A Report on Prince George's County's Existing and Possible Tree Canopy

Why is Tree Canopy Important?

Tree canopy (TC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. Tree canopy provides many benefits to communities, improving water quality, saving energy, lowering city temperatures, reducing air pollution, enhancing property values, providing wildlife habitat, facilitating social and educational opportunities, and providing aesthetic benefits. Establishing a tree canopy goal is crucial for communities seeking to improve their green infrastructure. A tree canopy assessment is the first step in this goal-setting process, providing estimates for the amount of tree canopy currently present in a county as well as the amount of tree canopy that could theoretically be established.

Prince George's County's Tree Canopy

An analysis of the county's tree canopy based on land cover data derived from high-resolution aerial imagery and LiDAR (Figure 1) found that 160,947 acres of the county were covered by tree canopy (termed Existing TC), representing 50% of the entire county (including water) and 52% of all land in the county. An additional 39% (120,637 acres) of the county could theoretically be modified (termed Possible TC) to accommodate tree canopy (Figure 2). In the Possible TC category, 7% (22,021 acres) of the county was classified as Impervious Possible TC and 32% was Vegetated Possible TC (98,615 acres). Vegetated Possible TC, or grass and shrubs, is more conducive to establishing new tree canopy, but establishing tree canopy on areas classified as Impervious Possible TC will have a greater impact on water quality and summer temperatures.

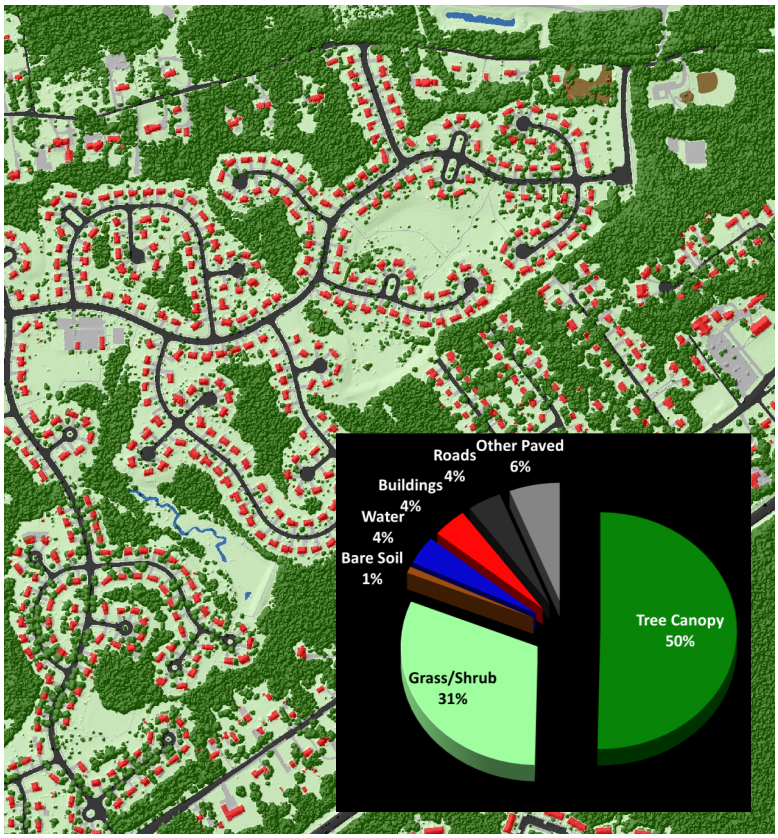


Figure 1: Land cover derived from high-resolution aerial imagery for Prince George's County. Percentages are relative to the entire county, including water, resulting in a lower percentage of tree canopy than in Figure 2.

Project Background

The goal of the project was to apply the USDA Forest Service's TC assessment protocols to Prince George's County. This analysis was conducted based on year 2009 data. Funded by The Maryland-National Capital Park and Planning Commission (M-NCPPC), this analysis of the county's tree canopy (TC) was conducted in collaboration with M-NCPPC and the USDA Forest Service's Northern Research Station. The Spatial Analysis Laboratory (SAL) at the University of Vermont's Rubenstein School of the Environment and Natural Resources conducted the assessment.

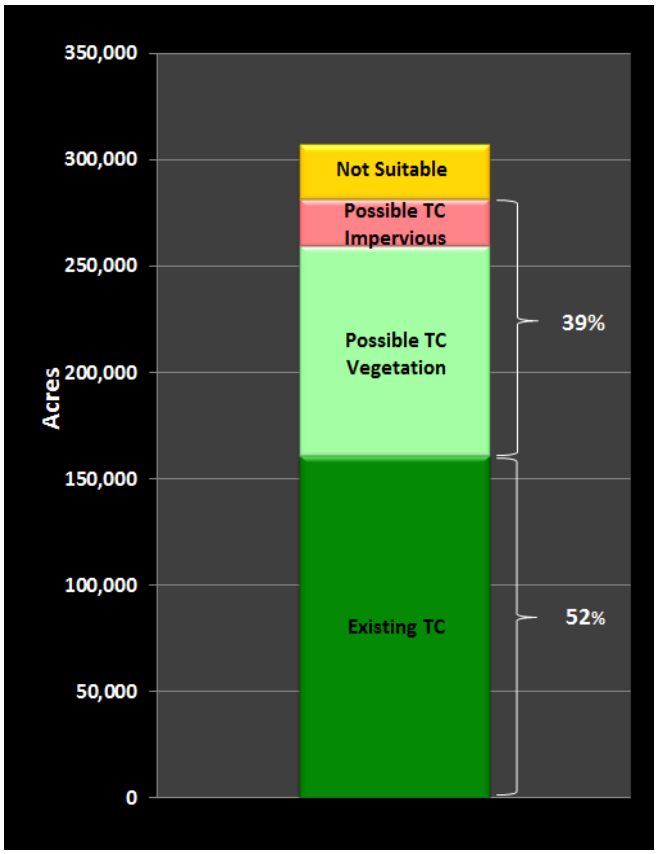


Figure 2: TC metrics for Prince George's County based on % of land area covered by each TC type. TC Metrics exclude water.

Key Terms

TC: Tree canopy (TC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above.

Land Cover: Physical features on the earth mapped from aerial or satellite imagery, such as trees, grass, water, and impervious surfaces.

Existing TC: The amount of tree canopy (urban and forests) present when viewed from above using aerial or satellite imagery.

Possible TC Impervious: Asphalt or concrete surfaces, excluding roads and buildings, that are theoretically available for the establishment of tree canopy.

Possible TC Vegetation: Grass or shrub area that is theoretically available for the establishment of tree canopy.

Not Suitable: Areas where trees cannot typically be planted, primarily buildings and roads.

Mapping Prince George's County's Trees

Prior to this study, an analysis was conducted to determine recommended tree canopy goals for the 2002 General Plan. Manual interpretation was used to map tree and forest canopy from aerial photographs (Figure 3a). At the time, the only aerial photographs available were "leaf-off," making delineation of the canopy difficult. The results of the 2002 tree and forest canopy study did not capture individual trees, and as a result the canopy percentages reported (45% countywide) were lower than those found in the current study (52% countywide). The 2009 tree canopy assessment (Figure 3b) was able to make use of the county's latest LiDAR data set (Figure 3c), which when combined with advanced automated processing techniques, enabled trees as short as 6-ft tall to be mapped Figure 3c).

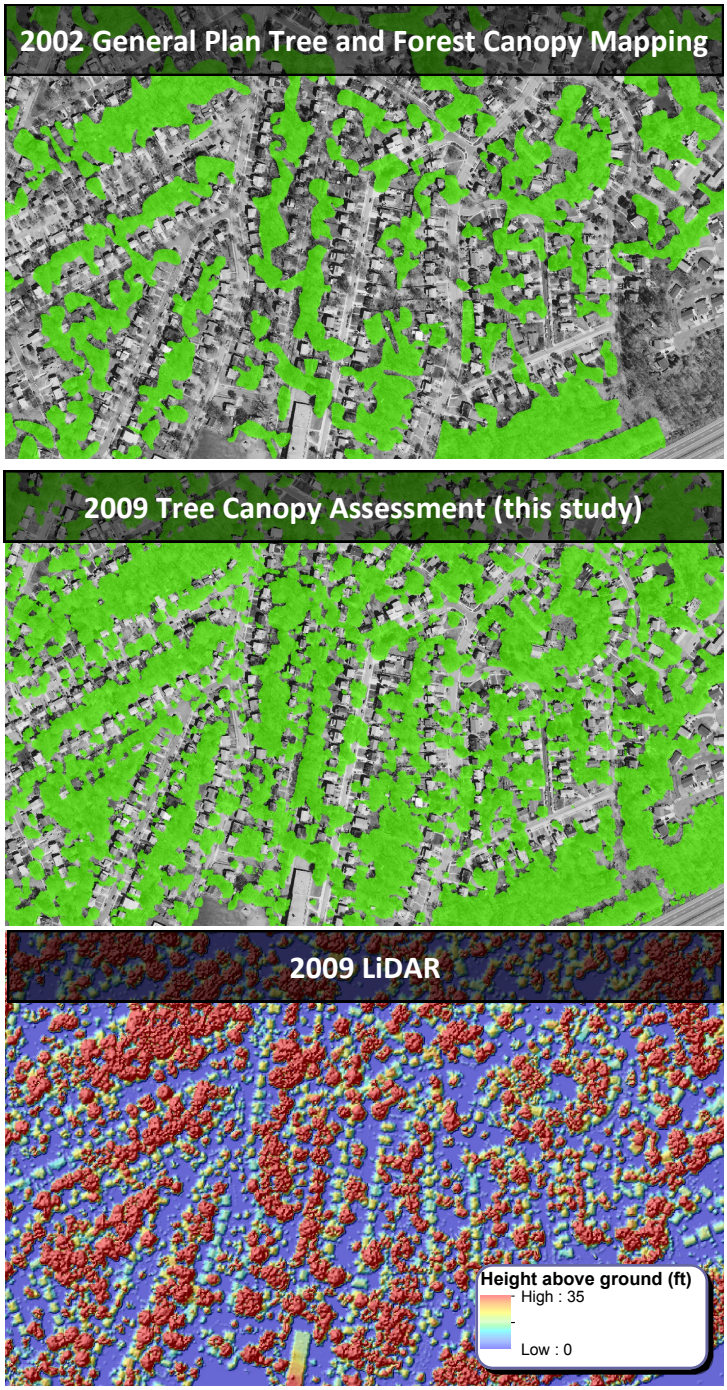


Figure 3a, 3b, 3c: Comparison of previous (2002) and current (2009) approaches to tree canopy mapping

Parcel Summary

Tree Canopy (TC) metrics were summarized for each property in the county's parcel database using the land cover data (Figure 4). Existing TC and Possible TC metrics were calculated for each parcel, both in terms of total area and as a percentage of the land area within each parcel (TC area ÷ land area of the parcel).

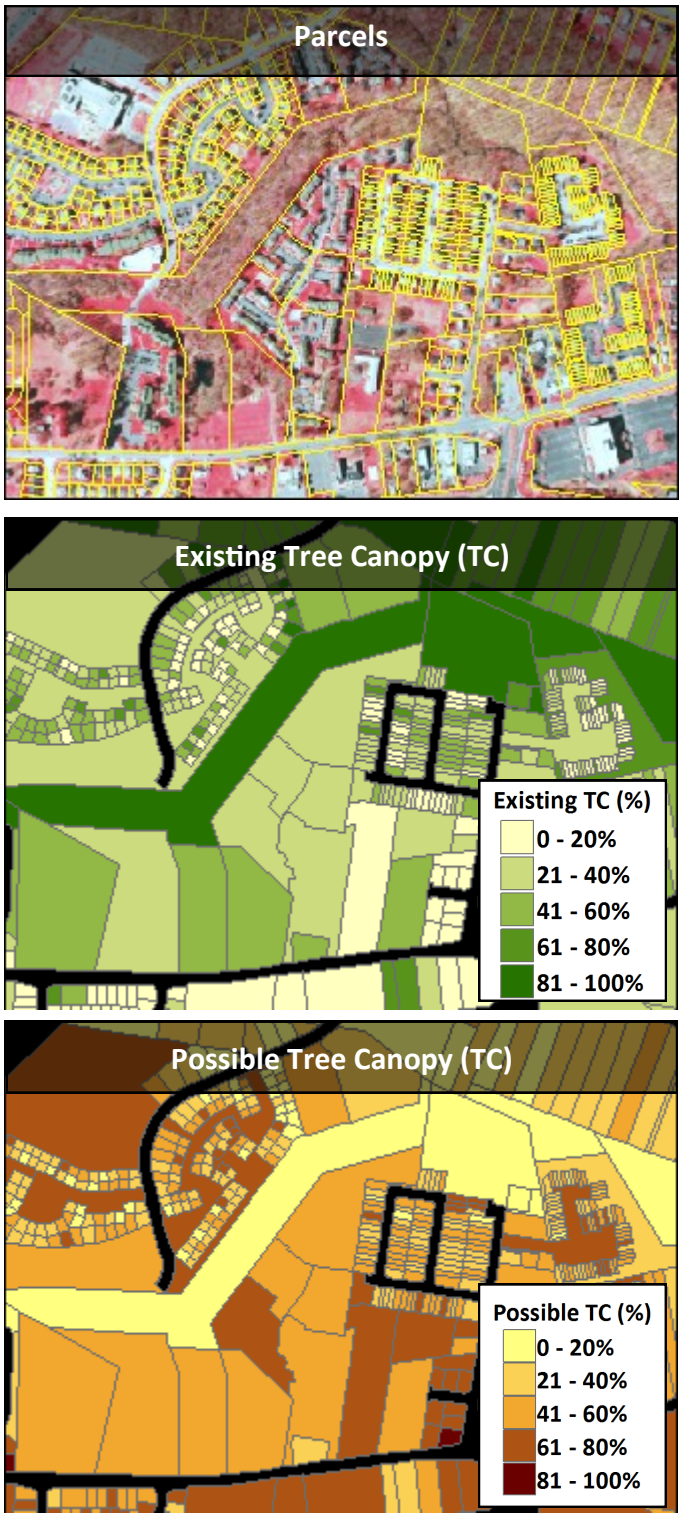


Figure 4a, 4b, 4c: Parcel-based TC metrics. TC metrics are generated at the parcel level, allowing each property to be evaluated according to its Existing TC and Possible TC.

Zoning

A similar analysis was performed on Prince George's County's zoning classes (selected zones are shown in Figure 5 and Table 1). In contrast to land use, which indicates the nature and extent of actual landscape features, zoning is a planning tool that indicates where specific land uses are encouraged and/or anticipated to occur. Most of the county's Existing TC occurs in the Residential and Open Space zoning classes, and these classes also contain the largest proportion of Potential TC. Agricultural fields and lawns likely account for many of the vegetated sites where expanded tree canopy is theoretically possible. This distribution emphasizes the vital role that individual citizens play in maintaining and expanding tree canopy; any program to maintain or increase tree canopy must include the active support and cooperation of residential landowners. While constituting a smaller portion of the county's land area, other zoning classes also provide opportunities for expanding tree canopy, including various commercial, industrial, and mixed use areas. These urbanized areas are especially important for facilitating runoff retention and other tree canopy benefits.

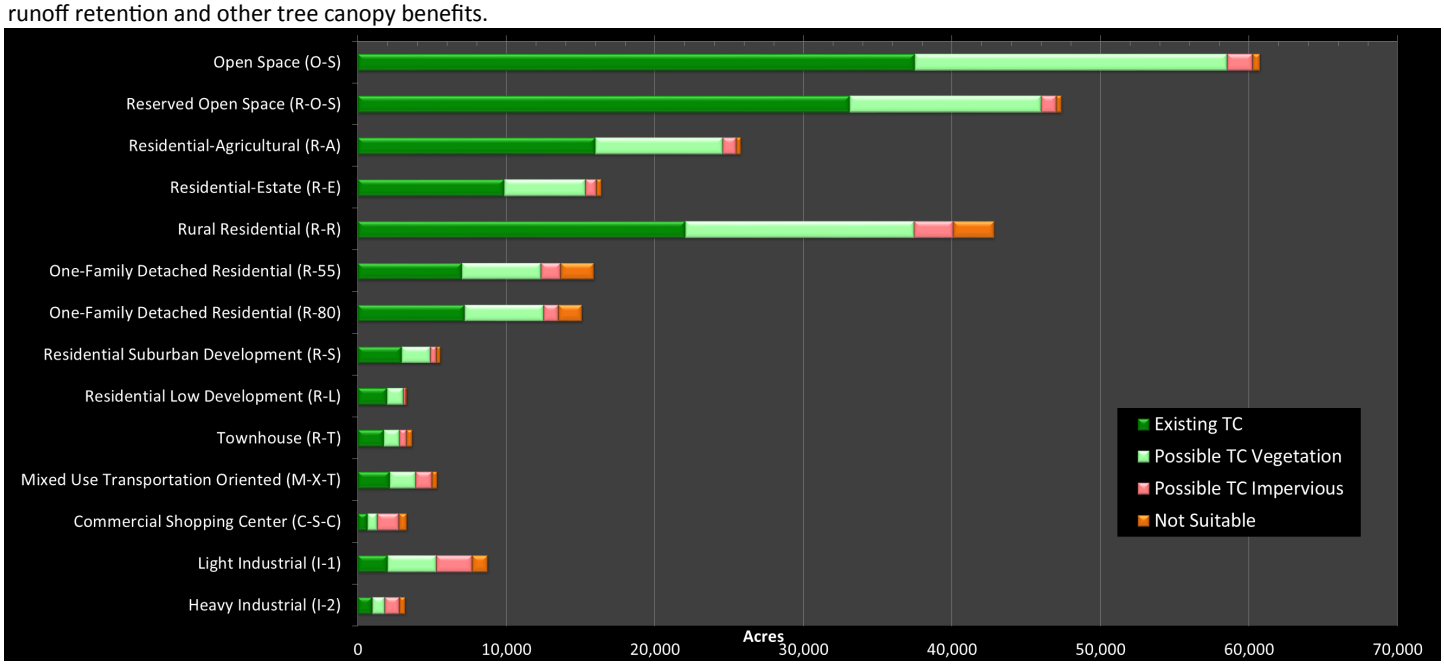


Figure 5: Tree Canopy (TC) metrics summarized by selected zoning classes.

Zoning Class	Existing TC			Possible TC Vegetation			Possible TC Impervious		
	% Land	% Category	% TC Type	% Land	% Category	% TC Type	% Land	% Category	% TC Type
Open Space (O-S)	14%	62%	25%	8%	35%	23%	1%	3%	8%
Reserved Open Space (R-O-S)	12%	70%	22%	5%	27%	14%	0%	2%	5%
Residential-Agricultural (R-A)	6%	62%	11%	3%	33%	9%	0%	4%	5%
Residential-Estate (R-E)	4%	60%	6%	2%	33%	6%	0%	4%	4%
Rural Residential (R-R)	8%	51%	14%	6%	36%	17%	1%	6%	13%
One-Family Detached Residential (R-55)	3%	44%	5%	2%	34%	6%	0%	8%	7%
One-Family Detached Residential (R-80)	3%	47%	5%	2%	35%	6%	0%	7%	5%
Residential Suburban Development (R-S)	1%	53%	2%	1%	34%	2%	0%	7%	2%
Residential Low Development (R-L)	1%	60%	1%	0%	33%	1%	0%	5%	1%
Townhouse (R-T)	1%	48%	1%	0%	29%	1%	0%	13%	2%
Mixed Use Transportation Oriented (M-X-T)	1%	41%	1%	1%	33%	2%	0%	20%	5%
Commercial Shopping Center (C-S-C)	0%	19%	0%	0%	20%	1%	1%	43%	7%
Commercial Waterfront (C-W)	0%	19%	0%	0%	50%	0%	0%	30%	0%
Employment and Institutional Area (E-I-A)	0%	43%	0%	0%	25%	0%	0%	21%	2%

$$\%\ \text{Land} = \frac{\text{Area of TC type for zoning class}}{\text{Area of all land}}$$

A % Land value of 1% indicates that 1% of Prince George's County's land area is covered by tree canopy in the Residential Suburban Development zoning class.

$$\%\ \text{Category} = \frac{\text{Area of TC type for zoning class}}{\text{Area of all land for specified land use}}$$

A % Category value of 53% indicates that 53% of land in the Residential Suburban Development zoning class is covered by tree canopy.

$$\%\ \text{TC Type} = \frac{\text{Area of TC type for zoning class}}{\text{Area of all TC type}}$$

A % TC Type value of 2% indicates that 2% of all tree canopy is in the Residential Suburban Development zoning class.

Table 1: For each zoning class, TC metrics were computed as a percentage of all land in the county (% Land), as a percentage of land in the specified use category (% Category), and as a percentage of the area for TC type (% TC Type). Not suitable percentages have been excluded from the table.

Land Use

The Maryland Department of Planning maintains a comprehensive geographic dataset describing primary land uses in Maryland. The 25 land use designations in this database include residential, commercial, industrial, agricultural, forest, and wetland categories. As part of the TC analysis, Existing and Possible tree canopy were summarized in each of the land use categories, ultimately focusing on a subset that best illustrated countywide land use patterns (Figure 6 and Table 2). For each land use class, TC metrics were calculated as a percentage of all land in the county (% Land), as a percentage of land area in the specified land-use category (% Category), and as a percentage of the area for TC type (% TC Type). Not surprisingly, these statistics showed that forested land use categories occupy the largest proportion of the county and contain the largest volumes of Existing TC. However, Potential TC also exists in the forest categories, suggesting that opportunities exist for expanding tree canopy coverage in those land uses. The residential land uses similarly contain relatively high proportions of Existing TC, but they simultaneously contain larger proportions of Potential TC, particularly areas vegetated with lawns and shrubs. Although the Cropland and Pasture categories also contain large proportions of Potential TC, opportunities for tree canopy expansion in these land uses would likely be limited by the continuation of agricultural uses.

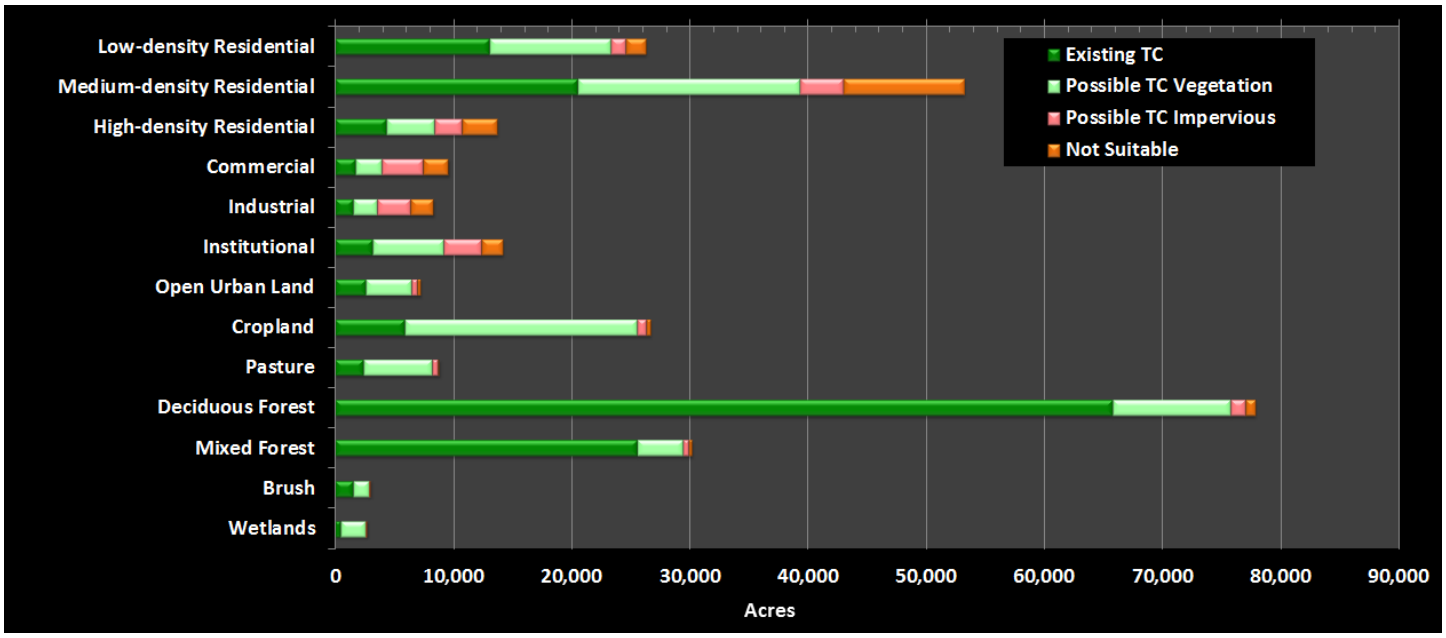


Figure 6: Tree Canopy (TC) metrics summarized by selected land use categories.

Land Use	Existing TC			Possible TC Vegetation			Possible TC Impervious		
	% Land	% Category	% TC Type	% Land	% Category	% TC Type	% Land	% Category	% TC Type
Low-density Residential	4%	50%	8%	3%	39%	11%	0%	4%	5%
Medium-density Residential	7%	39%	13%	6%	35%	19%	1%	7%	16%
High-density Residential	1%	32%	3%	1%	30%	4%	1%	17%	10%
Commercial	1%	18%	1%	1%	23%	2%	1%	37%	16%
Industrial	1%	19%	1%	1%	24%	2%	1%	34%	13%
Institutional	1%	22%	2%	2%	42%	6%	1%	23%	15%
Open Urban Land	1%	36%	2%	1%	54%	4%	0%	6%	2%
Cropland	2%	22%	4%	6%	74%	20%	0%	3%	4%
Pasture	1%	27%	1%	2%	66%	6%	0%	5%	2%
Deciduous Forest	21%	84%	41%	3%	13%	10%	0%	2%	6%
Mixed Forest	8%	85%	16%	1%	13%	4%	0%	2%	2%
Brush	1%	51%	1%	0%	44%	1%	0%	2%	0%
Wetlands	0%	18%	0%	1%	82%	2%	0%	0%	0%

$$\%\ \text{Land} = \frac{\text{Area of TC type for land use}}{\text{Area of all land}}$$

A % Land value of 2% indicates that 2% of Prince George's County's land area is covered by tree canopy in the Cropland land use class.

$$\%\ \text{Category} = \frac{\text{Area of TC type for land use}}{\text{Area of all land for specified land use}}$$

A % Category value of 22% indicates that 22% of land in the Cropland land use class is covered by tree canopy.

$$\%\ \text{TC Type} = \frac{\text{Area of TC type for land use}}{\text{Area of all TC type}}$$

A % TC Type value of 4% indicates that 4% of all tree canopy is in the Cropland land use designation.

Table 2: Tree Canopy (TC) metrics were summarized by land use. For each land use class, TC metrics were computed as a percentage of all land in the county (% Land), as a percentage of land in the specified use category (% Category), and as a percentage of the area for TC type (% TC Type).

Subwatershed Analysis

The county's subwatersheds with the highest proportion of Existing TC tended to be rural areas that contain a mosaic of forest and agriculture (e.g., Mattawoman Creek, Upper Beaverdam Creek) in both private and public ownership . Predictably, highly suburbanized watersheds generally had the lowest proportion of Existing TC and the highest proportion of Possible TC, especially near the border with Washington, DC (Figures 7 and 8). While the subwatershed with the highest proportion of Possible TC (Lower Patuxent River) was primarily rural, agricultural fields in this watershed accounted for the observed pattern. Of the county's 44 subwatersheds, 12 had less than 45% of their land area covered by tree canopy, a threshold that Goetz et al. (2003) associated with "good" stream health in the mid-Atlantic region. (Ranking includes: poor, fair, good, and excellent).

Goetz, S. J., R. K. Wright, A. J. Smith, E. Zinecker, and E. Schaub. 2003. IKONOS imagery for resource management: Tree cover, impervious surfaces, and riparian buffer analyses in the mid-Atlantic region. Remote Sensing of Environment 88, no. 1: 195-208.

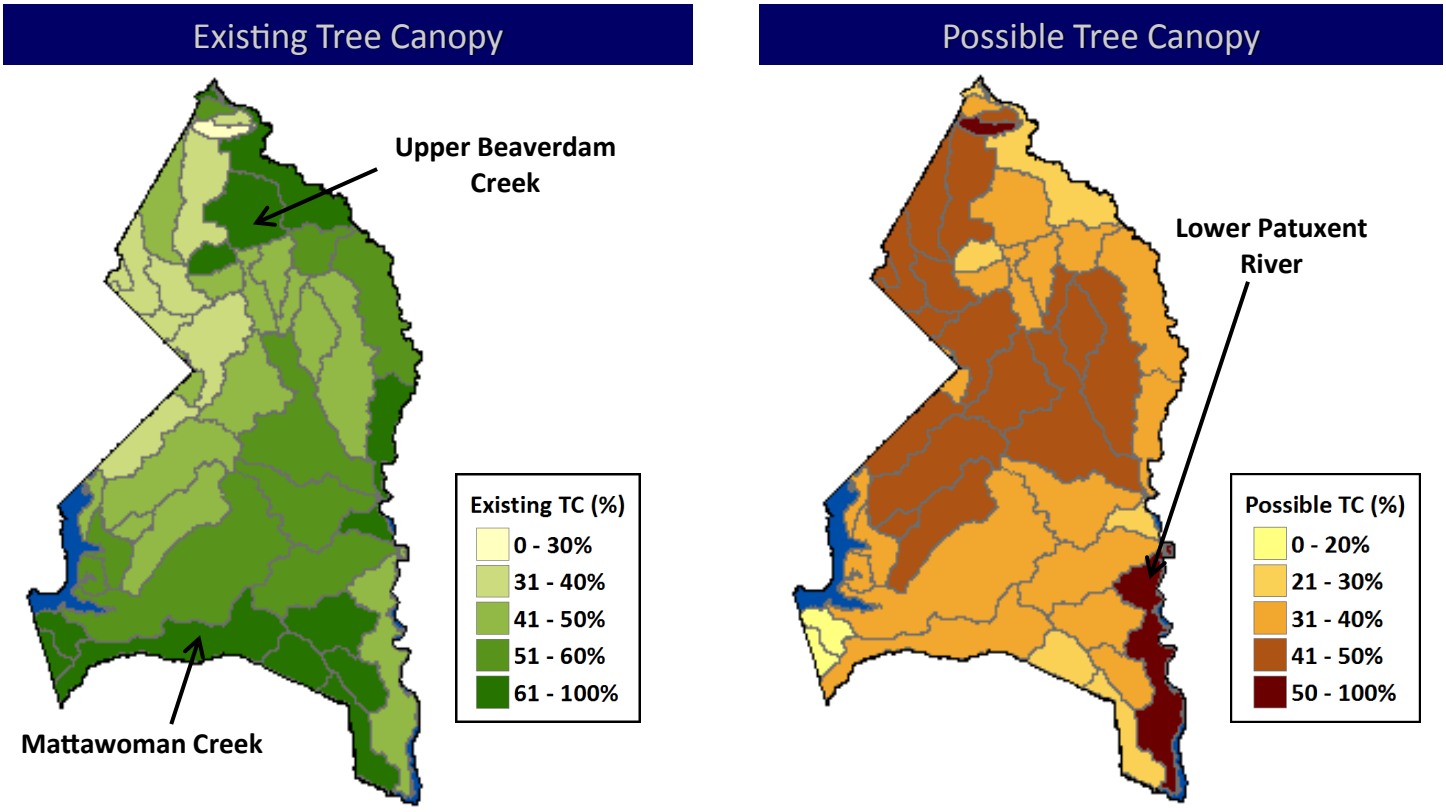


Figure 7: Existing TC (left) and Possible TC (right) as a percentage of area for each subwatershed.

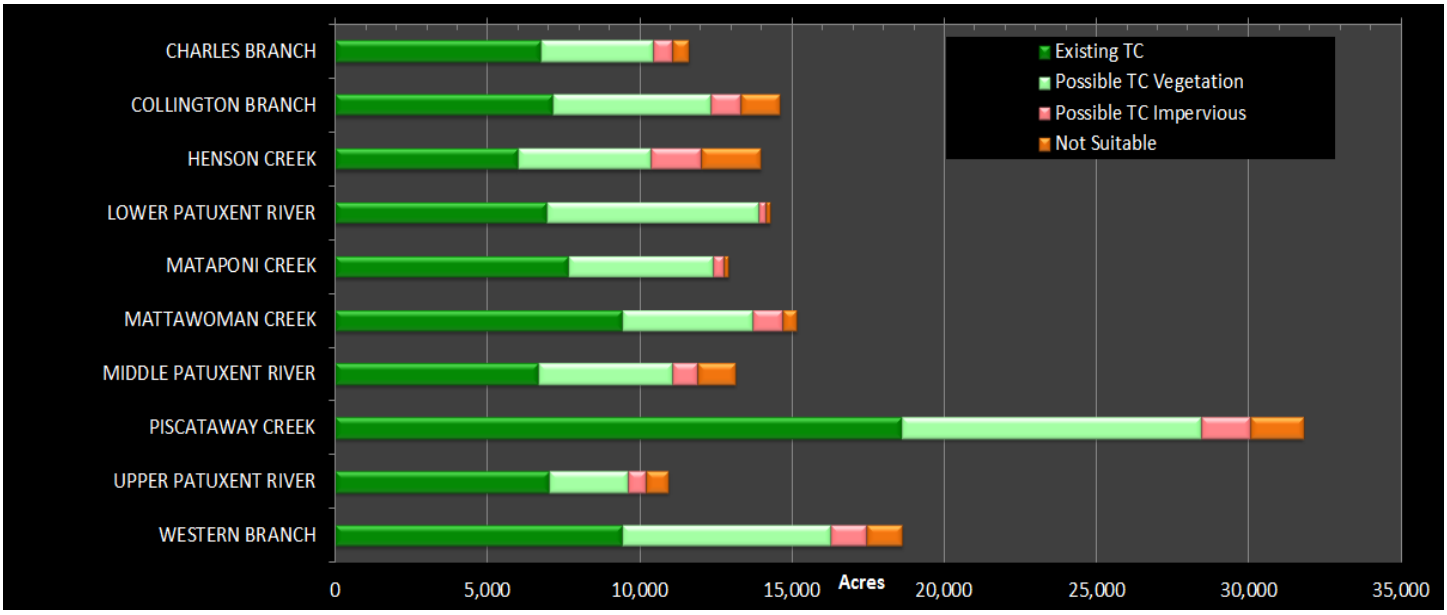
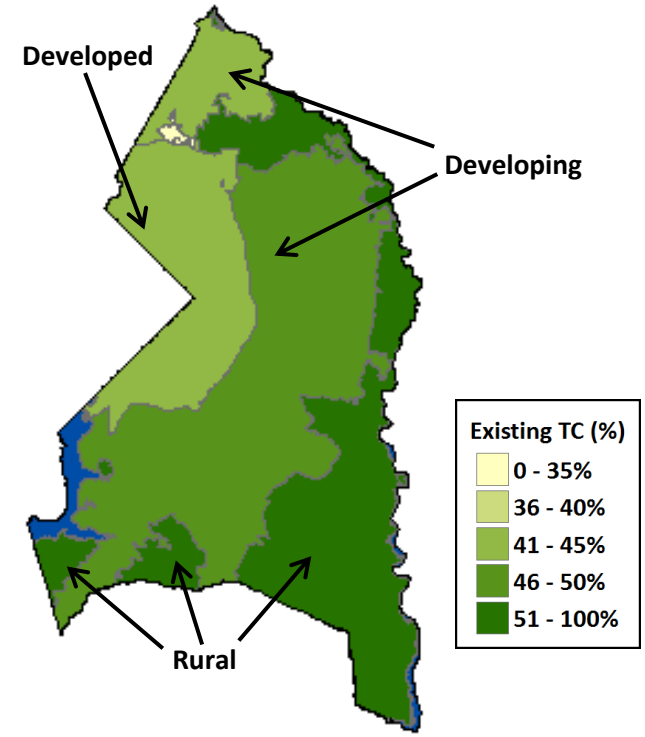


Figure 8. Graphical representation of tree canopy metrics for the ten largest subwatersheds by land area.

Growth Policy Tier Analysis

Growth policy tiers are another planning tool used by Prince George's County; these designations indicate the desired development patterns on a scale from highly urbanized areas to rural zones that contain a mix of forests and agriculture. A TC analysis by growth policy tiers further illustrated the preponderance of existing tree canopy in rural areas, especially along the county's southern and eastern boundaries (Figures 9 and 10). As expected, it also showed that the Developed Tier along the boundary with Washington, DC contains comparatively less tree canopy than adjacent Developing and Rural Tiers. Although Possible TC exhibited a narrower range of values by growth tier, it nonetheless indicated that opportunities for expanding tree canopy exist in all three tier designations, with the largest total area located in the Developing Tier. The Rural Tier contained the next largest area of Possible TC by land area, but agricultural fields contribute a large proportion of this total. The Developed Tier contains the least amount of Possible TC by land area, but more than 40% of this zone could support additional tree canopy using the assumptions of this study.

Existing Tree Canopy



Possible Tree Canopy

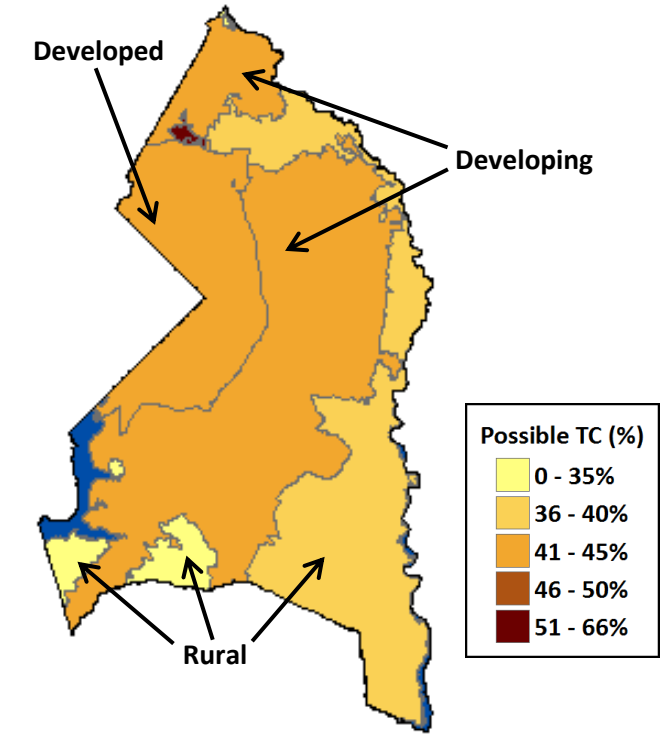


Figure 9: Existing TC (left) and Possible TC (right) as a percentage of area for each Prince George's County growth tier.

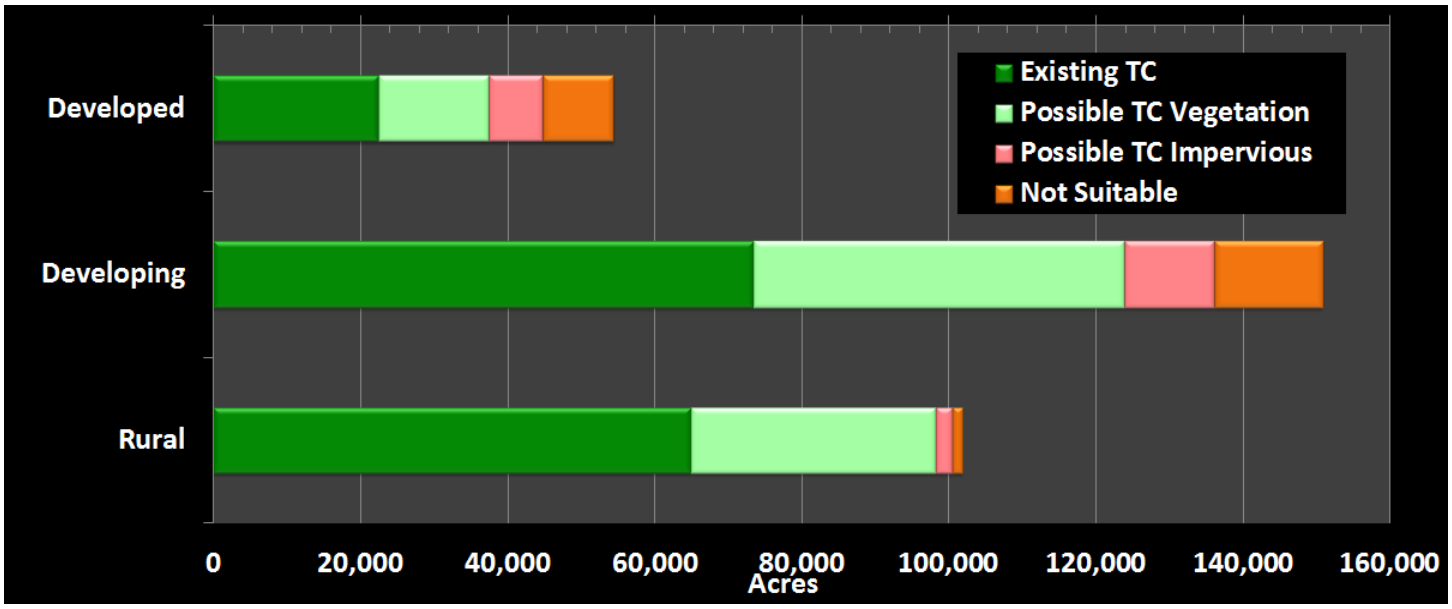


Figure 10. Graphical representation of the tree canopy metrics for Prince George's County growth tiers, by land area.

Tree Canopy Opportunity Index

In addition to simple descriptive statistics, more sophisticated techniques can help identify areas of the county where tree planting and stewardship programs would be most effective. One approach is to focus on spatial clusters of Existing and Possible TC. When a 1,000-foot grid network is superimposed on the county's land-cover map, it is possible to map regions of the county where high values of Existing TC are tightly clustered (Figure 11a). A similar map was constructed for Possible TC (Figure 15b). A single index was created by subtracting the percentage of Existing TC per grid cell from Possible TC, which produced a range of values from –1 to 1. When clustered, this Tree Canopy Opportunity (TCO) index highlights areas with high Possible TC and low Existing TC (Figure 15c); these areas theoretically offer the county the best places to strategically expand the county's tree canopy and increasing its many attendant benefits.

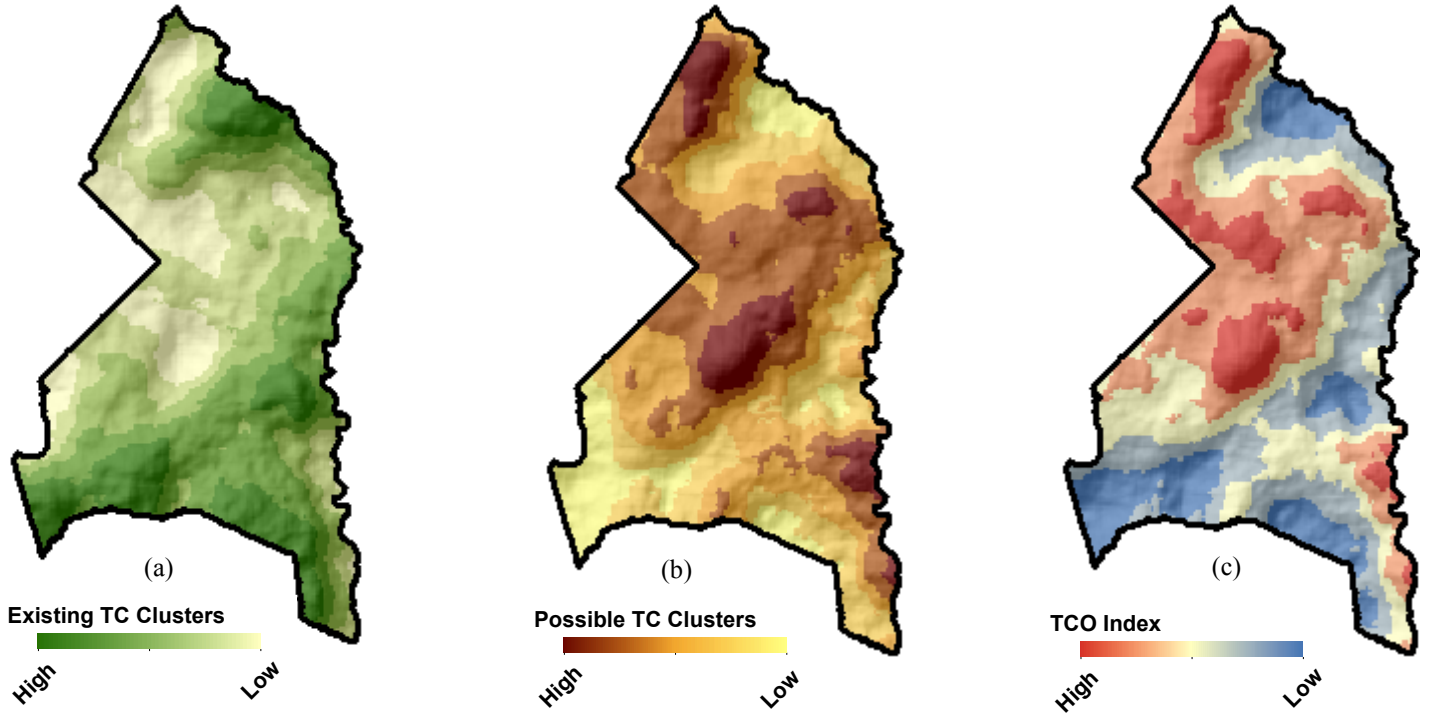
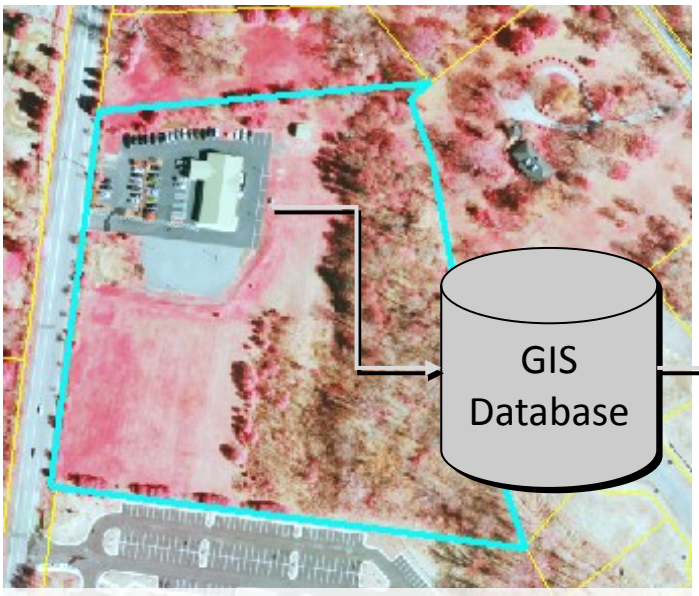


Figure 11: (a) Spatial clustering of Existing TC in Prince George's County; dark green areas are highly clustered and have high Existing TC values; (b) Spatial clustering of Possible TC in Prince George's County; dark red areas are highly clustered and have high Possible TC values.; and (c) Spatial clustering of a combined index of Existing and Possible TC; red areas theoretically provide the best opportunities for expanding tree canopy.

Decision Support



Parcel-based Tree Canopy (TC) metrics were integrated into the county's existing GIS database (Figure 12). Decision makers can use GIS to query specific TC and land cover metrics for a parcel or set of parcels. For example, this information can be used to estimate the amount of tree loss in a planned development or set TC improvement goals for an individual property.

Attribute	Value
Parcel ID	87700
Zoning	Residential
Land Use	Institutional
Existing TC	45%
Possible TC	53%
Possible TC – Vegetation	41%
Possible TC – Impervious	12%
Existing Impervious	14%

Figure 12: GIS-based analysis of parcel-based TC metrics for decision support. In this example, GIS is used to select an individual parcel. The attributes for that parcel, including the parcel-based TC and land cover metrics, are displayed in tabular form providing instant access to relevant information.

Conclusions

- Prince George's County's tree canopy is a vital county asset that reduces storm water runoff, improves air quality, reduces the county's carbon footprint, enhances quality of life, contributes to savings on energy bills, and serves as habitat for wildlife.
- Although this assessment indicates that 39% of the land in Prince George's County could theoretically support additional tree canopy, planting new trees on much of this land may not be socially desirable (e.g. recreational fields), logistically feasible (e.g. areas required to meet County Code requirements), or consistent with other goals (e.g. agricultural lands). When setting tree canopy goals, all relevant factors must be considered in the assessment of potential areas of new tree canopy .
- With Existing and Possible TC summarized at the parcel level and integrated into the county's GIS database, individual parcels and subdivisions can be evaluated for TC improvement. Of particular focus for TC improvement should be parcels that have large, contiguous impervious surfaces. These parcels contribute high amounts of runoff, which degrades water quality. The establishment of tree canopy on these parcels will help reduce stormwater runoff during periods of peak overland flow.
- The majority of the County's tree canopy occurs on private property. These lands also represent the highest potential for planting trees. Programs that educate residents on tree stewardship and provide incentives for tree planting are crucial if Prince George's County is to sustain its tree canopy in the long term.
- With TC metrics summarized at the subwatershed level, individual watersheds or basins can be examined and targeted for TC improvement. For example, research by Goetz et al. (2003) indicates that watersheds with 37% tree canopy can be categorized as "fair" in a stream health rating; watersheds with 45% tree canopy can be categorized as "good."
- Additional analyses could be performed to analyze the distribution of tree canopy using various geographic segments. These summaries can also be used to target tree planting and preservation efforts in different parts of the county.

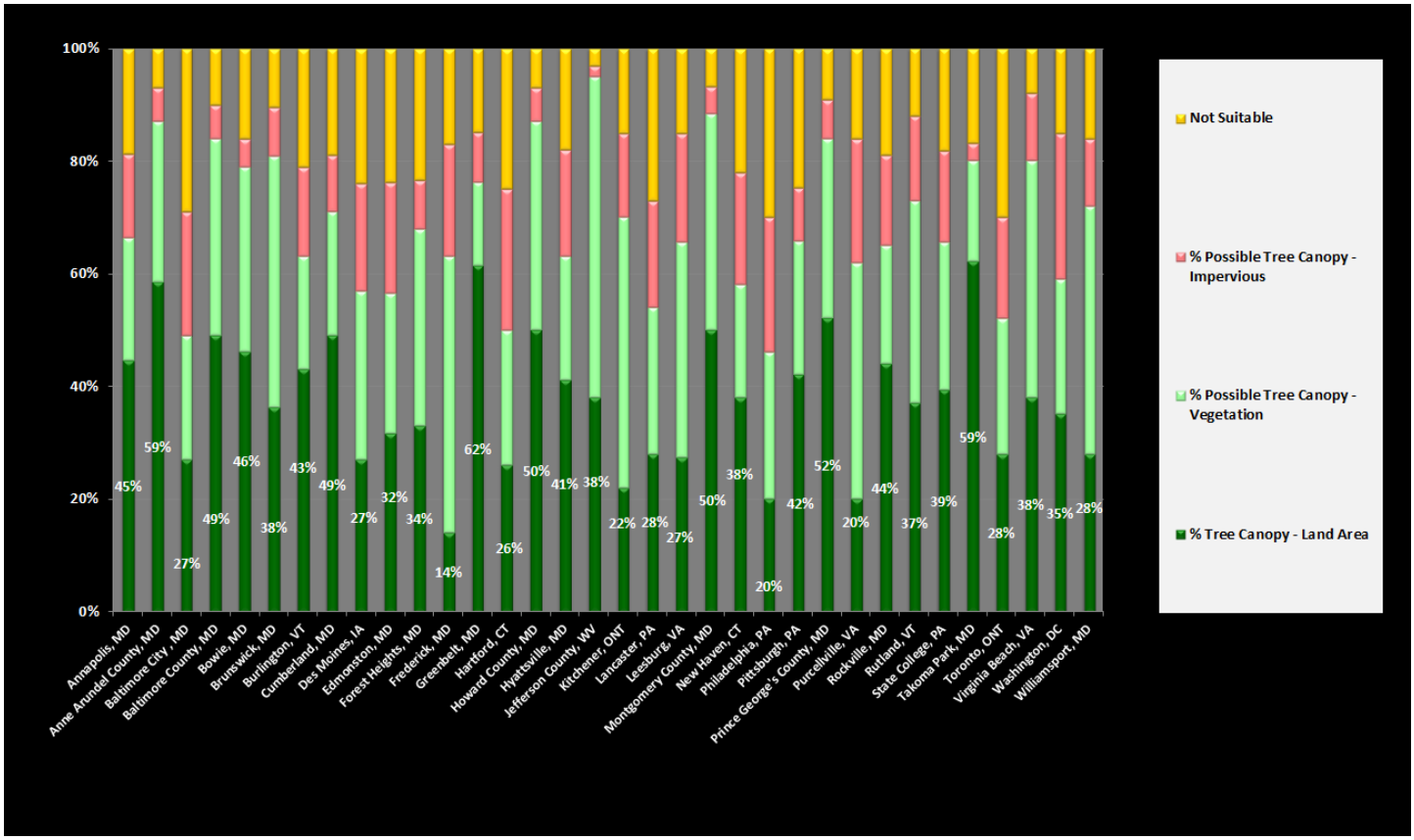


Figure 13: Comparison of Existing and Possible Tree Canopy with other selected municipalities that have completed Tree Canopy Assessments.

Prepared by:

Jarlath O'Neil-Dunne
University of Vermont
Spatial Analysis Laboratory
joneildu@uvm.edu
802.656.3324

Additional Information

Funding for this project was provided by the Maryland-National Capital Park and Planning Commission. More information on the TC assessment project can be found at the following web site:

http://nrs.fs.fed.us/urban/utc/

Spatial Analysis Lab Tree Canopy Assessment Team: Brian Beck, Terence Bennett, Lauren Demars, Tayler Engel, Samantha Gollub, Ray Gomez, Michael Grobicki, Daniel Hedges, Donald Hefferon, Lindsay Jordan, Dan Koopman, Sean MacFaden, Jarlath O'Neil-Dunne, Keith Pelletier, Eleanor Regan, Anna Royar, Sam Shaefer-Joel, Bronson Shonk, Bobby Sudekum

University of Vermont Spatial Analysis Lab