Tree Canopy Report: Montgomery County, PA

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 essential 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.

National Research Council. *Urban Forestry: Toward an Ecosystem Services Research Agenda: A Workshop Summary*. Washington, DC: The National Academies Press, 2013.

How Much Tree Canopy Does Montgomery County Have?

An analysis of Montgomery County, PA based on land cover data derived from high-resolution aerial imagery and LiDAR (Figure 1) found that 125,352 acres of the county were covered by tree canopy (termed Existing TC), representing 41% of all land in the study area (Figure 2). An additional 48% (148,988 acres) of the county's land area could theoretically be modified to accommodate tree canopy (termed Possible TC). In the Possible TC category, 39% (121,352 acres) of total land area was classified as Vegetated Possible TC and another 9% as Impervious Possible TC (27,635 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.

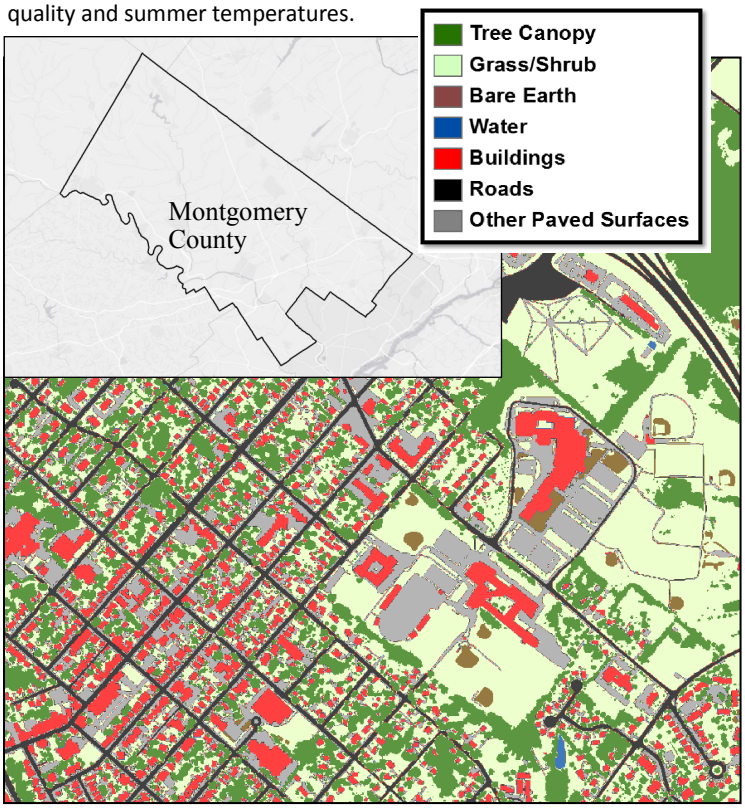

Figure 1: Study area and example of the land cover derived from high-resolution imagery for this project.

Project Background

The goal of the project was to apply the USDA Forest Service's Tree Canopy Assessment protocols to Montgomery County, Pennsylvania. The analysis was conducted using imagery acquired in 2010 and LiDAR acquired in 2008. This project was made possible through funding from the Pennsylvania Horticultural Society. 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 Montgomery County and the USDA Forest Service.

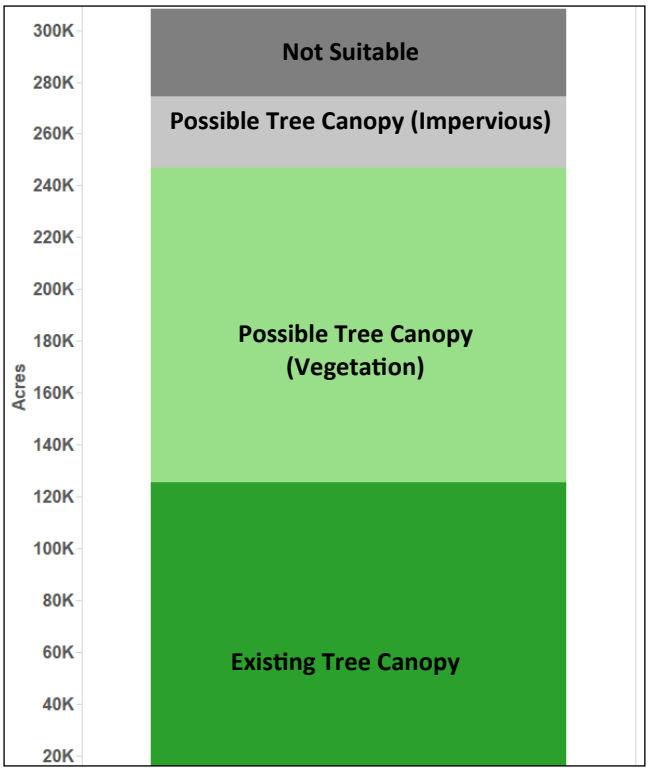

Figure 2: Tree Canopy metrics for Montgomery County based on % of land area covered by each TC type.

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 Montgomery County's Trees

A previous estimate of tree canopy for Montgomery County, derived from the 2011 National Land Cover Database (NLCD 2011), was 29%, much lower than the 41% obtained in this study (based on the total area of the county, including water). This large difference was attributable to the low resolution of NLCD 2011 (Figure 3a), which only accounted for relatively large patches of tree canopy. Using high-resolution satellite imagery acquired in the summer of 2010 (Figure 3b), and LiDAR acquired in 2010, in combination with advanced automated processing techniques, land cover for Montgomery County was mapped with such detail that individual trees were detected (Figure 3c).

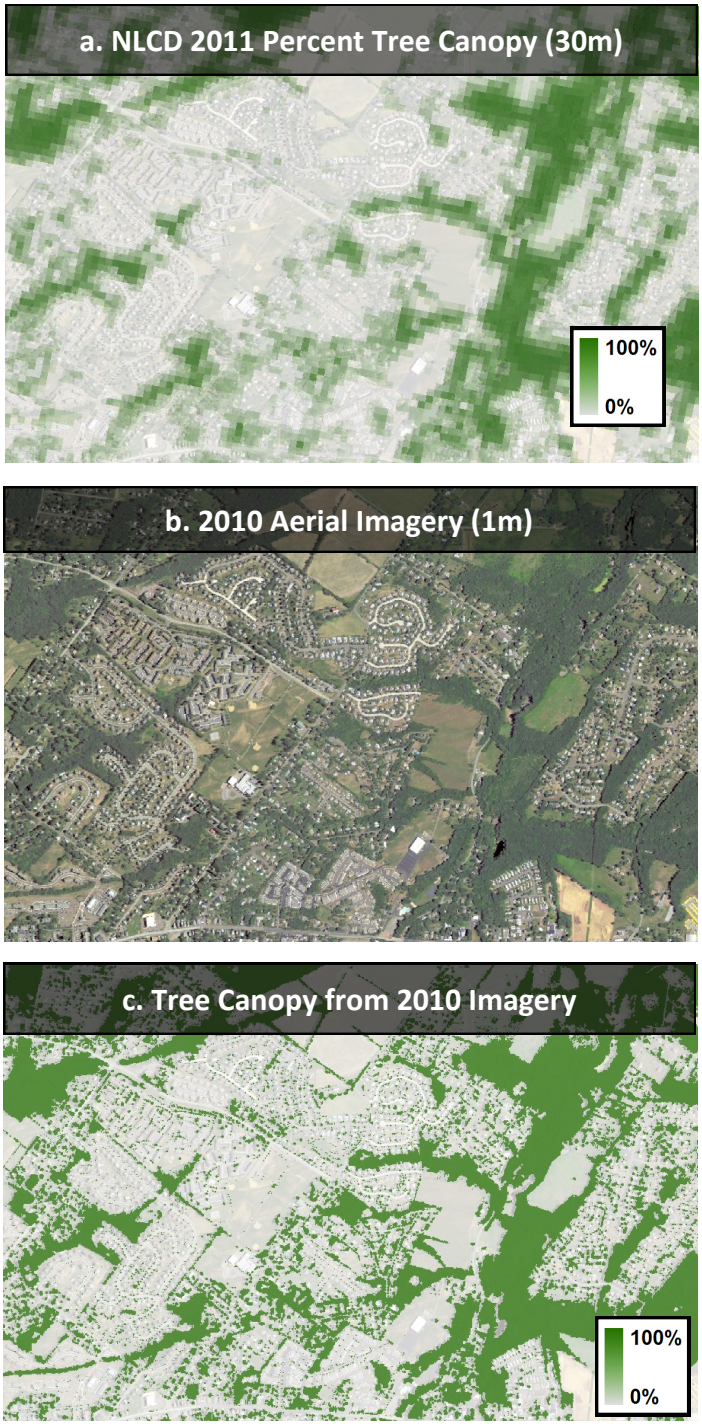

Figure 3: Comparison of NLCD 2011 (a) to high-resolution imagery (b) and tree canopy (c) derived for this study.

Parcel Summary

After land cover was mapped for the study area, Tree Canopy (TC) metrics were summarized for each property in the study area'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 divided by land area of the parcel). The resulting data can be used to assess the tree canopy and tree planting opportunities for every property in Montgomery County.

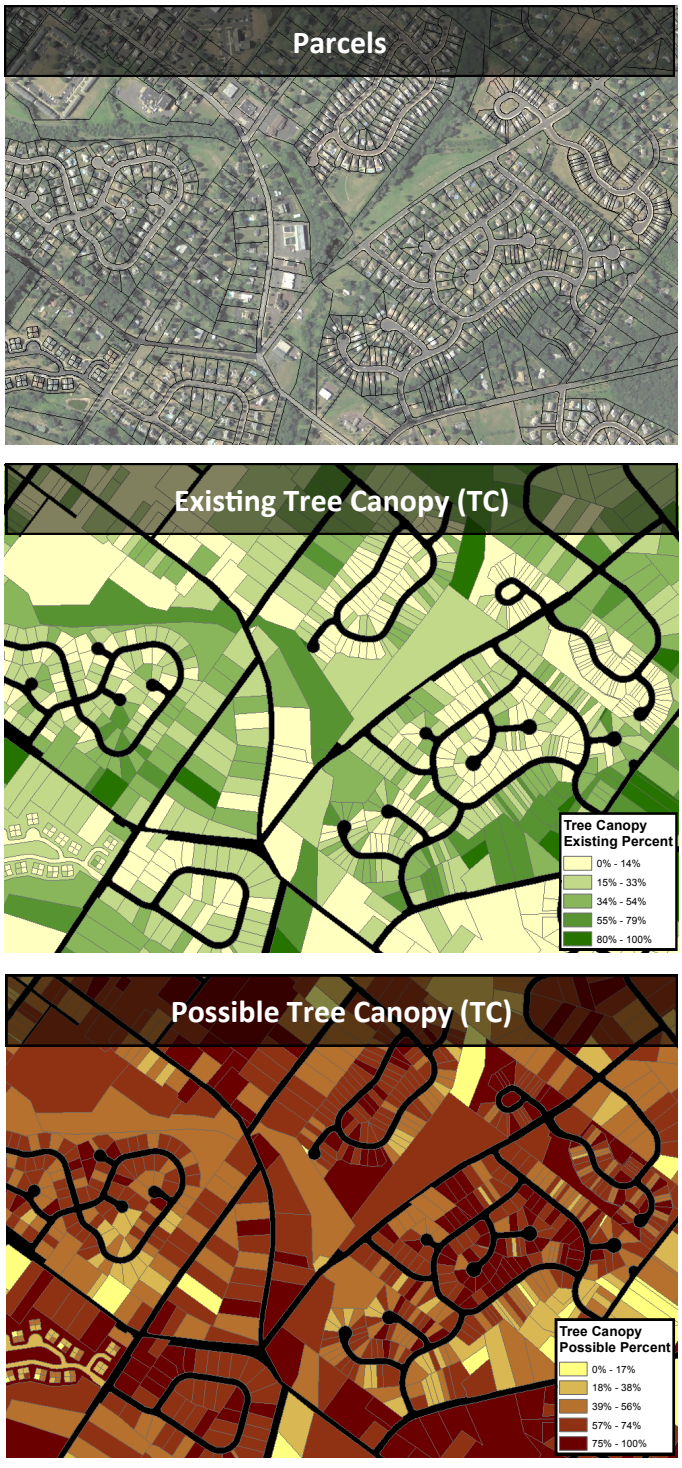

Figure 4: Parcel-based TC metrics. TC metrics are generated at the parcel level, allowing each property to be evaluated according to its Existing TC and Possible TC.

Land Use

Tree canopy metrics were also computed for each parcel in the study area. Much like the other metrics that were computed for this study, Residential has the most Existing and Possible Tree Canopy by area (Figure 5). Agricultural land uses and Utility land uses contain large proportions of Possible Tree Canopy Vegetation at 60% and 46%. An "all lands" approach is required for maintaining and increasing tree canopy, with governments, residents, non-profits, and the private sector all playing a role. For all land uses (besides Right of Way (ROW) which contains only one feature) there is an inverse relationship between Existing Tree Canopy and Possible Tree Canopy (Figure 6). This indicates that land uses with large amounts of tree canopy generally have less room to plant new trees, but this relationship does not always hold true in the more urbanized areas where select parcels with low Existing Tree Canopy also have low Possible Tree Canopy. The Unknown land use type is a combination of miscellaneous land with little development, these areas consist primarily of forested land and open fields.

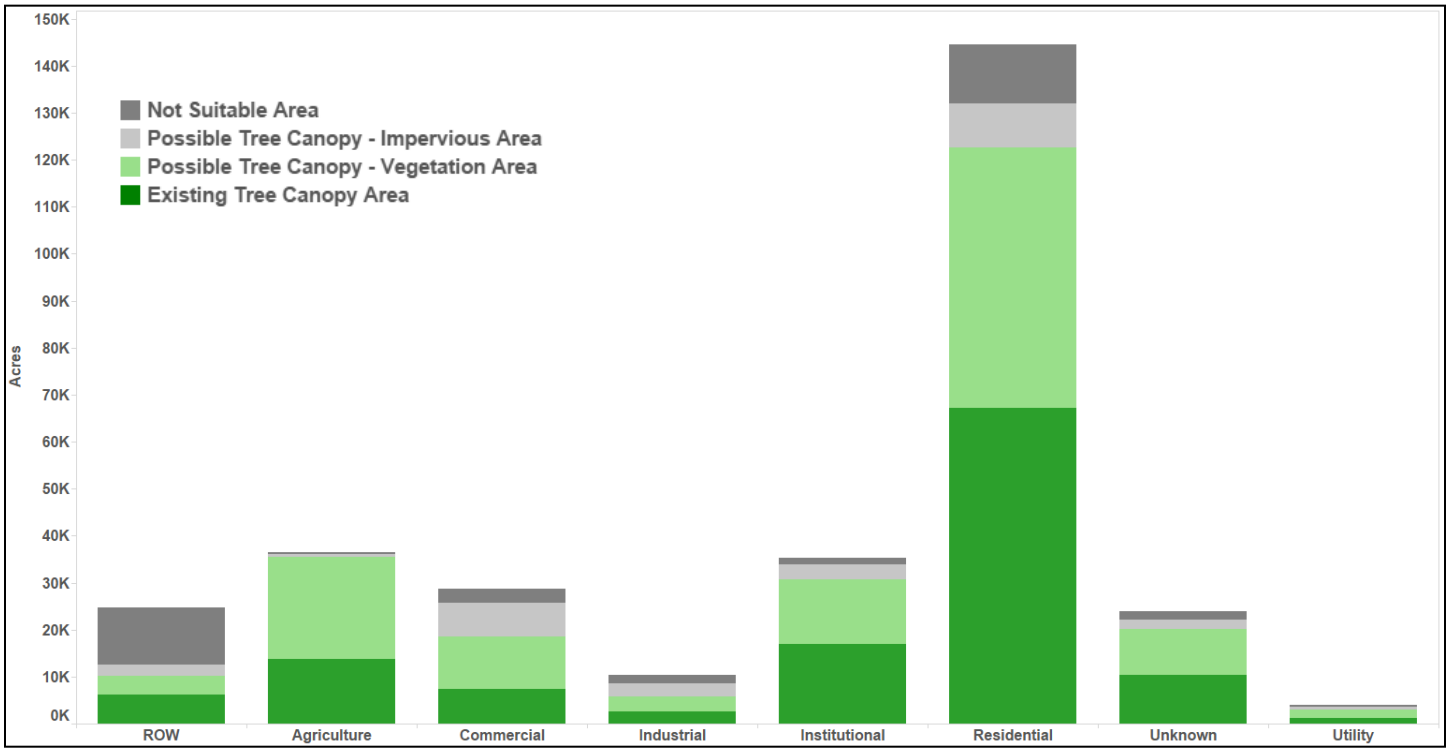

Figure 5: Tree canopy metrics derived from the parcel dataset broken down by land use.

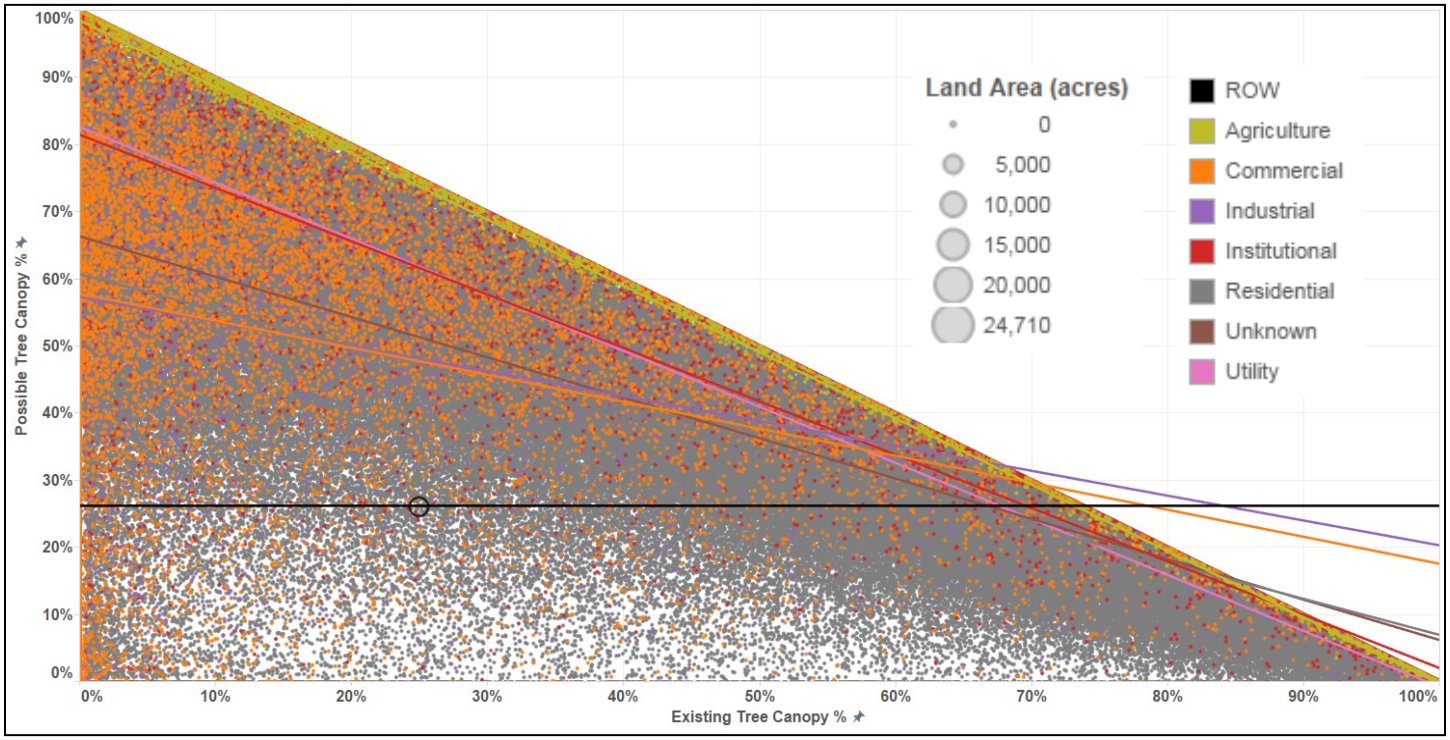

Figure 6: Relationship between Existing Tree Canopy and Possible Tree Canopy for each parcel in Montgomery County.

Land Use & Land Cover

To examine the relationship between land use and land cover, the total area for each land use class was summarized and the percent of vegetated cover (trees, grass, and shrubs) in each land use category was computed (Figure 7). This analysis provides an understanding of how "green" each land use class is. The largest single land use category is Residential, followed by Agriculture. Agriculture and Institutional are the most green land use classes, with 97% and 87% of their land area covered by vegetation. At the low end ROW land uses have 41% of their land covered by vegetation. Any steps that Montgomery County can take to green up the county will help to reduce storm water runoff and reduce the urban heat island effect. The strategy for greening will likely differ by land use class. Examples include tree give away programs for residents, conservation easements along riparian buffers in agricultural areas, and zoning regulations limiting the amount of impervious surfaces in commercial areas.

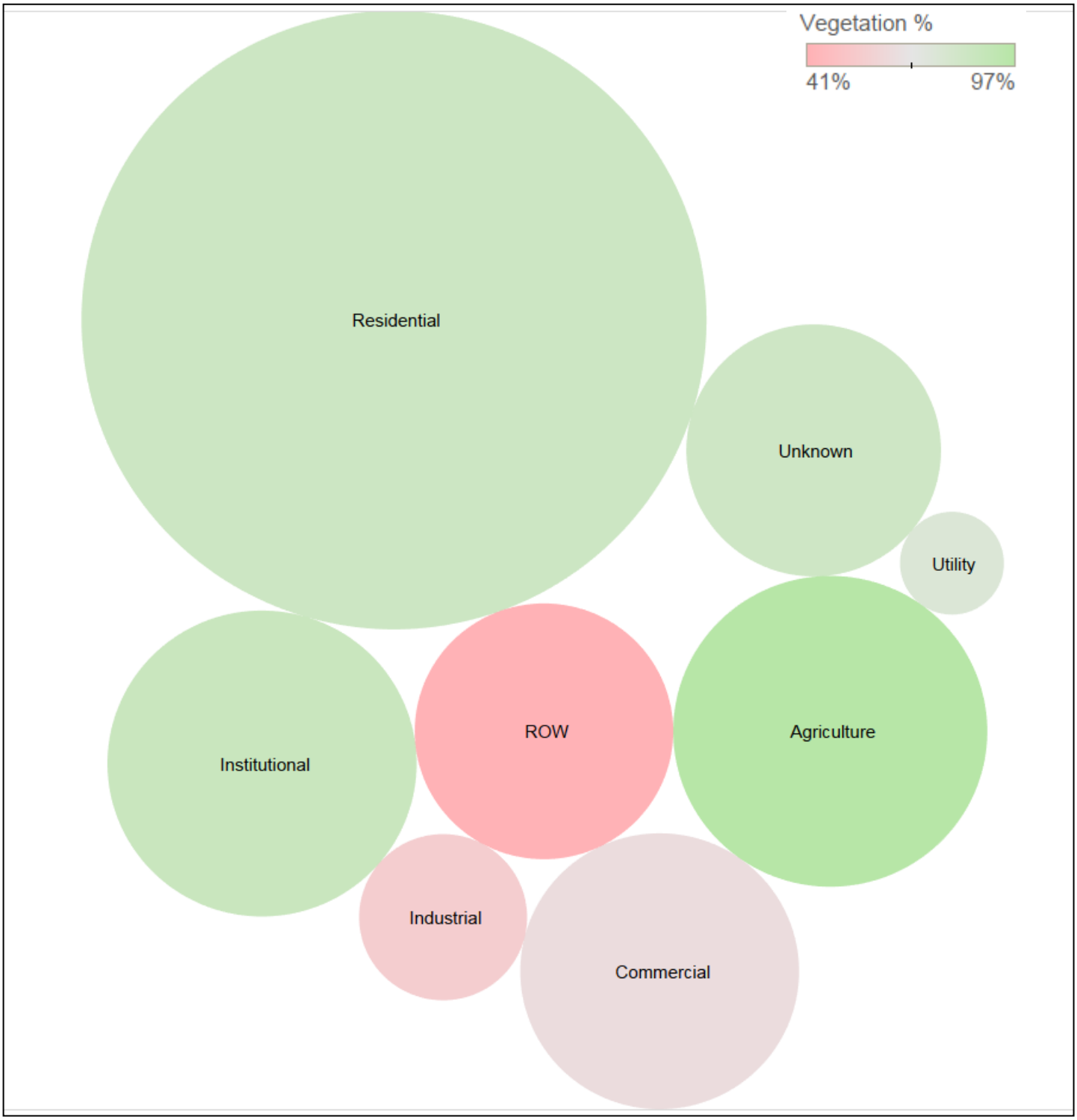

Figure 7: Percent of vegetated cover for each land use class in relation to total land area. The size of the circle represents the total land area, the color gradient represents the percentage of vegetation. Percentages are calculated based on the amount of vegetation relative to land area (i.e. water is excluded).

Urban Heat Island Effect

A well-known benefit of trees is their ability to reduce ground-surface temperatures, both by direct shading and retention of soil moisture. In areas where tree canopy has been removed, surface temperatures can be substantially higher than adjacent forested areas. The effect may be most pronounced in areas with extensive impervious surfaces, which absorb and hold thermal radiation from the sun. Analysis of recent thermal data (Landsat, August 28, 2010) illustrated this effect in the Montgomery County region (Figure 8). This relationship was further confirmed by plotting surface temperature versus Existing Tree Canopy, (Figure 9). An inverse relationship exists between tree canopy and surface temperature providing clear evidence that trees help to reduce the urban heat island effect. The large forest patches in northwestern Montgomery County results in substantially lower temperatures.

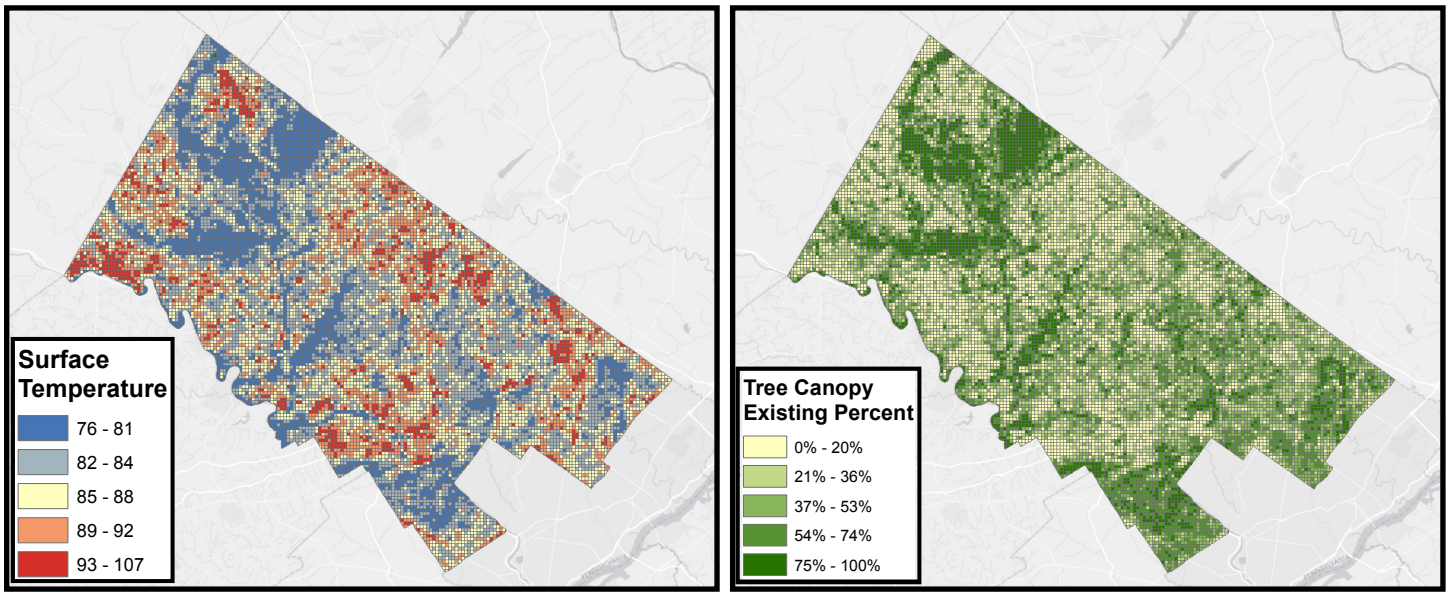

Figure 8: Surface temperature, degrees Fahrenheit on August 28, 2010 (left) in comparison with Existing Tree Canopy (right).

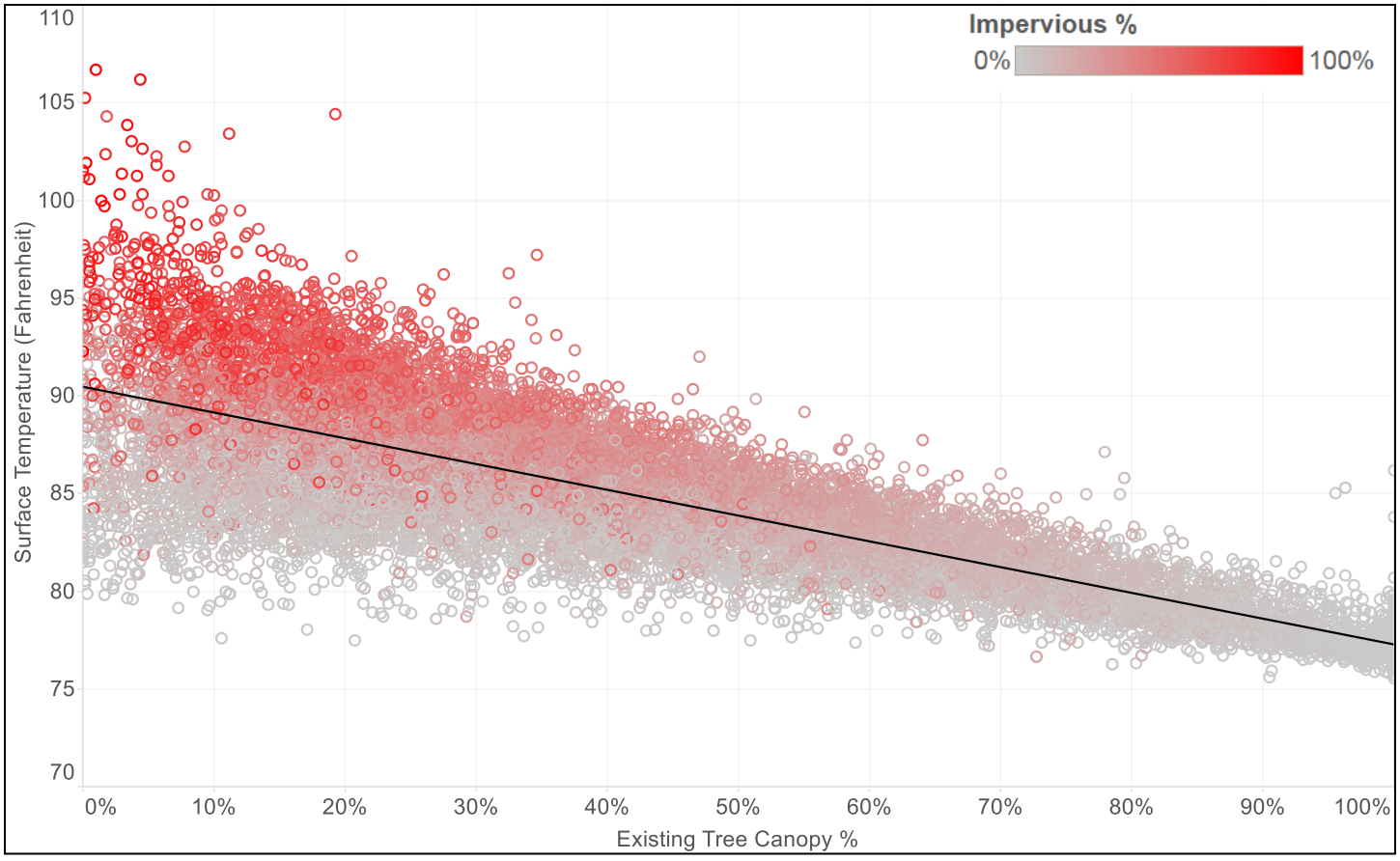

Figure 9: Surface temperature in relation to percent tree canopy. Each circle represents a 1000ft grid cell. A 1000ft x 1000ft grid was overlaid on the region and for each grid cell the percent tree canopy, percent impervious, and average surface temperature were summarized. Surface temperature was derived from Landsat satellite imagery acquired on August 28, 2010.

Municipalities

Tree canopy metrics were computed for each municipality in Montgomery County. Lower Merion has the largest land area and the most Existing Tree Canopy in Montgomery County (Figure 10). Marlborough has the highest percentage of Existing Tree Canopy (65%), with Lower Frederick having the second highest at 62% (Figure 11). Red Hill and Bridgeport, which primarily encompass urban areas with low tree canopy, have relatively low percentages of Existing Tree Canopy at 16% and 17%, respectively. In terms of establishing new Tree Canopy, Franconia and Douglass have 70% and 65% of their land area classified as Possible Tree Canopy. Franconia contains large areas of agricultural fields which will constrain tree planting opportunities when farming operations are active, but select improvements in tree canopy could be made in riparian areas. Douglass contains multiple new housing developments with very small trees and as these trees grow it will increase the tree canopy percentage.

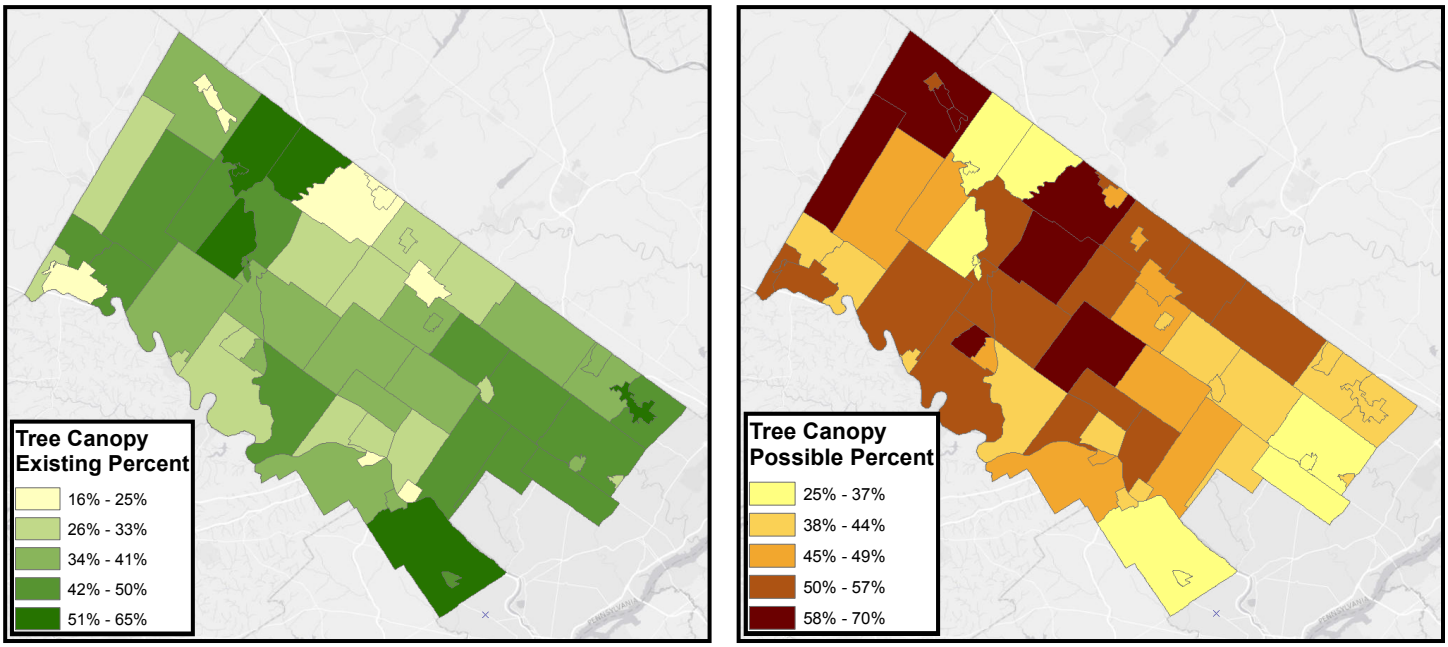

Figure 10: Percent Existing Tree Canopy by municipality (left) in comparison to Percent Possible Tree Canopy by municipality (right).

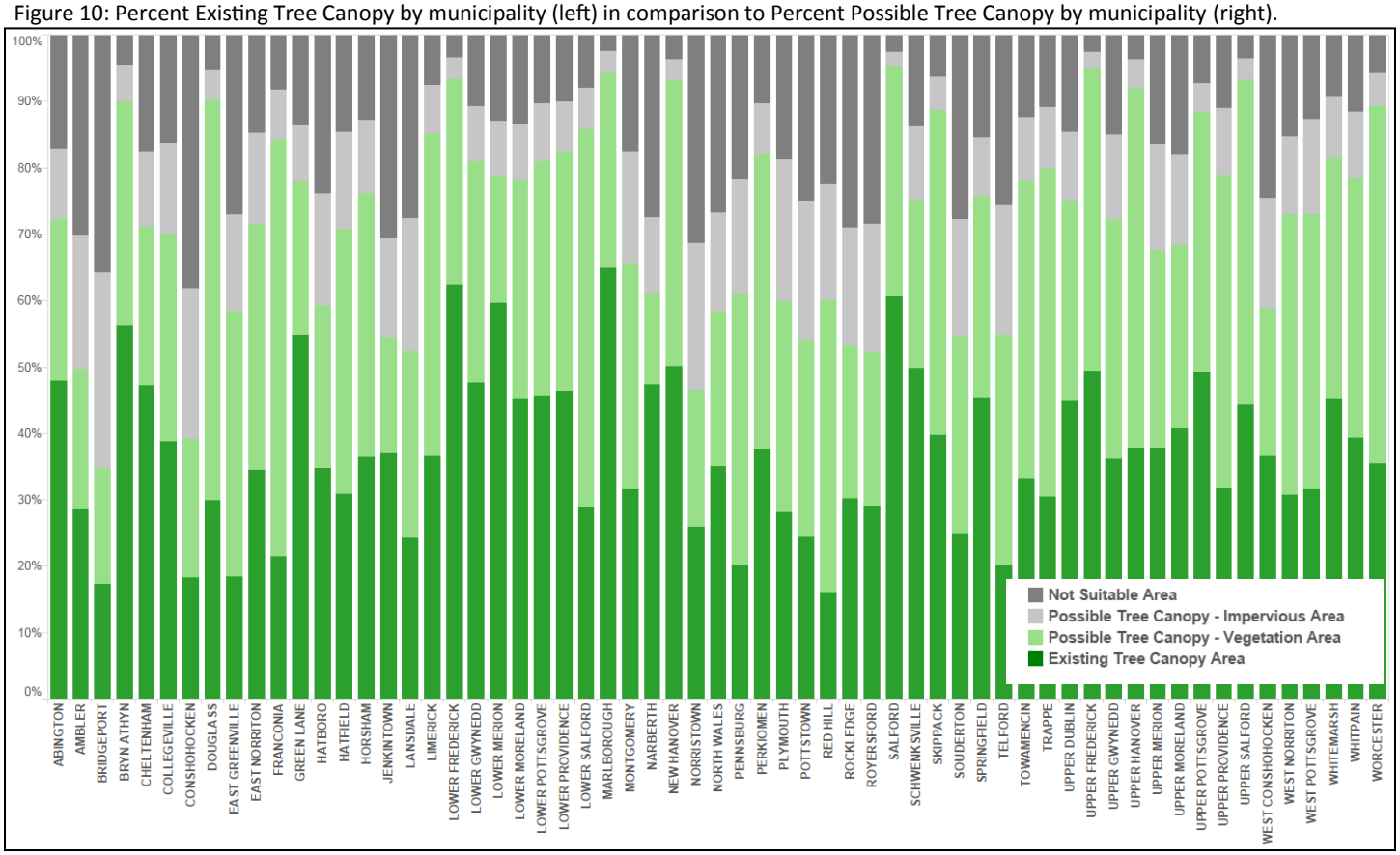

Figure 11: Comparison of Existing and Possible Tree Canopy by municipality in Montgomery County.

Watersheds

Existing and Possible Tree Canopy were summarized by watersheds within Montgomery County, PA. The Little Valley Creek - Valley Creek Watershed has the highest percentage of Existing Tree Canopy (82%), but the majority of it's borders are located outside of Montgomery County (Figure 12). Unami Creek Watershed has the second highest percentage of Existing Tree Canopy (76%). This watershed, which contains Unami Creek and Ridge Valley Creek is largely forested with comparatively little urban development. East Branch Perkiomen Creek Watershed has the highest percentage of Possible Tree Canopy (62%). Skippack Creek Watershed, the largest watershed in Montgomery County, contains a relatively low percentage of Existing Tree Canopy (34%) and has the second highest percentage of Possible Tree Canopy (56%). East Branch Perkiomen Creek Watershed encompasses large areas of agricultural fields and multiple housing developments with little tree canopy (Figure 13). Skippack Creek Watershed represents an excellent watershed to focus on for tree planting projects as it contains relatively large amounts of Possible Tree Canopy Vegetation on Residential lands.

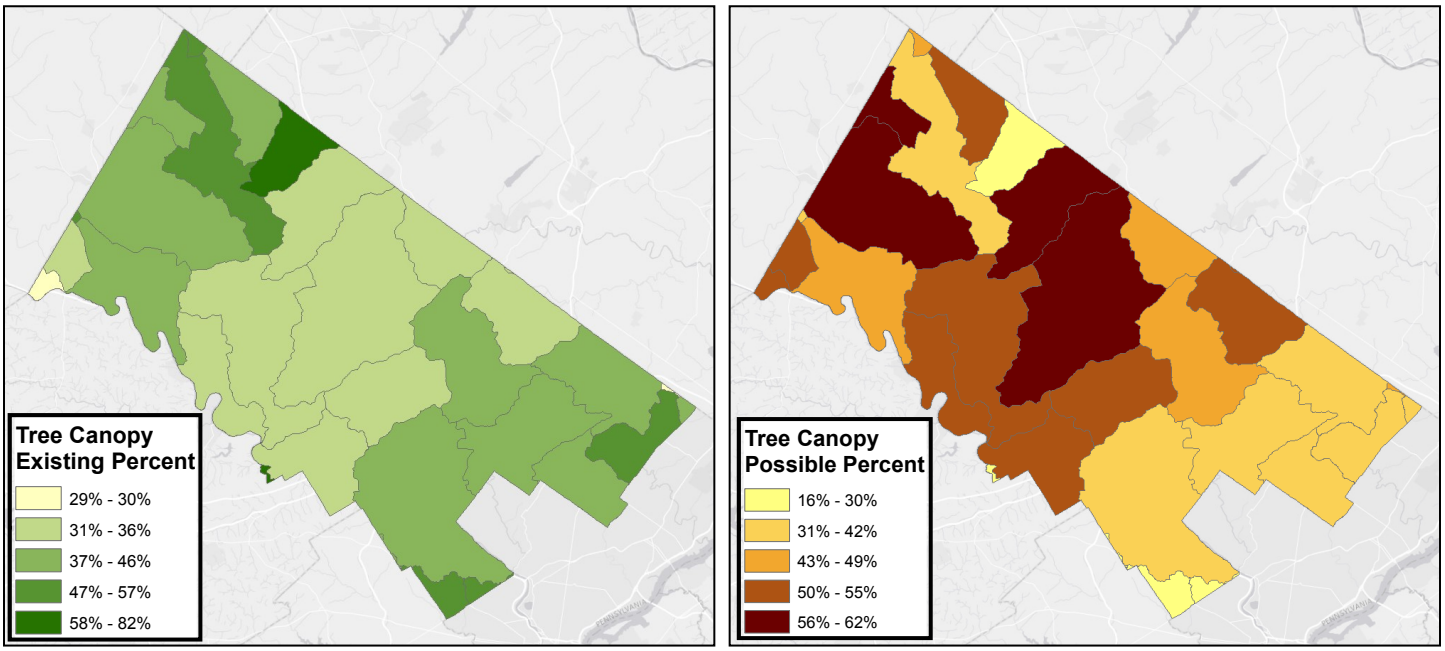

Figure 12: Percent Existing Tree Canopy by watershed in comparison to Percent Possible Tree Canopy by watersheds.

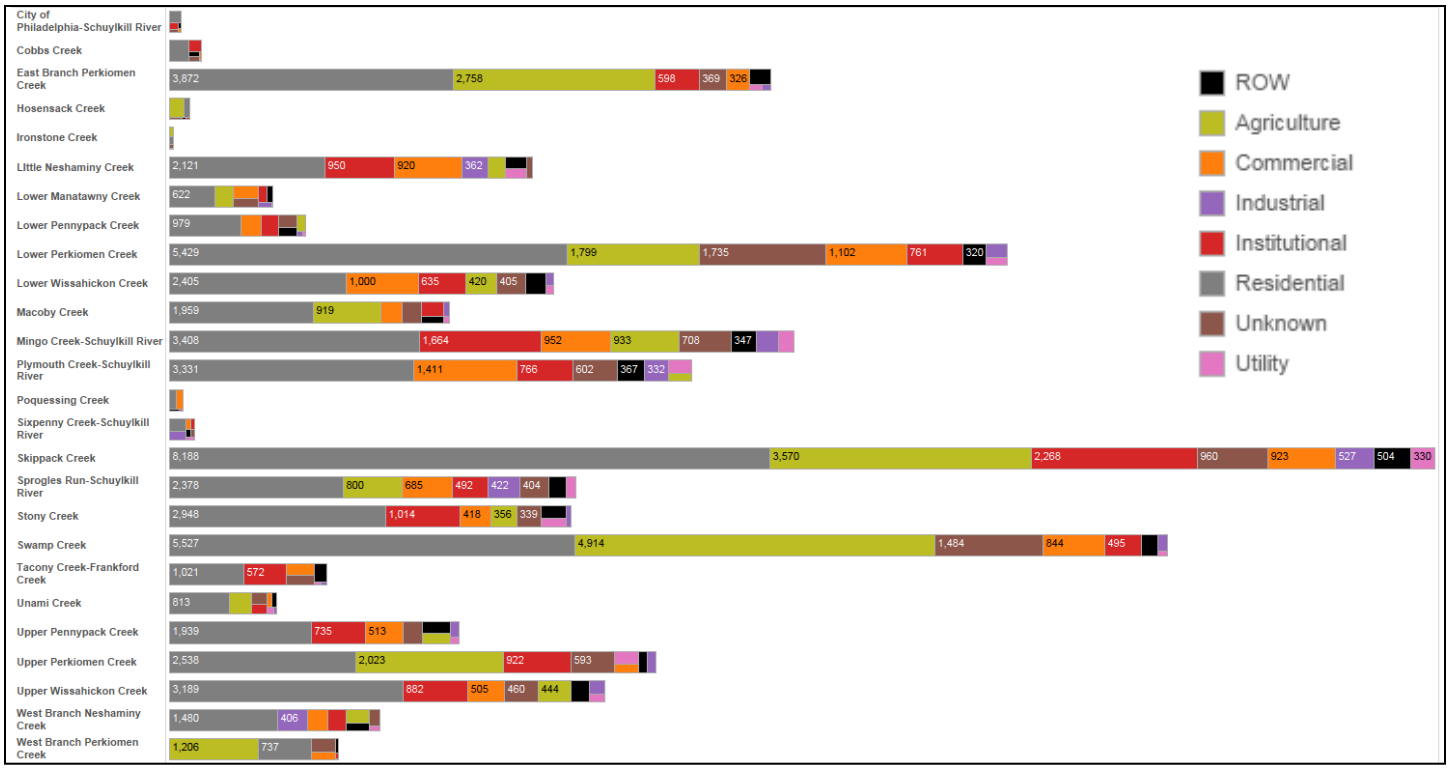

Figure 13: Total area (Acres) of Possible Tree Canopy Vegetation for each watershed in Montgomery County and summarized by Land Use.

Riparian Areas

Environmental analyses are also possible at finer scales, including assessment of Existing and Possible TC in riparian corridors. When vegetated with contiguous tree canopy, these ecologically-important landscape features are known to reduce runoff and protect habitats for a diversity of aquatic and riparian wildlife. For example, when rivers, streams, and other water bodies are buffered by 100 feet on each side and then broken down by land use classes, it becomes apparent that riparian corridors in Montgomery County occur primarily in Residential areas and are largely forested (Figure 14). Within the riparian areas, which total 17,041 acres, 68% is Existing Tree Canopy and 28% is Possible Tree Canopy (Figure 15). Residential and ROW zones contain the largest area of Possible Tree Canopy, suggesting that opportunities exist for further tree-canopy improvements.

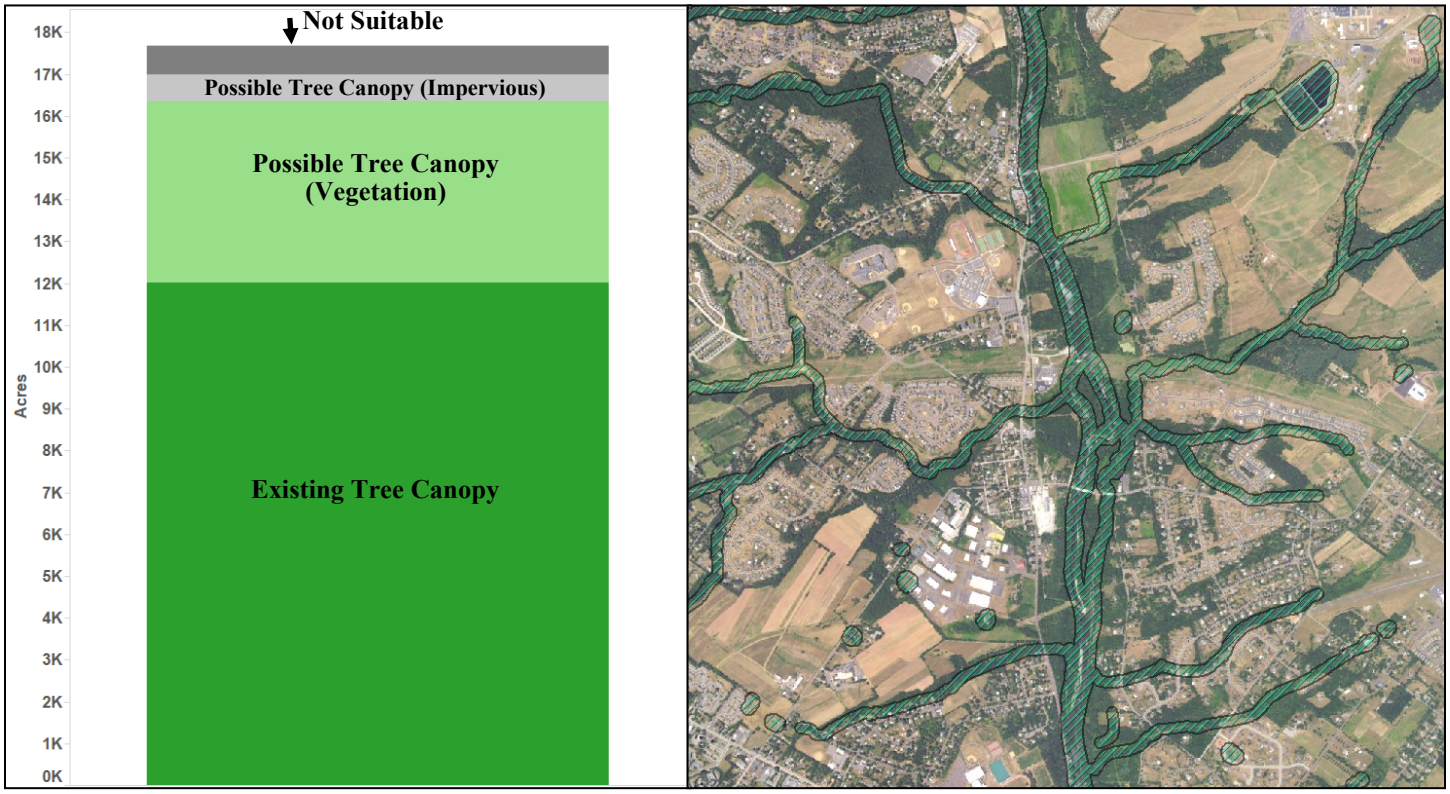

Figure 14: Tree Canopy Metrics summarized by 100 foot riparian buffer.

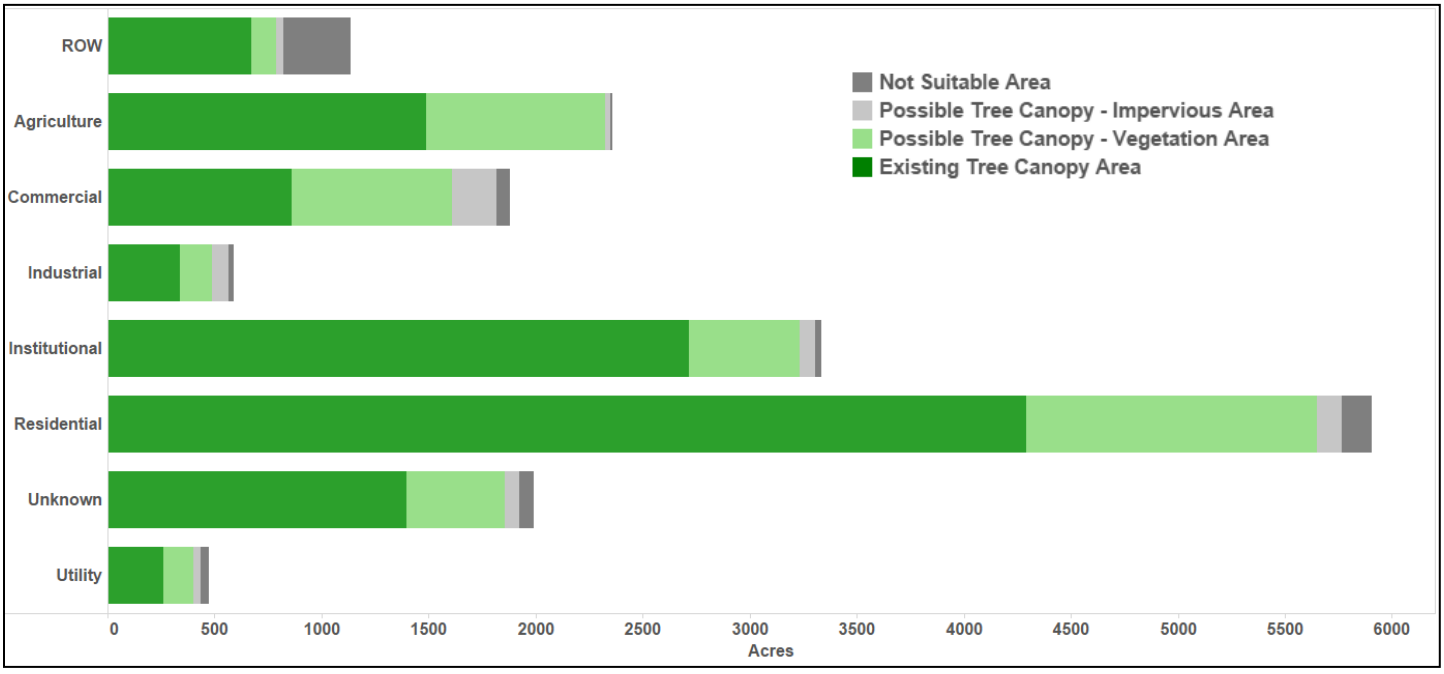

Figure 15: Tree Canopy Metrics broken down by land use for riparian buffer areas in Montgomery County. The length of each bar represents the area in acres of Existing Tree Canopy, Possible Tree Canopy, and areas that are not suitable for planting trees.

Urbanization

Tree Canopy Metrics were computed for the Urbanization Gradient, which is part of the Census Block Groups data set. A majority of the Principal Urban Centers and Metro Cities are located in the southeast near Philadelphia (Figure 16). As the Urbanization classification changes from urban to rural it would be expected that Existing Tree Canopy percentage would increase, however, this is not the case in Montgomery county (Figure 17). Rural areas in Montgomery County contain large areas of open fields and Agricultural land uses decreasing the Existing Tree Canopy percentage and increasing the Possible Tree Canopy Vegetation percentage. Principal Urban Centers have similar proportions of Existing Tree Canopy as the other urbanization classes but contain the smallest proportion of Possible Tree Canopy Vegetation (30%). The Suburban areas represent an excellent opportunity for tree planting projects as they contain relatively large amounts of Possible Tree Canopy Vegetation on Residential and Commercial land uses (Figure 18).

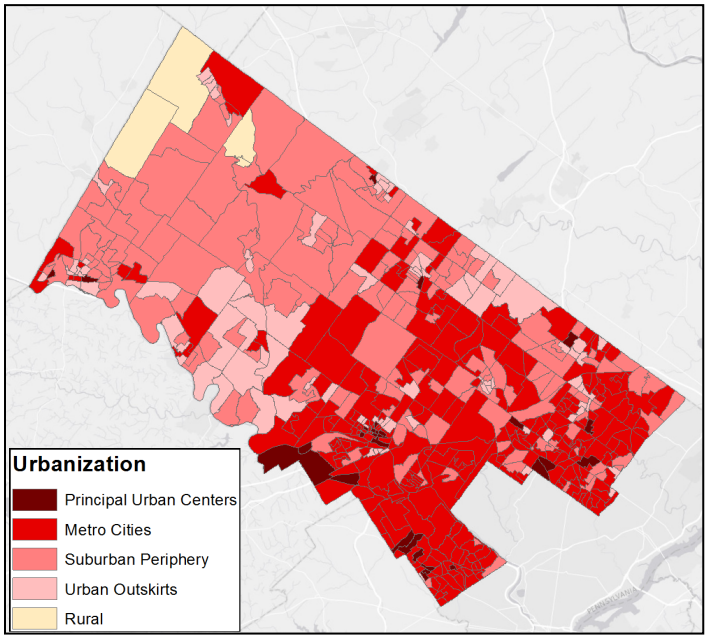

Figure 16: Urbanization Gradient displayed by Census block group.

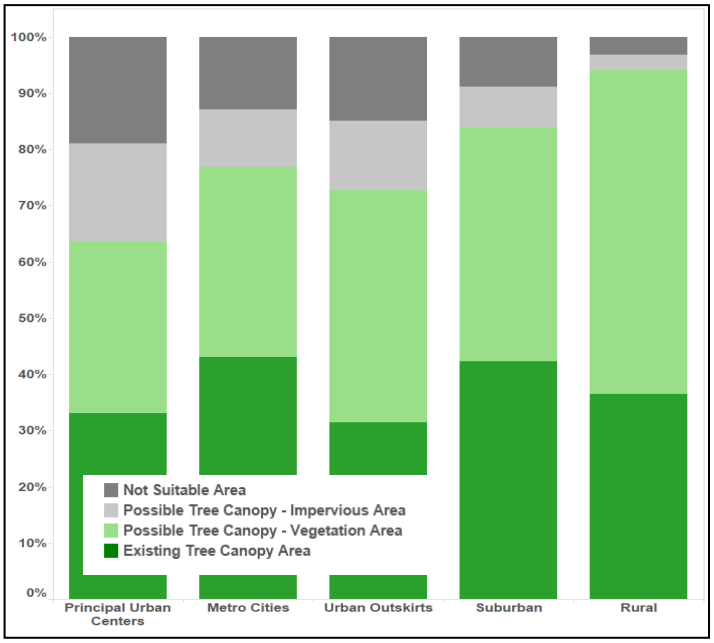

Figure 17: Tree Canopy Metrics percentages by urbanization group.

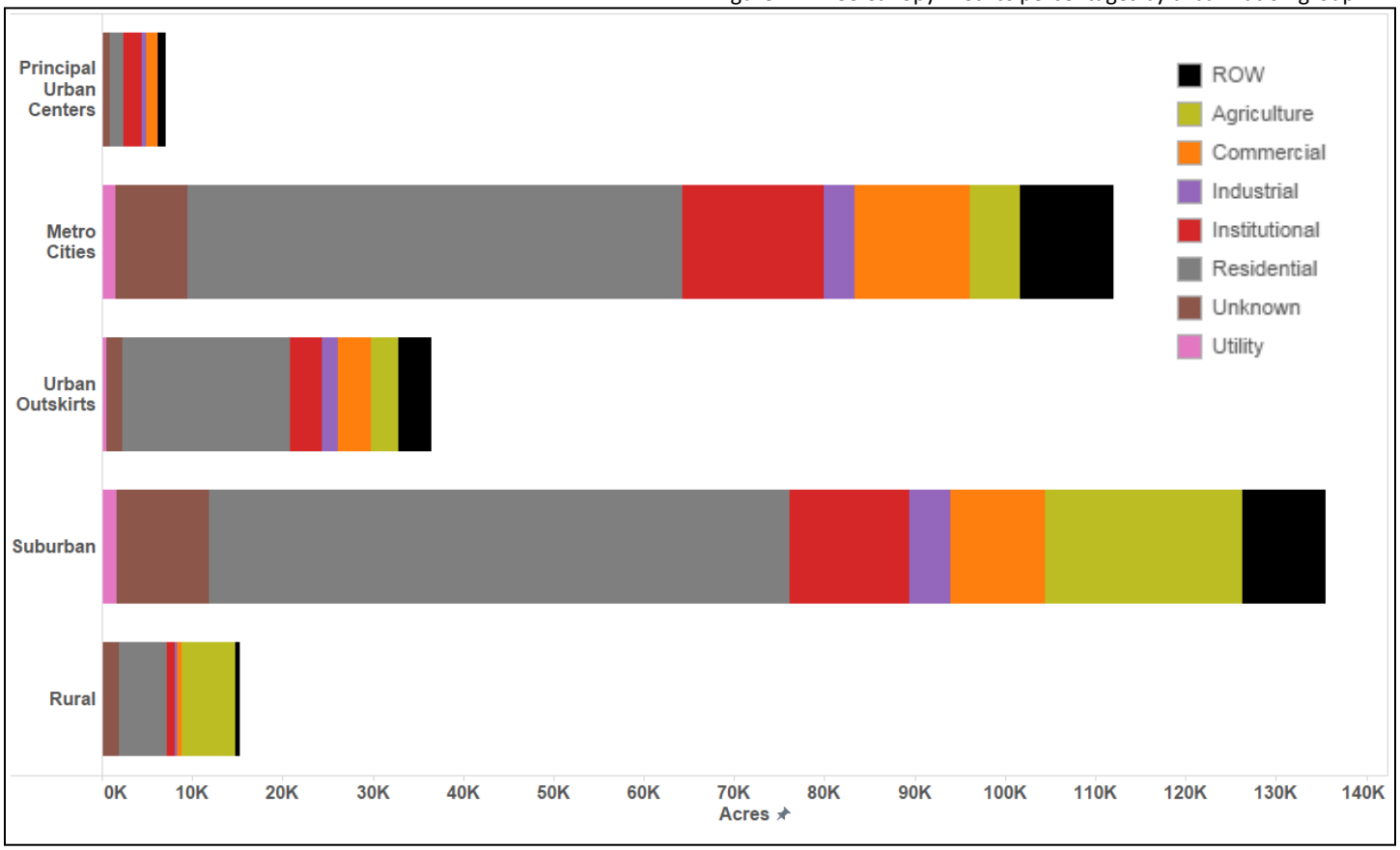

Figure 18: Total area Acres for each Urbanization Group and summarized by Land Use.

Tree Canopy Height

Average tree canopy and maximum tree canopy height was mapped for Montgomery County. Leaf-on imagery and leaf-off LiDAR were combined to create a highly accurate tree canopy map. The tree canopy and LiDAR were then combined to create polygons with maximum and average tree canopy height. The result of this process creates a vector polygon database that can be used to visualize the tree canopy and compute statistics on average canopy height and maximum canopy height (Figures 19 & 20). This data can also be used by planners to find the tallest trees in the county or to find the number of trees over 100 feet in the county.

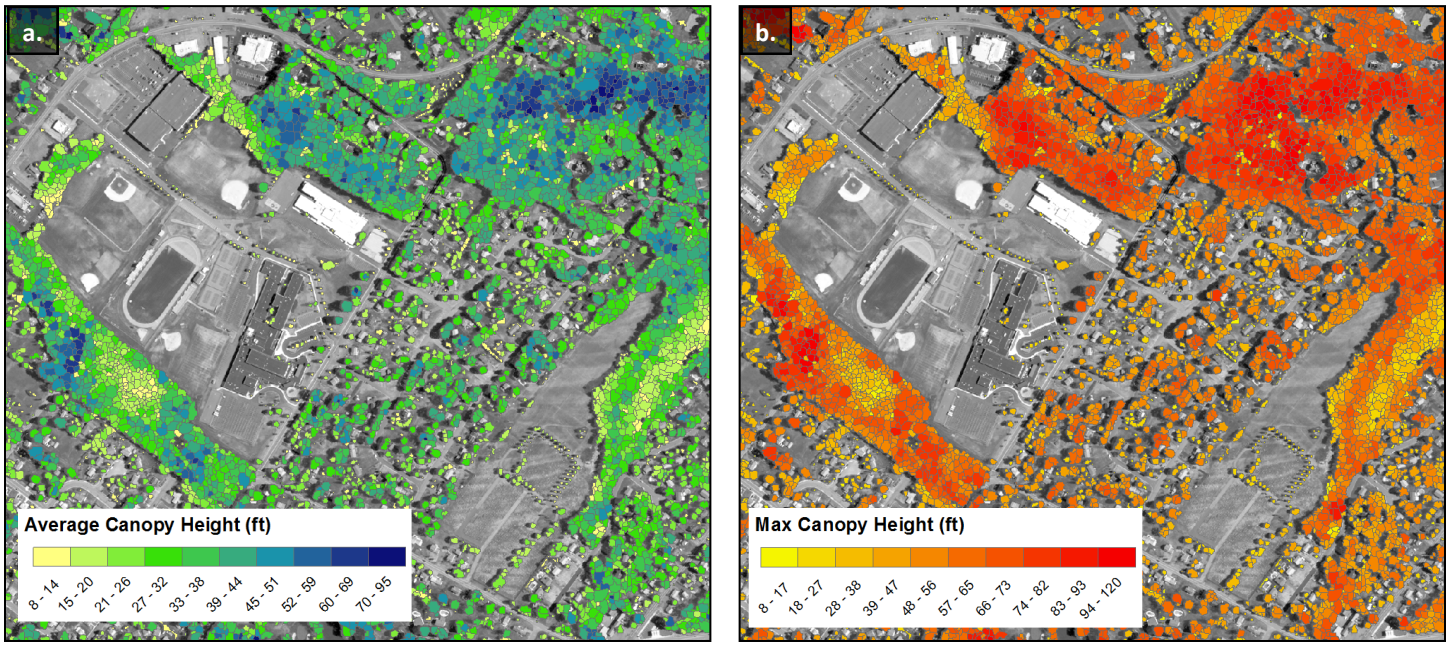

Figure 19: Average tree canopy height in feet (a) and maximum tree canopy height in feet (b).

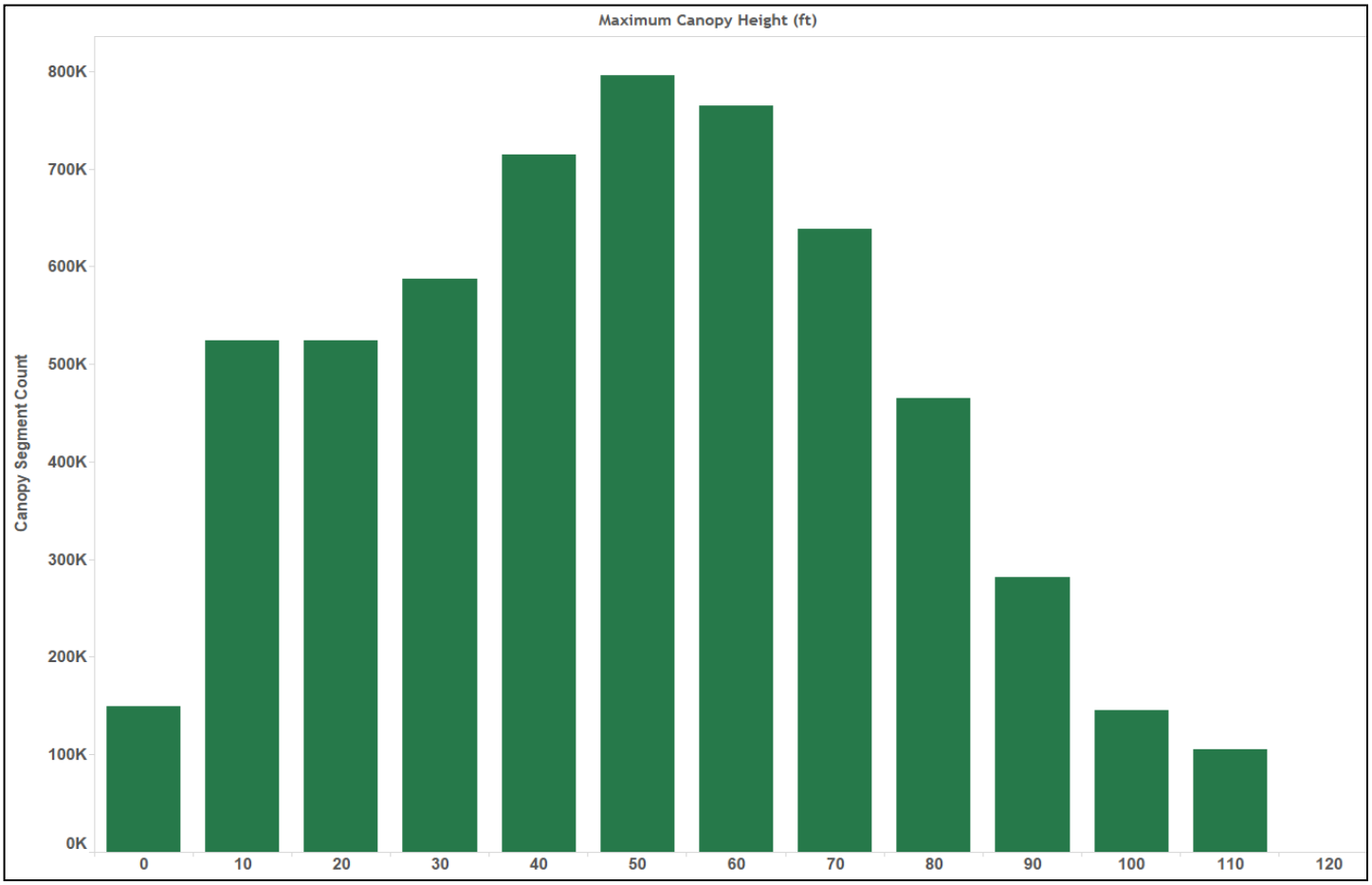

Figure 20: The height of the bar reflects the number of tree canopy segments and each bar represents the height of tree canopy.

Conclusions

- Tree canopy in Montgomery County, PA is a vital asset that reduces storm water runoff, improves air quality, reduces the borough's carbon footprint, enhances quality of life, contributes to savings on energy bills, and serves as a habitat for wildlife.
- Montgomery County should consider setting tree canopy goals, not only for increasing the overall tree canopy but to focus on increasing tree canopy in urban and residential areas that have low Existing Tree Canopy and high Possible Tree Canopy.
- Strategies for increasing tree canopy will likely differ by land-use type. The outreach and incentive mechanisms for planting trees on commercial properties will differ greatly from residential properties.
- New urban development projects in Montgomery County should include in their plans new tree plantings in yards, common areas, and transportation rights-of-way. These new trees will produce a net gain in canopy while mitigating the effects of increased impervious surfaces.
- This type of limited but strategic tree planting is pertinent to all land-use types that contain vegetated or impervious surfaces; many opportunities exist for expanding tree canopy. For example, other potential sites include road medians, sidewalks, driveways, storage areas, large expanses of lawn, and brushy vegetation. Under the right circumstances, these sites could be modified to support additional trees.
- Despite the dominance of residential land use within the county all land use types have vegetated or impervious surfaces, that if improved, could yield additional tree canopy.
- Montgomery County's residents are key to preserving existing tree canopy along with any efforts to increase tree canopy, as residential land is the single largest land use type. More tree canopy is on residential land than any other land use type, and there is more room to plant trees on residential land than any other land use type.
- Efforts to preserve and expand Montgomery County's tree canopy will likely take many forms. Tree canopy prioritization analyses can help managers make strategic decisions to match their objectives, from the property parcel level to the watershed scale.

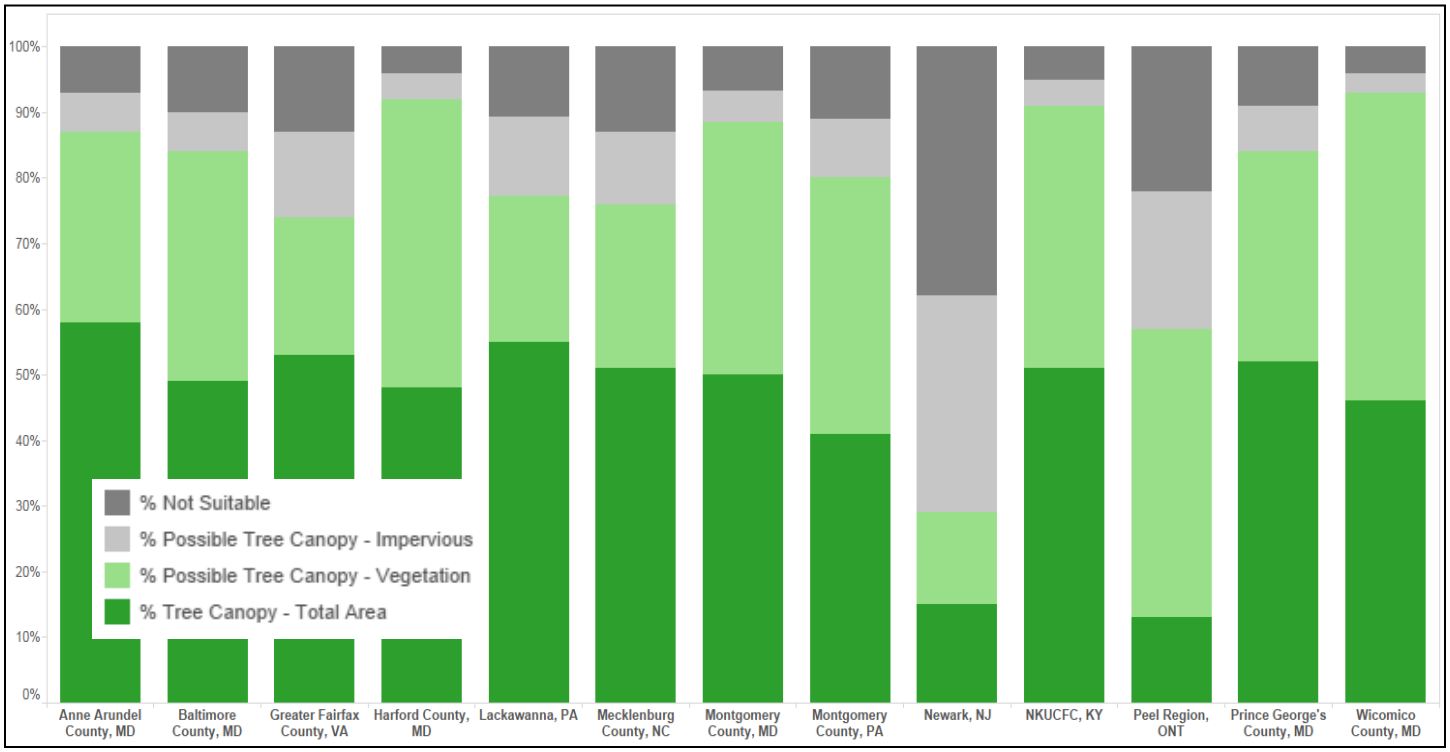

Figure 21: Comparison of Existing and Possible Tree Canopy with other communities similar in size that have completed Tree Canopy Assessments.

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Additional Information

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

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