A Report on Berkeley 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 summer 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 urban forest planning, 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.

How Much Tree Canopy Does Berkeley Co. Have?

An analysis of eastern Berkeley County based on land cover data derived from high-resolution aerial imagery and LiDAR (Figure 1) found that 51,460 acres of the area were covered by tree canopy (termed Existing TC), representing 41% of all land in this part of the county. An additional 55% (68,573 acres) of the area's land area could theoretically be modified (termed Possible TC) to accommodate tree canopy (Figure 2). In the Possible TC category, 51% (63,916 acres) of total land area was classified as Vegetated Possible TC and another 4% as Impervious Possible TC (4,657 acres). Vegetated Possible TC, or grass/shrub, 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.

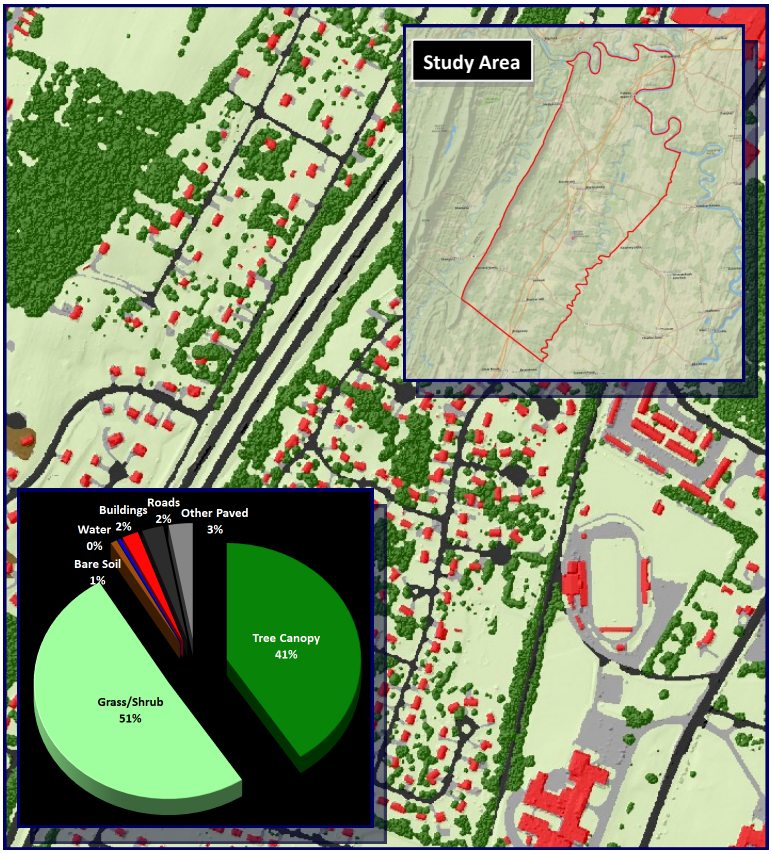


Figure 1: Study area and example of the land cover derived from high-resolution imagery for this project.

Project Background

The goal of the project was to apply the USDA Forest Service's Tree Canopy Assessment protocols to Berkeley County. The analysis was centered on eastern Berkeley County/Opequon Creek watershed (Figure 1) and carried out using year 2011 data. The study area boundary was determined based on the availability of LiDAR, a key input dataset. This project was made possible through funding from the Cacapon Institute. The Spatial Analysis Laboratory (SAL) at the University of Vermont's Rubenstein School of the Environment and Natural Resources carried out the assessment in collaboration with Berkeley County, SavATree, and the USDA Forest Service's Northern Research Station.

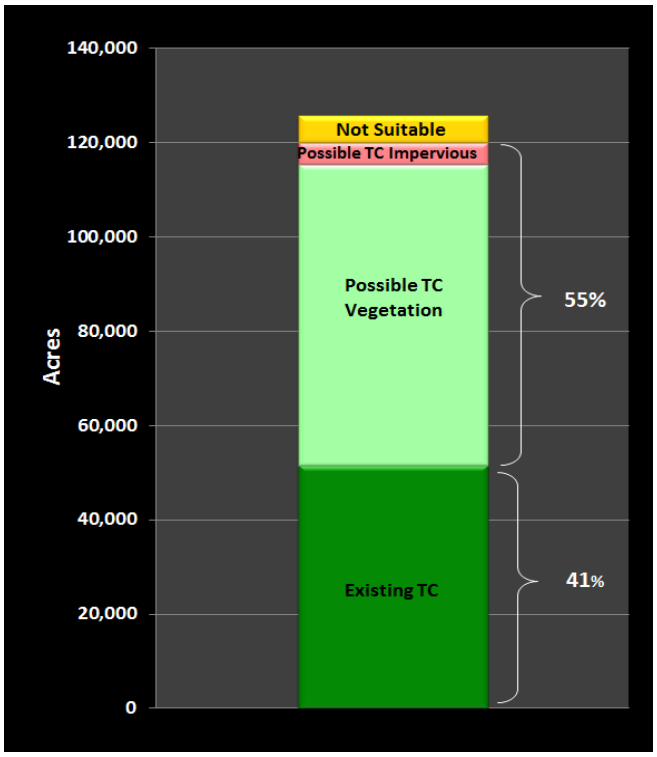


Figure 2: TC metrics for southeastern Berkeley County based on % of land area covered by each TC type.

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 urban tree canopy present when viewed from above using aerial or satellite imagery.
Impervious Possible TC: Asphalt or concrete surfaces, excluding roads and buildings, that are theoretically available for the establishment of tree canopy.
Vegetated Possible TC: Grass or shrub area that is theoretically available for the establishment of tree canopy.
Not Suitable: Areas where it is highly unlikely that new tree canopy could be established (primarily buildings and roads).

Mapping Berkeley's Trees

A prior estimate of tree canopy for the entirety of the Berkeley County study area (including water) from the 2001 National Land Cover Database (NLCD 2001) was 25%, far lower than the 41% obtained in this study. The large difference is due to the fact that NLCD 2001 (Figure 3a) and only accounted for relatively large patches of tree canopy. The same is true for the area's vegetation layer (not shown). Using high-resolution aerial imagery (Figure 3b), in combination with advanced automated processing techniques, land cover for the area was mapped with such detail that trees as short as 8ft tall were detected (Figure 3c).

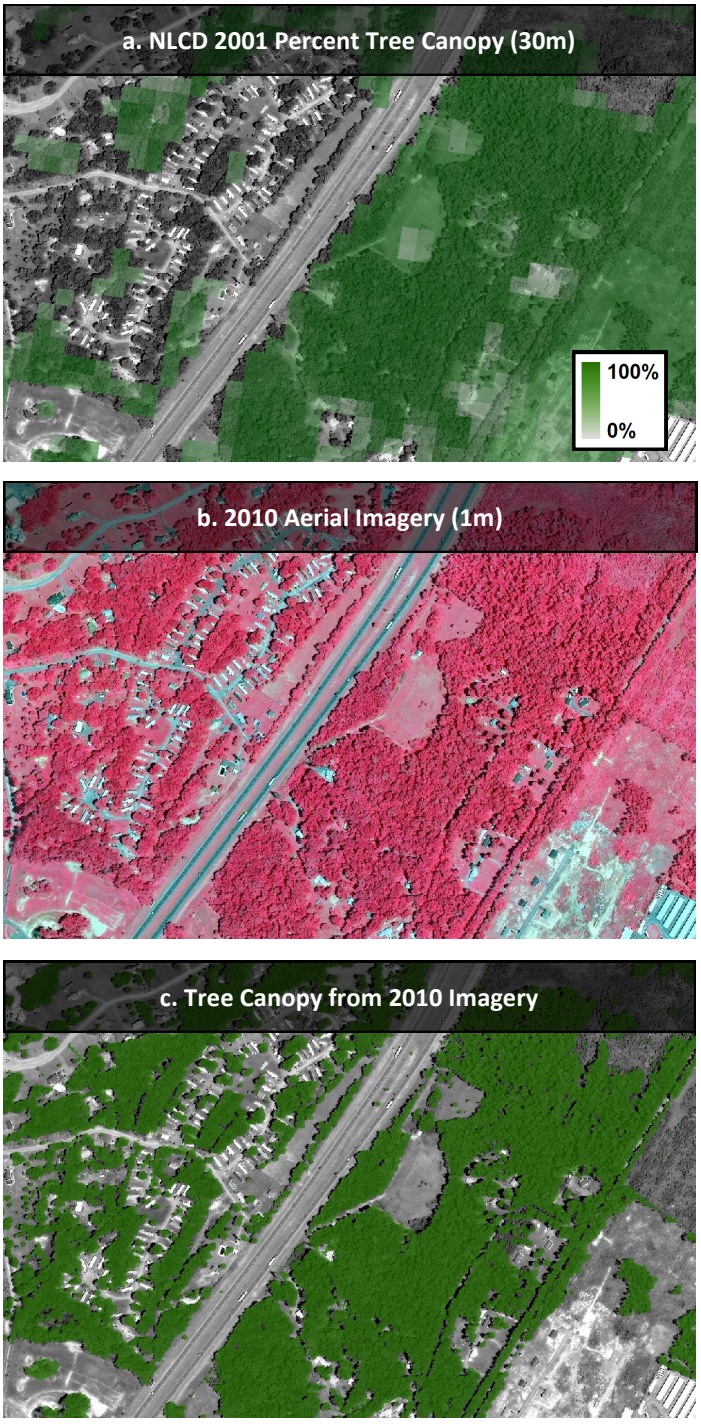


Figure 3: Comparison of NLCD 2001 (a) to high-resolution imagery (b) and tree canopy (c) derived for this study.

Parcel Summary

After land cover was mapped for the study area, Tree Canopy (TC) metrics were summarized for each property in the County Assessor's parcel database (Figure 4). Existing TC and Possible TC metrics were calculated for each parcel, both in terms of total area (square footage) and as a percentage of the land area within each parcel (TC area ÷ land area of the parcel).

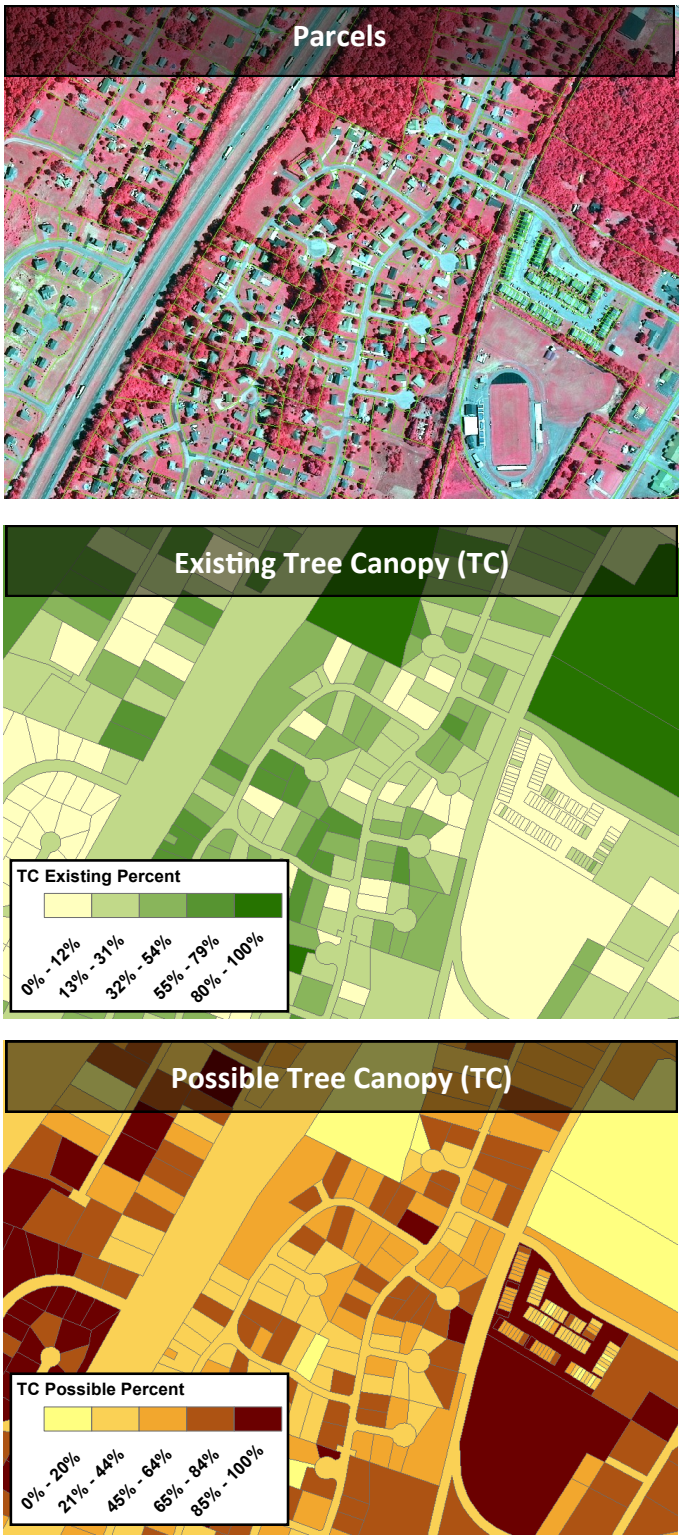


Figure 4a, 4b, 4c: Parcel-based TC metrics. TC metrics are generated at the parcel level, allowing each property to be evaluated according to its Existing TC and Possible TC.

Forest Patch Size

The spatial configuration of forest cover changes as development and other land use conversion occurs across a landscape. A trend toward smaller, more isolated forest tracts adversely affects the sustainability of flora and fauna that depend on interior forest habitat and also diminishes forest ecosystem services that support human well-being. Commercial viability of industrial and non-industrial, forest-based enterprise depends to some extent on the size of available forest tracts. In Berkeley County southeast of North Mountain, 52% of tree canopy is in large patches; 45% is in medium sized patches (Figure 5). This patch size distribution must be considered with care, given that individual patches identified using LiDAR can represent differences in vertical structural characteristics that result in two or more distinct forest patches that collectively compose a single, contiguous forest tract (Figure 6). Tree canopy in the large patch class is predominantly distributed along North Mountain, Opequon Creek and its tributaries and near the Potomac River, although large tree canopy patches can be found in many other locations in the mapped area (Figure 7). Efforts to increase tree canopy in Berkeley County could be informed by patch size distributions with the intent of maintaining larger forest tracts and mitigating tree canopy losses by selectively filling gaps and creating connections among closely aggregated patches.

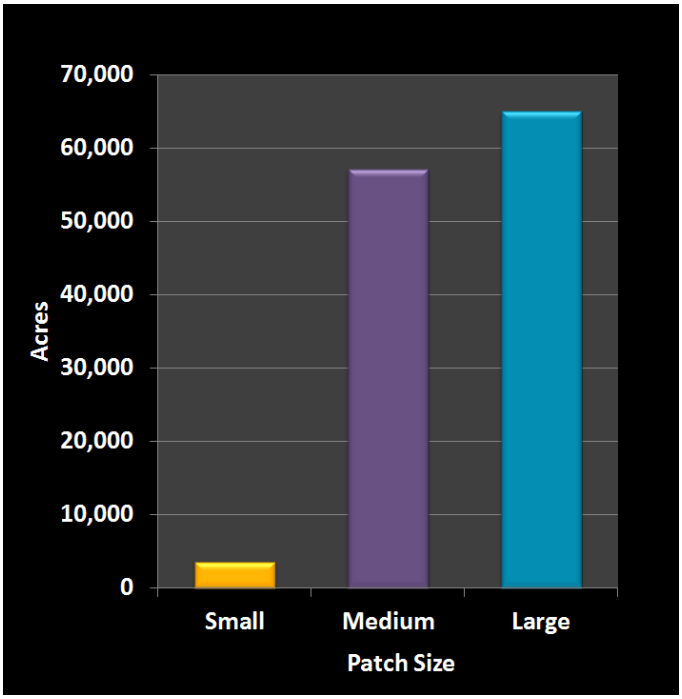


Figure 5: Forest Patch sizes summarized by area.

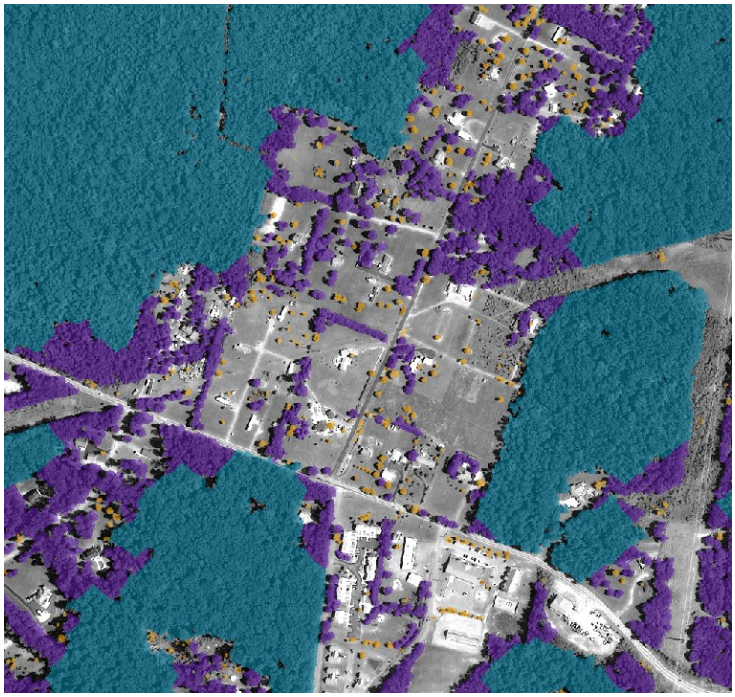


Figure 6: Large scale example of tree canopy classified by patch size.

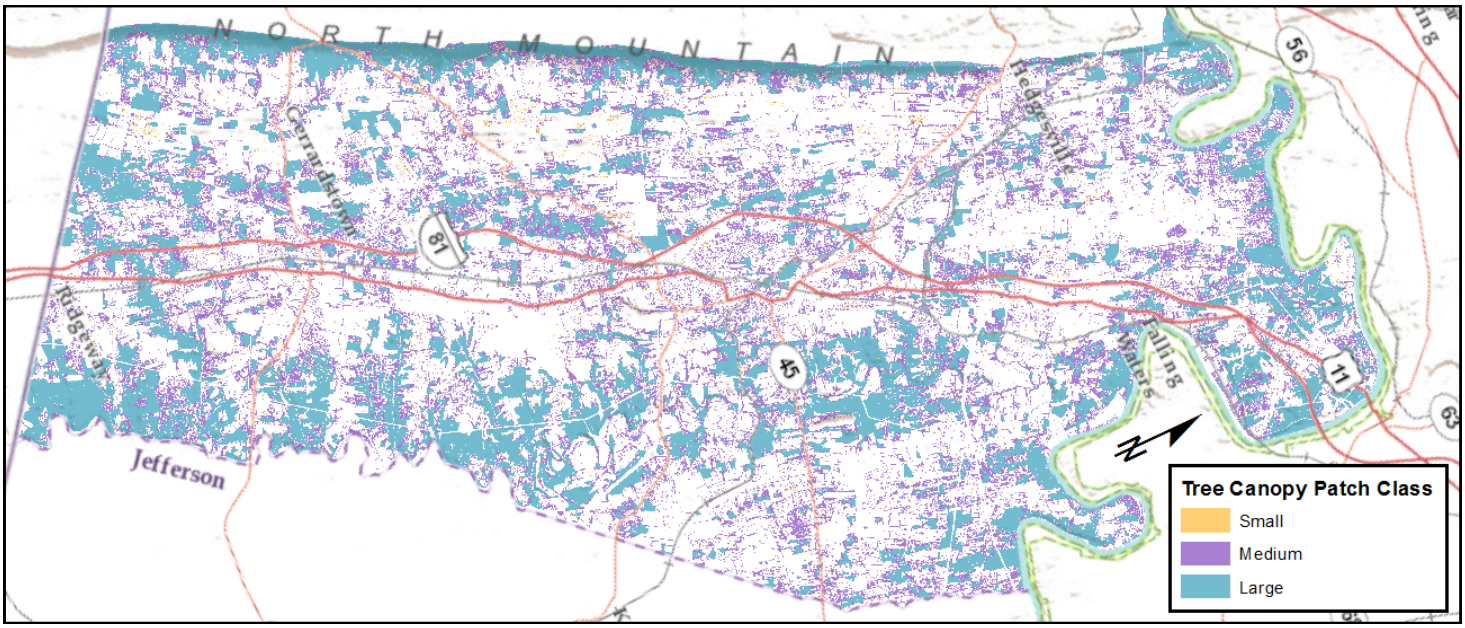


Figure 7: Tree canopy patches in the Berkeley County study area.

Property Class

An analysis of Existing and Possible TC by land use category was conducted using the County Assessor's parcel data, which can be categorized by Property Class (Figure 8, Table 1). For each land use category, tree canopy metrics were calculated as a percentage of all land in the Berkeley County study area (% Land), as a percentage of land area in the specified land use (% Category), and as a percentage of total area in the tree canopy type (% TC Type). The majority of the mapped area in Berkeley County is residential or farm land, and thus it comes as no surprise that these two categories have not only the majority of the area's tree canopy, but also the most room to plant new trees. The Commercial and Exempt categories also present opportunities for tree planting. Of the two predominant land use categories, Residential lands might contain the most area where resources could efficiently be directed to increase tree canopy, although recreation and other open space would be a competitive land use. Residential lands contain 20,862 acres (43%) of land classified as Possible Tree Canopy. Farm land also has a substantial amount of land in the Possible Tree Canopy Vegetation class, but only 2% of this plantable land lies within a 35 foot buffer zone around streams and other waterways where tree planting would be highly desirable. Outside of these riparian zones, pressure to maintain (or to develop) productive agricultural land might be a challenge for large scale tree planting efforts.

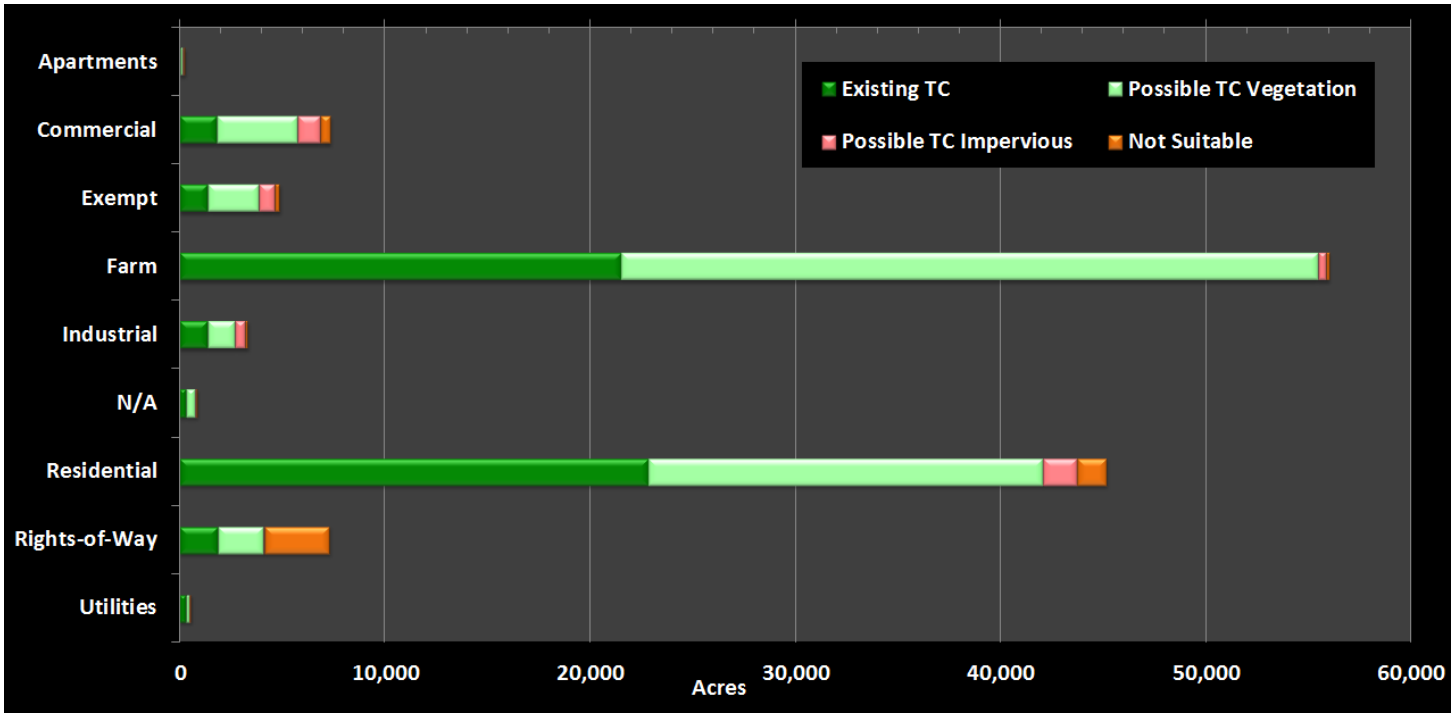


Figure 8: Tree Canopy (TC) metrics summarized for each zoning district.

Property Class	Existing TC			Possible TC Vegetation			Possible TC Impervious		
	% Land	% Category	% TC Type	% Land	% Category	% TC Type	% Land	% Category	% TC Type
Apartments	0%	21%	0%	0%	35%	0%	0%	26%	2%
Commercial	1%	25%	4%	3%	53%	6%	1%	16%	25%
Exempt	1%	29%	3%	2%	50%	4%	1%	16%	17%
Farm	17%	38%	42%	27%	61%	53%	0%	1%	9%
Industrial	1%	41%	3%	1%	41%	2%	0%	15%	11%
N/A	0%	39%	1%	0%	58%	1%	0%	3%	0%
Residential	18%	51%	44%	15%	43%	30%	1%	4%	35%
Rights-of-Way	2%	26%	4%	2%	30%	3%	0%	1%	1%

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

The % Land Area value of 51% indicates that 51% of Berkeley County's land area is covered by tree canopy in the Residential property class.

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

The % Land value of 44% indicates that 44% of land in the Residential property class.

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

The % TC Type value of 43% indicates that 43% of all tree canopy is in land classified in the Residential property class .

Table 1: Tree Canopy (TC) metrics were summarized by land use. For each land use category, TC metrics were computed as a percentage of all land in the county(% Land), as a percentage of land in the specified category (% Category), and as a percentage of the area for TC type (% TC Type).

Socio-Demographic Analysis

US Census Block Groups contain a wealth of socio-demographic information that, when combined with TC metrics, provide new insights into the relationship between the citizens of Berkeley County and their tree canopy. Percent Existing and Percent Possible Tree Canopy maps indicate socio-demographic units where tree canopy is sparse and where planting opportunities exist (Figure 9a & 9b). These maps can be used to help direct resources for tree planting. In general, and particularly in Martinsburg, Tree canopy per capita (Figure 9c) is lowest in block groups with a high amount of impervious surface and relatively low per capita income (Figure 9d & 9e). The Priority Planting Index (PPI) incorporates census data and TC metrics to score block groups based on the need for tree plantings. The Priority Planting Index, which factors in population density, tree stocking levels, and per capita tree cover helps to identify areas where tree planting efforts can be targeted to address issues of environmental justice (Figure 9f). Interestingly, the areas with high PPI values also have relatively high amounts of Possible TC.

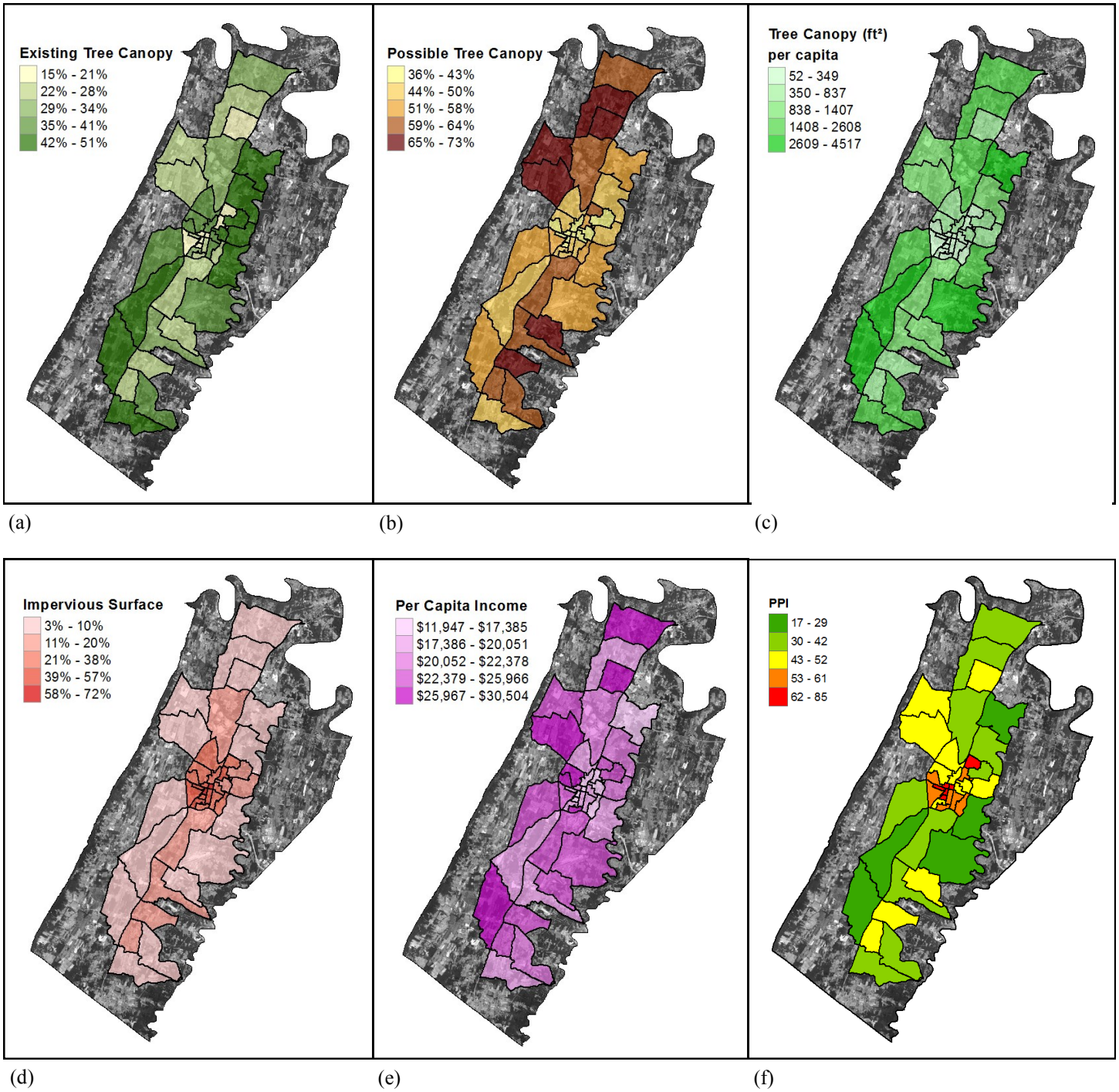
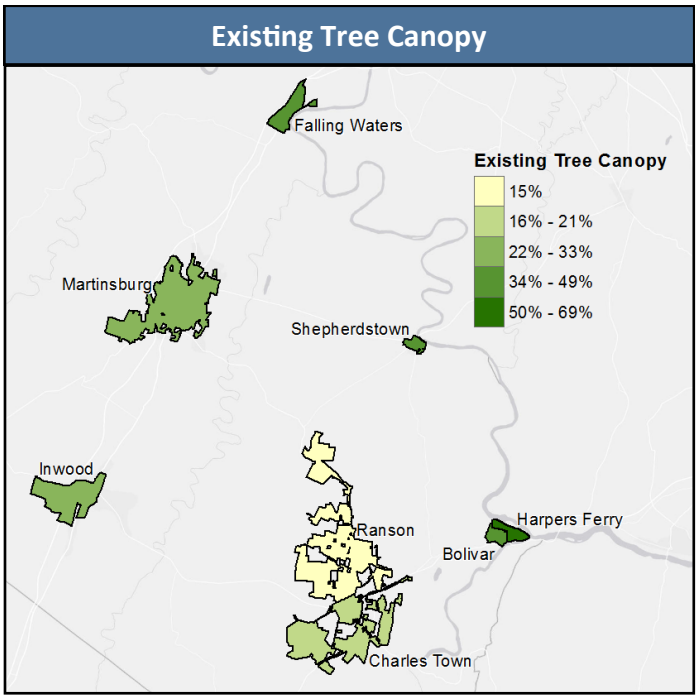


Figure 9: (a) Percent Existing TC; (b) Percent Possible TC; (c) 2011 income per capita; (d) tree canopy per capita; (e) percent impervious surface; and (d) Priority Planting Index for census block groups entirely within Berkeley County southeast of North Mountain.

Census Places

Existing and Possible Tree Canopy were also summarized by the three municipalities (census places) in Berkeley County. An earlier tree canopy assessment that used 2009 data for Jefferson County, WV, allows comparison of tree canopy among municipalities in the two counties (Figure 10). Martinsburg has the largest amount of land (1351 acres) in Existing Tree Canopy but is also one of the two largest municipalities (Figure 11). Harper's Ferry, a much smaller municipality has much less acreage but easily outranks the others in percentage of land in Existing Tree Canopy (69%). Bolivar, Shepherdstown and Falling Waters all have greater than 40% Existing Tree Canopy. In terms of establishing new tree canopy, Ranson and Charles Town have the greatest amount of land categorized as Possible Tree Canopy (78% and 70%, respectively, and most of that land is in the vegetated class. New tree planting in impervious areas can provide many benefits but typically comes at greater expense compared to planting in areas of existing vegetative cover. Relative to more heavily developed urban areas, the municipalities of Berkeley and Jefferson Counties have a small fraction of land in impervious surfaces. Martinsburg has the greatest amount with 13% of its land categorized as Impervious Possible Tree Canopy.



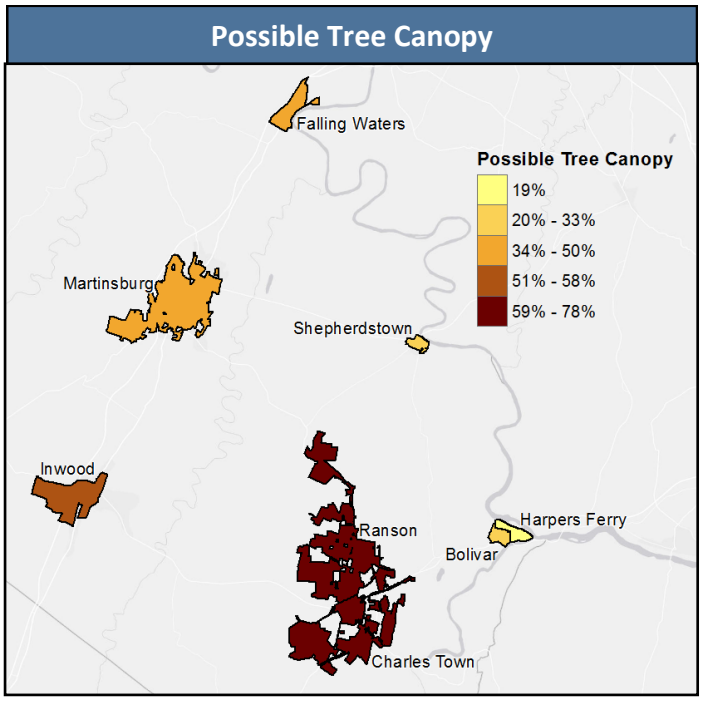


Figure 10: (a) Percent Existing TC; (b) Percent Possible TC; and (c) tree canopy per capita

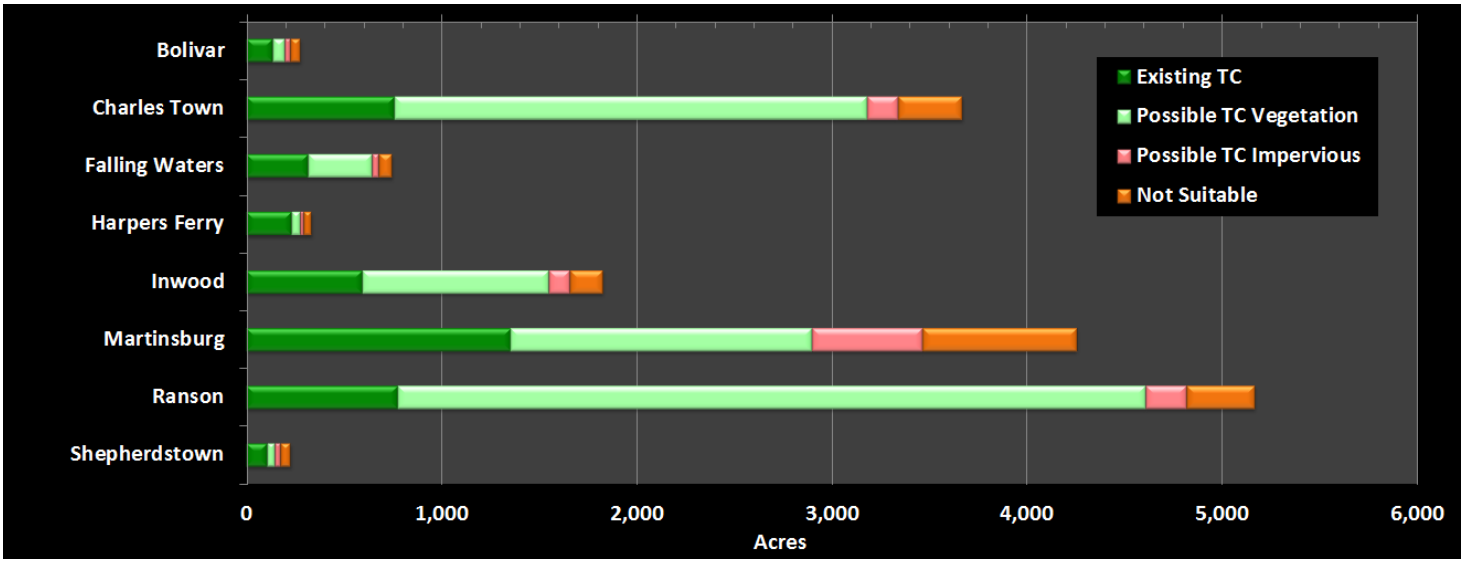


Figure 11: TC metrics summarized by ROW for Priority Neighborhoods.

Riparian Areas

Riparian zones in the Berkeley County focus area have been modeled using a 35 foot buffer around streams and other hydrologic features. Existing and Possible Tree Canopy were tabulated for these riparian areas (Figure 12). Within the riparian areas, which total 2,892 acres (land area), 60% of land is Existing Tree Canopy and 49% is categorized as Possible Tree Canopy. Of the 49% available land, less than 5% is impervious surface, so ample opportunities exist to stabilize stream banks and protect water quality by increasing the amount of tree canopy in these environmentally important zones.

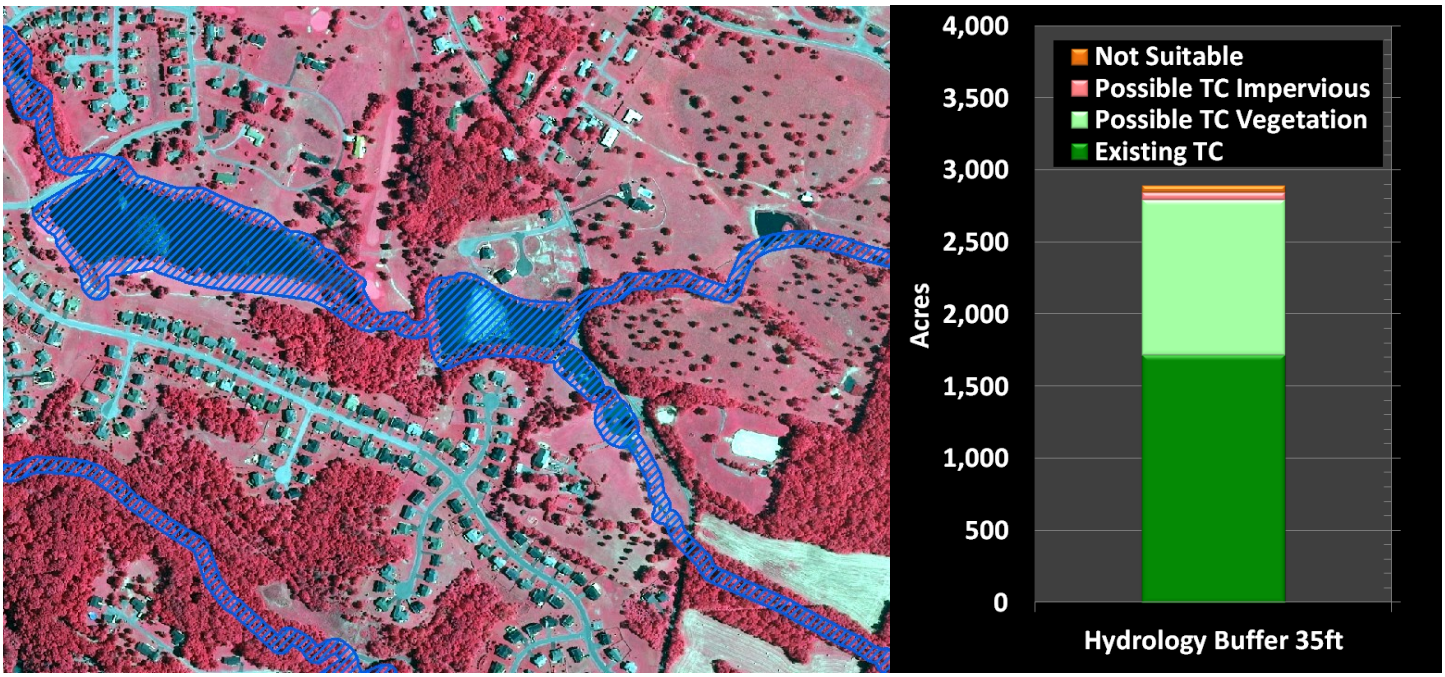
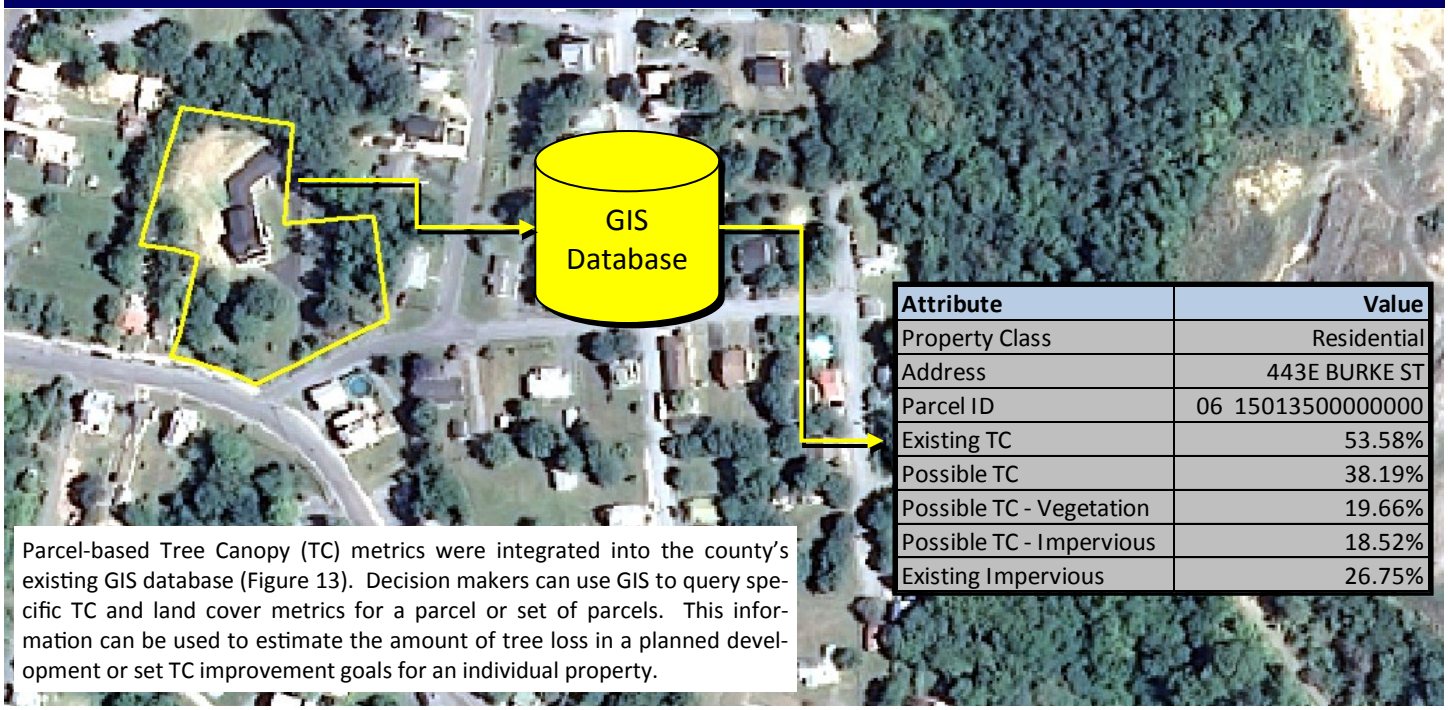


Figure 12. Large scale view of 35 ft. hydrography buffer and tree canopy metrics for riparian areas.

Decision Support



Attribute	Value
Property Class	Residential
Address	443E BURKE ST
Parcel ID	06 15013500000000
Existing TC	53.58%
Possible TC	38.19%
Possible TC - Vegetation	19.66%
Possible TC - Impervious	18.52%
Existing Impervious	26.75%

Parcel-based Tree Canopy (TC) metrics were integrated into the county's existing GIS database (Figure 13). Decision makers can use GIS to query specific TC and land cover metrics for a parcel or set of parcels. 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.

Figure 13: 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.

Tree Canopy Opportunity Index

In addition to simple descriptive statistics, more sophisticated techniques can help identify areas of the city 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 250-foot grid network is superimposed on the land-cover map (Figure 14a), it is possible to map regions of the study area where high values of Existing TC are tightly clustered (Figure 14b). A similar map was constructed for Possible TC (Figure 14c). 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 14d); these areas theoretically offer the best places to strategically expand Berkeley County's tree canopy and to increase its many attendant benefits. Unlike PPI (Figure 8f), TCO does not take into account population information. As such, the areas with the highest TCO are rural and agricultural areas that have low Existing and high Possible TC. As with all such analyses, however, landscape context must be evaluated before setting priorities.

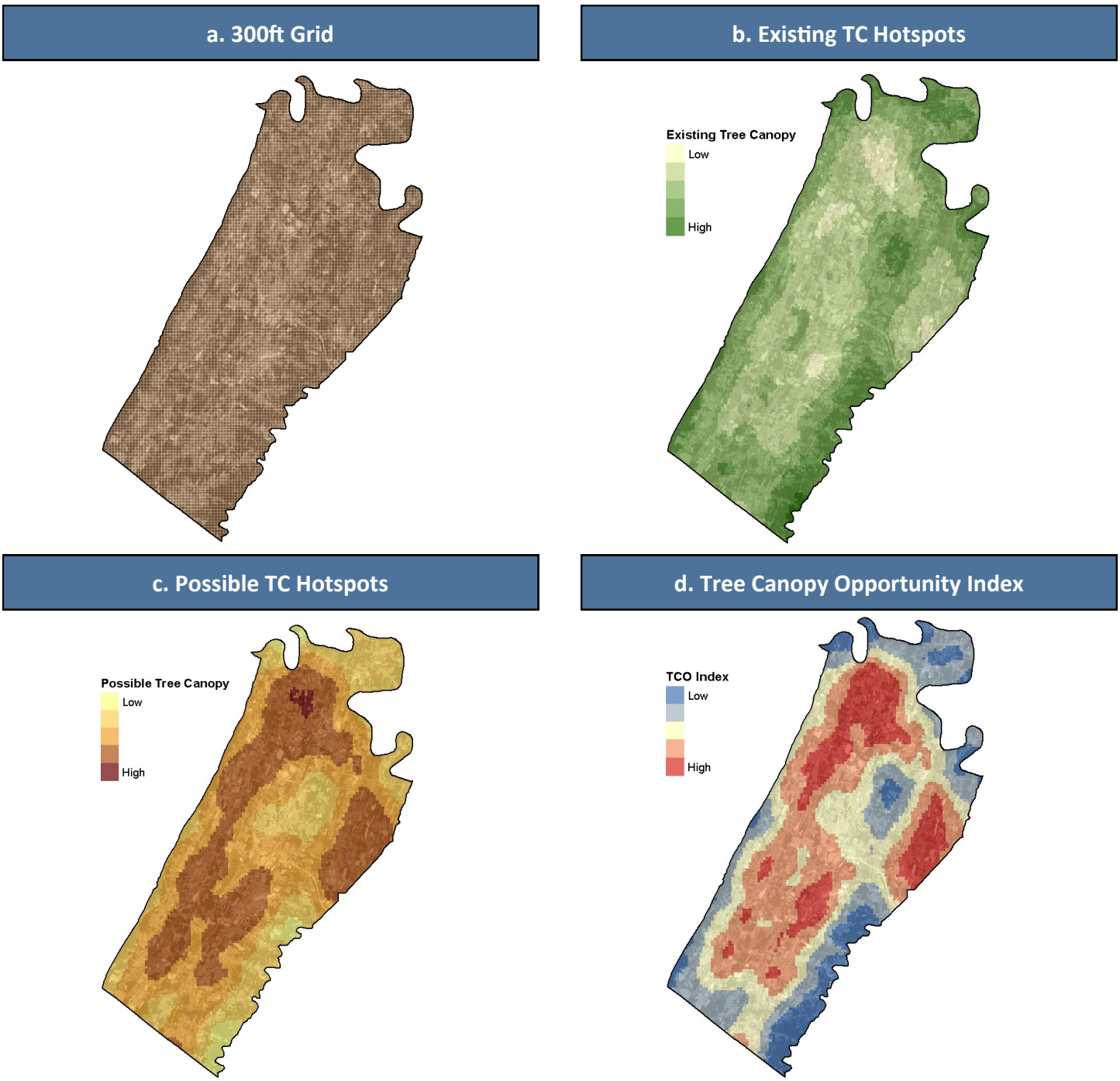
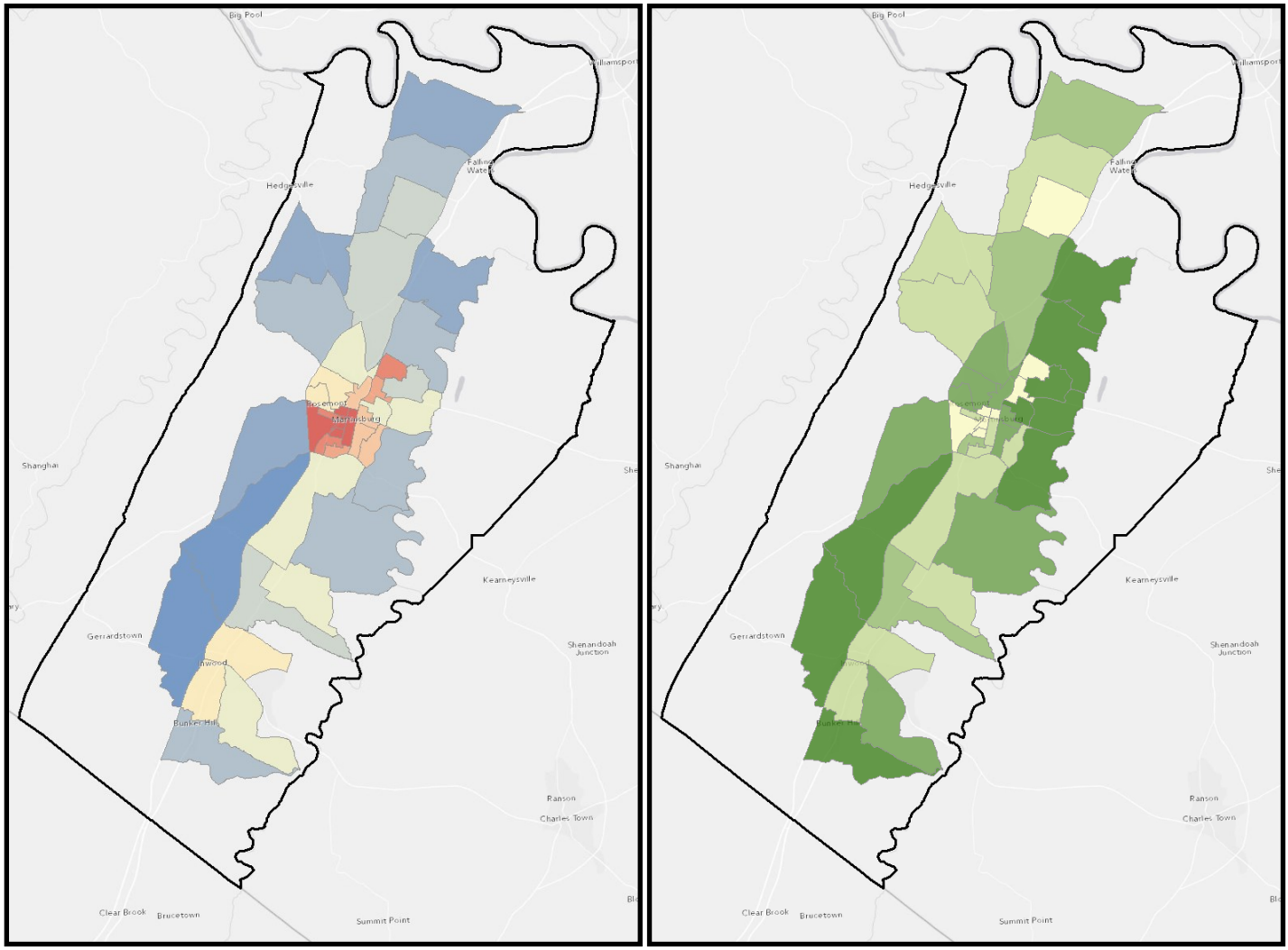


Figure 14: (a) Grid network (300-foot cells) superimposed on land-cover map for Newark and then used in spatial cluster analyses; (b) Spatial clustering of Existing TC in Newark; dark green areas are highly clustered and have high Existing TC values; (c) Spatial clustering of Possible TC in Newark; dark red areas are highly clustered and have high Possible TC values.; and (d) Spatial clustering of a combined index of Existing and Possible TC; red areas theoretically provide the best opportunities for expanding tree canopy.

Surface Temperature

One of the chief benefits of tree canopy is the ability to reduce summer temperatures in urbanized areas, ameliorating the urban heat island effect. The urban heat island effect is largely a result of impervious surfaces, which unlike vegetation, retain and emit heat. To examine the urban heat island effect in study area we used a Landsat satellite image acquired on June 10, 2011. Landsat has the ability to measure surface temperature at a relatively detailed scale. Landsat surface temperatures were summarized at the Census block group level (Figure 15a) and compared to both tree canopy (Figure 15b) and impervious surfaces. It was found that block groups with lower amounts of tree canopy and higher amounts of impervious surfaces tend to have higher temperatures. Higher summer temperatures are associated with increased energy use, which in turn, drives up the cost of living along with operational costs for commercial and industrial operations.



Surface Temperature

Coolest — Warmest

(a)

TC Existing Percent

15% - 21% | 22% - 28% | 29% - 34% | 35% - 40% | 41% - 51%

(b)

Figure 15: Surface temperature derived from the Landsat satellite (a) in relation to tree canopy (b) at the Census block group level.

Conclusions

- Berkeley County's tree canopy is a vital county asset that reduces stormwater 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.
- Berkeley County should consider setting tree canopy goals, not only for increasing the county's overall tree canopy but to focus on increasing tree canopy in riparian zones, municipalities and rural areas that have the least Existing Tree Canopy and high Possible Tree Canopy.
- Although the overall tree canopy within the portion of the county mapped for this project is quite high, it is not evenly distributed. Areas with active agriculture and those dominated by urbanized land uses have considerably less tree canopy.
- Despite the overall rural nature of the county, there are portions of the county's urbanized areas whose amount of tree canopy and impervious surfaces match that of inner city neighborhoods in some of the country's largest cities. Residents and workers in these areas are surrounded by less green infrastructure and thus are forced to deal with substantially warmer summer temperatures than other portions of the county. Warmer surface temperatures have been equated with increased energy consumption. These highly urbanized areas are often associated with lower median income and higher population densities.
- With Existing and Possible TC summarized at the parcel level and integrated into the county's GIS database, individual parcels can be examined and targeted for TC improvement. Of particular focus for TC improvement should be urbanized areas within the county that have large contiguous impervious surfaces. These areas contribute high amounts of runoff, which degrades water quality. The establishment of tree canopy in these municipalities will help reduce runoff during periods of peak overland flow.
- Agricultural land represents a large fraction of Possible Tree Canopy in non-residential land use. As these lands are in high demand for agricultural production, tree planting initiatives can be targeted at riparian buffer zones and other ecologically important sites. This study indicates ample opportunity for increasing tree canopy within 35ft of existing water bodies.
- Development in Berkeley County will increase problems associated with impervious surfaces, such as peak temperatures and stormwater runoff. Tree planning programs that coincide with new developments will not solve these problems immediately, but such investments in green infrastructure will pay off in the long term.

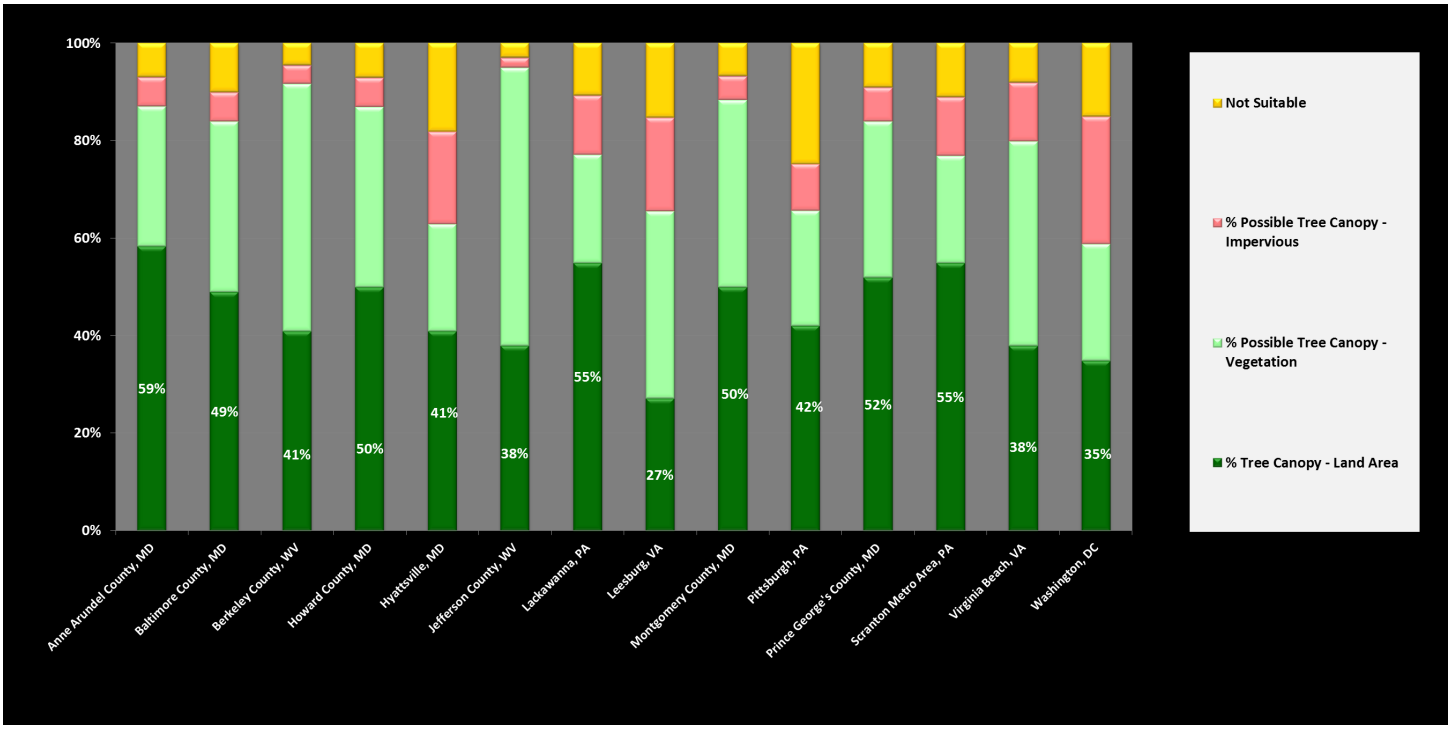


Figure 16: Comparison of Existing and Possible Tree Canopy with other similar communities that have completed Tree Canopy Assessments.

Prepared by:

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

Additional Information

For more info on the Urban Tree Canopy Assessment please visit **http://nrs.fs.fed.us/urban/UTC/**

Spatial Analysis Lab Tree Canopy Assessment Team: Ernie Buford, Jon Cusick, Lauren Demars, Christoph Griesshammer, Ray Gomez, Sean MacFaden, Michelle Marasco, Alan McCarthy, Jarlath O'Neil-Dunne, Max Reis, Anna Royar, Will Seegers, Charles Souchuns, Brad Stewart, D.J. Westley, Rebecca Zeyzus and Adam Zylka.