state universities, University of Florida (UF) and Florida International University (FIU), collaborated in assessing urban tree cover (UTC) for part of northwestern Miami-Dade County, covering an area of approximately 380 km² (147 mi²). The analysis estimated the area with current tree canopy (existing UTC), the area of potential tree canopy (possible UTC), and various other land cover categories. The assessment used two methods to establish those estimates. The first method utilized the i-Tree canopy assessment tool provided by the USDA Forest Service. The second method used a combination of multi-spectral satellite data and airborne Light Detection and Ranging (LiDAR) datasets for detection and classification of land cover. Classification results were further analyzed in a Geographic Information System (GIS) to relate land cover distribution patterns (obtained from the second land cover classification method) to surface temperatures, land use patterns, and socioeconomic factors.

Objectives

- Estimate areal extent of existing and possible urban tree canopy in an urbanized area of Miami-Dade County using two methods: i-Tree canopy assessment & 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

With approximately 1,080 km² of urban area in Miami-Dade County, the 380 km² study area was chosen as a representative urban area study site.

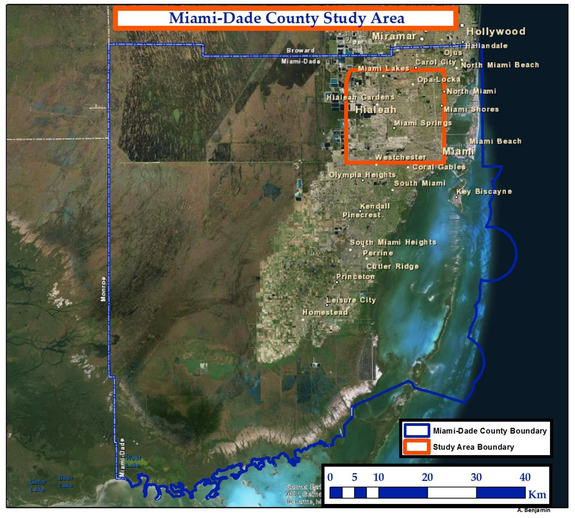

Fig. 1 –Study area located in an urbanized area of Miami-Dade County

i-Tree Canopy Assessment

The USDA Forest Service's i-Tree Canopy online application was used to estimate tree coverage and other land cover classes within the study area (Fig. 2). Statistical results (Fig. 3) indicate buildings, grass, and impervious surfaces are the most common land cover types in the study area while bare ground and wetlands were the least common.

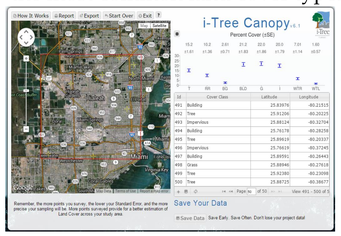

Fig. 2 – The i-Tree Canopy application randomly laid 500 sample points onto Google base map imagery for classification by the user.

Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree/shrub	T	76	15.2 ±1.61
Road	Road/railroad	RR	51	10.2 ±1.36
Bare ground	Bare ground	BG	13	2.61 ±0.71
Building	Building	BLD	106	21.2 ±1.83
Grass	Grass	G	110	22.0 ±1.86
Impervious	Impervious	I	100	20.0 ±1.79
Water	Water	WTR	35	7.01 ±1.14
Wetland	Wetland	WTL	8	1.60 ±0.57

Fig. 3 – Statistical estimate of percent cover in each of the 8 land cover classes along with an estimate of the uncertainty of the estimate.

Land Cover Classification

A land cover classification map (Fig. 4) was generated using a combination of WorldView-2 satellite imagery data acquired between 2011 and 2014 and 2008 LiDAR data. The final land cover classification map with its 8 classes has a bias adjusted accuracy of 95%. 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 res., 2m spatial res.) and LiDAR-derived object heights. Various vector data layers, provided by Miami-Dade County, were incorporated into the map generation process for quality enhancement after the initial classification. The vector layers included: large buildings (polygons), small buildings (points buffered with a 3m radius), edge of pavement (polylines converted to polygons), railroads (polylines buffered with a 3m distance), and water bodies (polygons).

Land cover class distribution (Fig. 5) shows existing tree canopy (including shrubs) covers 12.2% (~46 km²). Possible tree canopy, which includes grass, bare ground, and impervious surfaces (e.g. parking lots, but not buildings, streets, or railroads) covers an additional 48.9% (~185 km²).

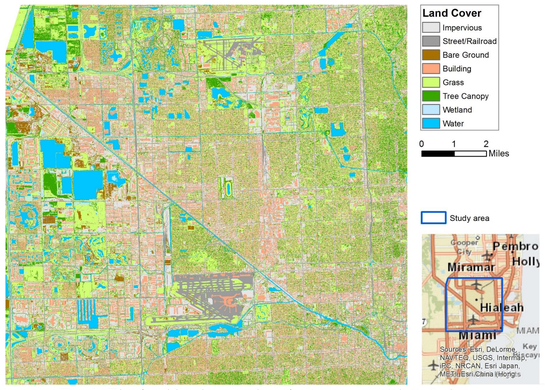

Fig. 4 –The final land cover classification map with its 8 classes.

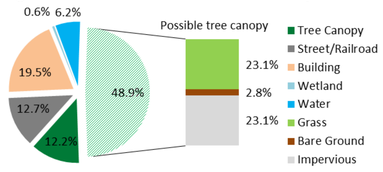

Fig. 5 –Land cover class distribution.

Surface Temperature Analysis

A surface temperature map (Fig. 7) was derived from the Landsat Enhanced Thematic Mapper (ETM) thermal band to determine the relationship between land cover mix and surface temperature (Fig. 8). 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).

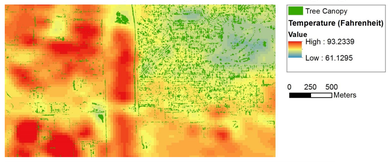

Fig. 7 – Zoomed in view of the surface temperature map with existing UTC (shown in green).

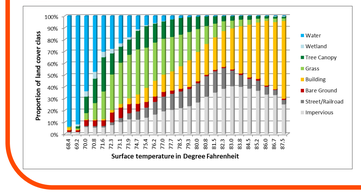

Fig. 8 –The relationship between land cover mix and surface temperature shows the cooling effect of water and trees is evident at lower temperatures.

Land Use Pattern Analysis

To investigate the tree canopy and land use relationship, the 8 existing 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

UTC types were summarized by land use category (Fig. 9) based on selected land use categories from the FDOT 2014 land use classification map.

	Existing UTC			Possible UTC-Vegetation			Possible UTC-Impervious		
Land use	*% Land*	*% Category*	*% UTC Type*	*% Land*	*% Category*	*% UTC Type*	*% Land*	*% Category*	*% UTC Type*
Industrial	1%	4%	5%	2%	12%	6%	5%	42%	25%
Institutional	0%	14%	4%	1%	37%	5%	1%	27%	4%
Public/semi-pub.	1%	6%	7%	5%	40%	22%	3%	20%	12%
Recreation	0%	10%	3%	1%	38%	5%	0%	12%	2%
Residential	7% (*)	21% (**)	62% (***)	9%	26%	37%	4%	12%	20%
Retail/office	1%	8%	7%	2%	14%	7%	5%	48%	24%
Vacant nonres.	1%	11%	8%	3%	35%	11%	2%	23%	8%
Vacant res.	1%	12%	8%	2%	20%	6%	2%	30%	11%

Notes:
% Land = (Area of UTC type for specified land use) / (Area of all land)
(*) 7% of the land in the study area has tree canopy and falls into the "Residential" land use category.

% Category = (Area of UTC type for specified land use) / (Area of all land for specified land use)
(**) 21% of residential land is covered by tree canopy.

% UTC Type = (Area of UTC type for specified land use) / (Area of all land for specified UTC Type)
(***) 62% of all existing tree canopy lies in the residential land use.

Fig. 9 – 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 Variables

Tree canopy distribution patterns among certain population groups were analyzed by using socioeconomic data (Fig. 10) from the America Community Survey (2008-2012).

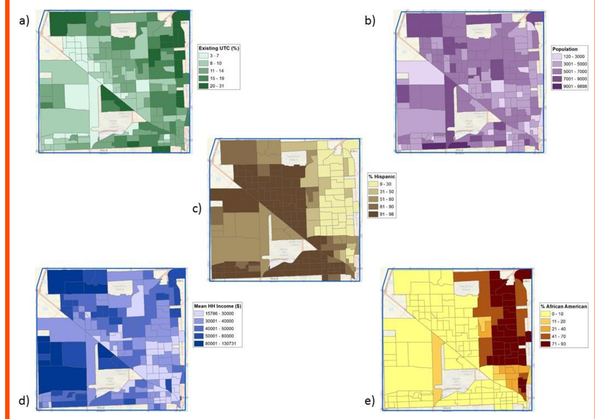

Fig. 10 – For 169 populated census tracts within the study area, these maps visualize the percent of existing tree canopy (a), population size (b), percent African American population (c), mean annual household income in US $ (d), and percent African American population (e).

Conclusions

- Urban tree canopy (UTC) in 2012 was 12.2%.
- The study area offers great potential for additional UTC.
  - Areas consist of approx. equal parts pervious surfaces (grass, bare ground) & impervious surfaces (asphalt)
- Residential housing (vacant & non-vacant) represent 70% of existing UTC in the study area.
- Tree canopy, grass, and water bodies are associated with lower surface temperatures.
- This project does not study the specific species of trees that are present in the project area. In order to catalog the species that compose the urban tree canopy, ground surveys or higher spatial and spectral (hyperspectral) remotely sensed data sets would be required.

Acknowledgements

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