A Report on the Allegheny 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 the temperature, 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 city as well as the amount of tree canopy that could theoretically be established.

How Much Tree Canopy Does Allegheny County Have?

An analysis of Allegheny County's tree canopy (TC) based on land cover data derived from high-resolution aerial imagery and LiDAR (Figure 1) found that 263,731 acres of the county were covered by tree canopy (termed Existing TC), representing 57% of all land in the county. An additional 34% (159,869 acres) of the county could theoretically be modified (termed Possible TC) to accommodate tree canopy (Figure 2). In the Possible TC category, 10% (45,550 acres) of the county was classified as Impervious Possible TC and another 24% was Vegetated Possible TC (114,319 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.

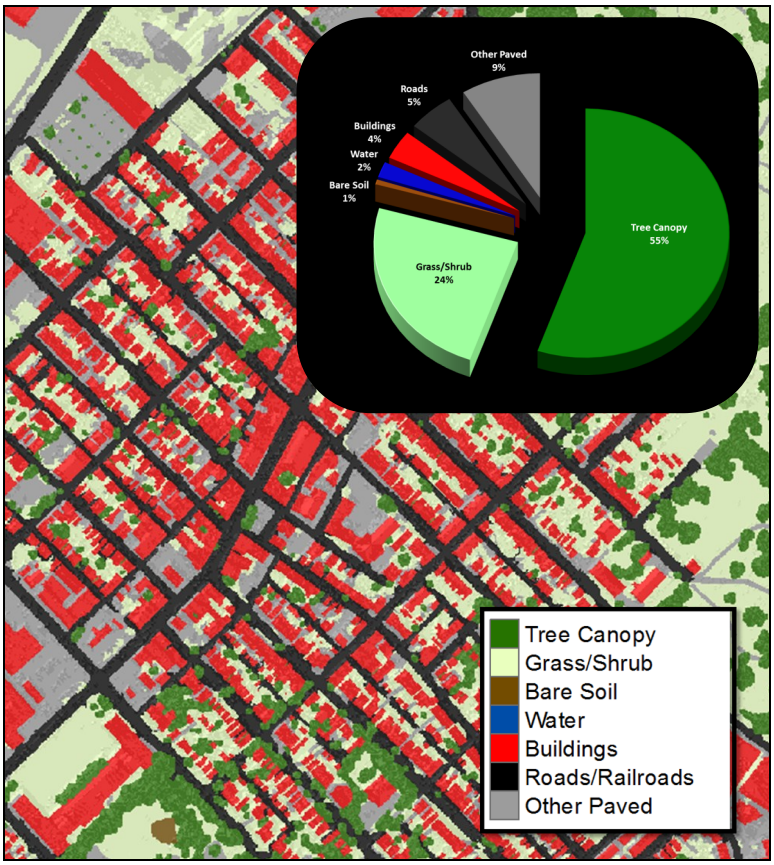


Figure 1: Land cover derived from high-resolution aerial imagery for Allegheny County. Percentages reflect total county area, including water.

Project Background

The goal of the project was to apply the USDA Forest Service's Tree Canopy (TC) Assessment Protocols to Allegheny County. The analysis was conducted based on 2010 data. This project was made possible by funding from Allegheny County and the USDA Forest Service. 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 Allegheny County, Tree Pittsburgh, and the Pennsylvania Department of Conservation & Natural Resources.

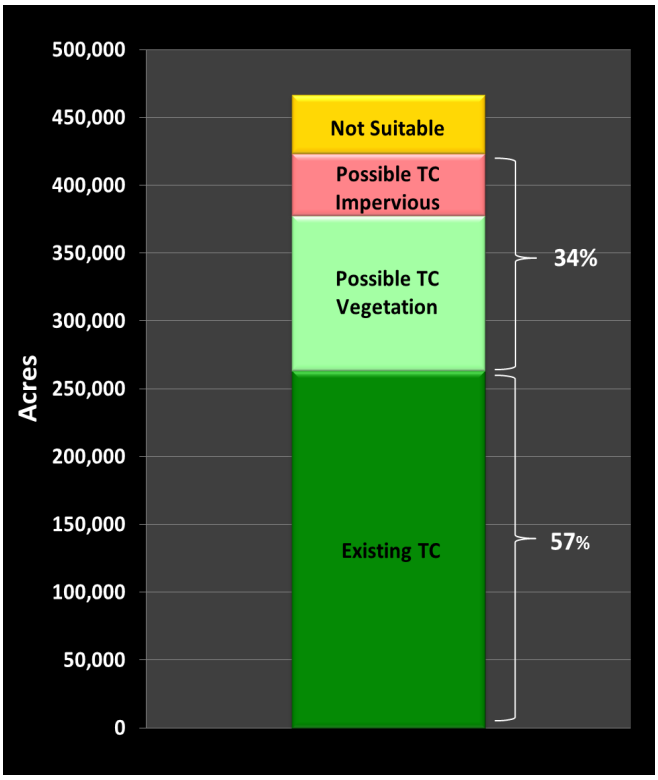


Figure 2: Tree Canopy (TC) metrics for Allegheny County based on % of land area covered by each TC type. Water is excluded from the TC metrics, resulting in a slight increase in the overall percentage of Existing Tree Canopy as compared to Figure 1. Not suitable areas are largely comprised of roads and buildings.

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.

Mapping Allegheny County's Trees

Prior to this study, the only comprehensive remotely-sensed estimates of tree canopy for Allegheny County was from the 2001 National Land Cover Database (NLCD 2001). While NLCD 2001 is valuable for analyzing land cover at the regional level, it is derived from relatively coarse, 30-meter resolution satellite imagery (Figure 3a). Using high-resolution aerial imagery (Figure 3b) and LiDAR acquired in 2010 and 2006 respectively, in combination with advanced automated processing techniques, land cover for the county was mapped in much greater detail (Figure 3c). NLCD 2001 substantially under estimated Allegheny County's tree canopy, at 43%, largely because it failed to capture smaller patches.

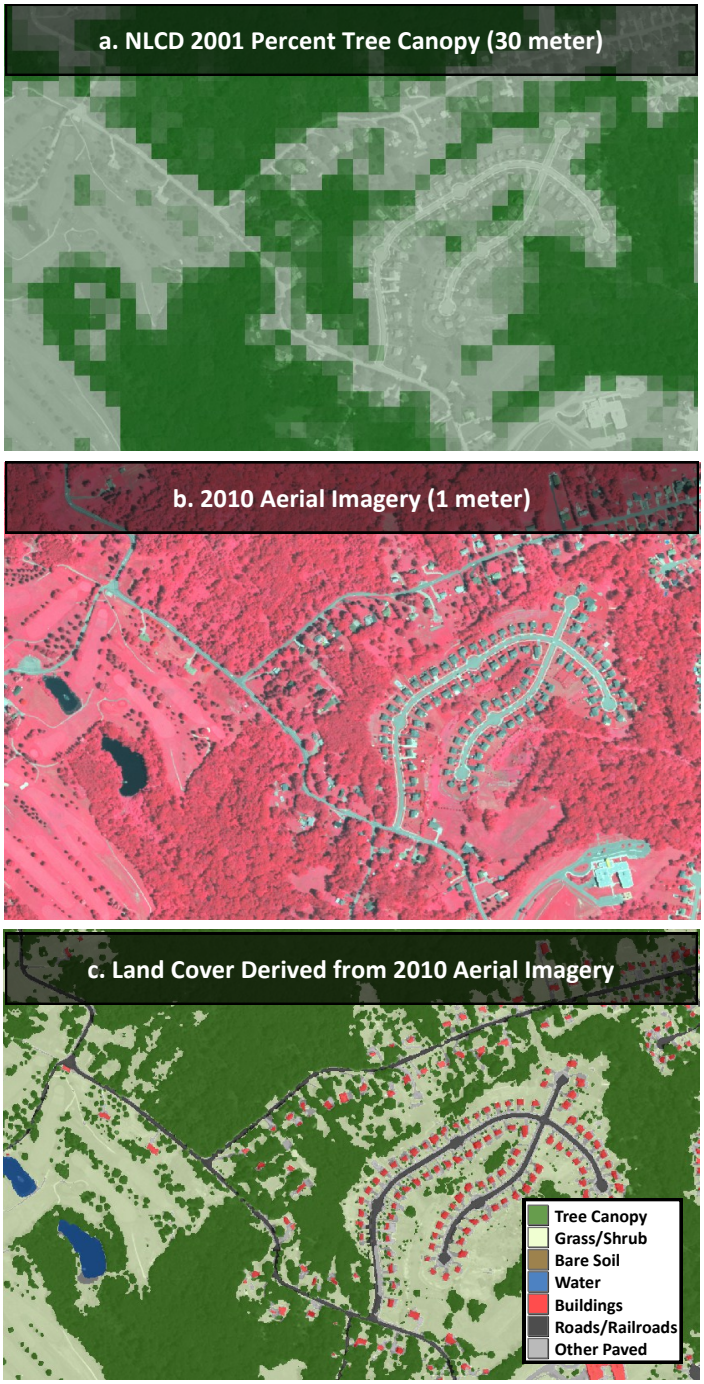


Figure 3a, 3b, 3c: Comparison of NLCD 2001 to high-resolution imagery and land cover.

Parcel Summary

After land cover was mapped countywide, Tree Canopy (TC) metrics were summarized for each property in the county's parcel database (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).

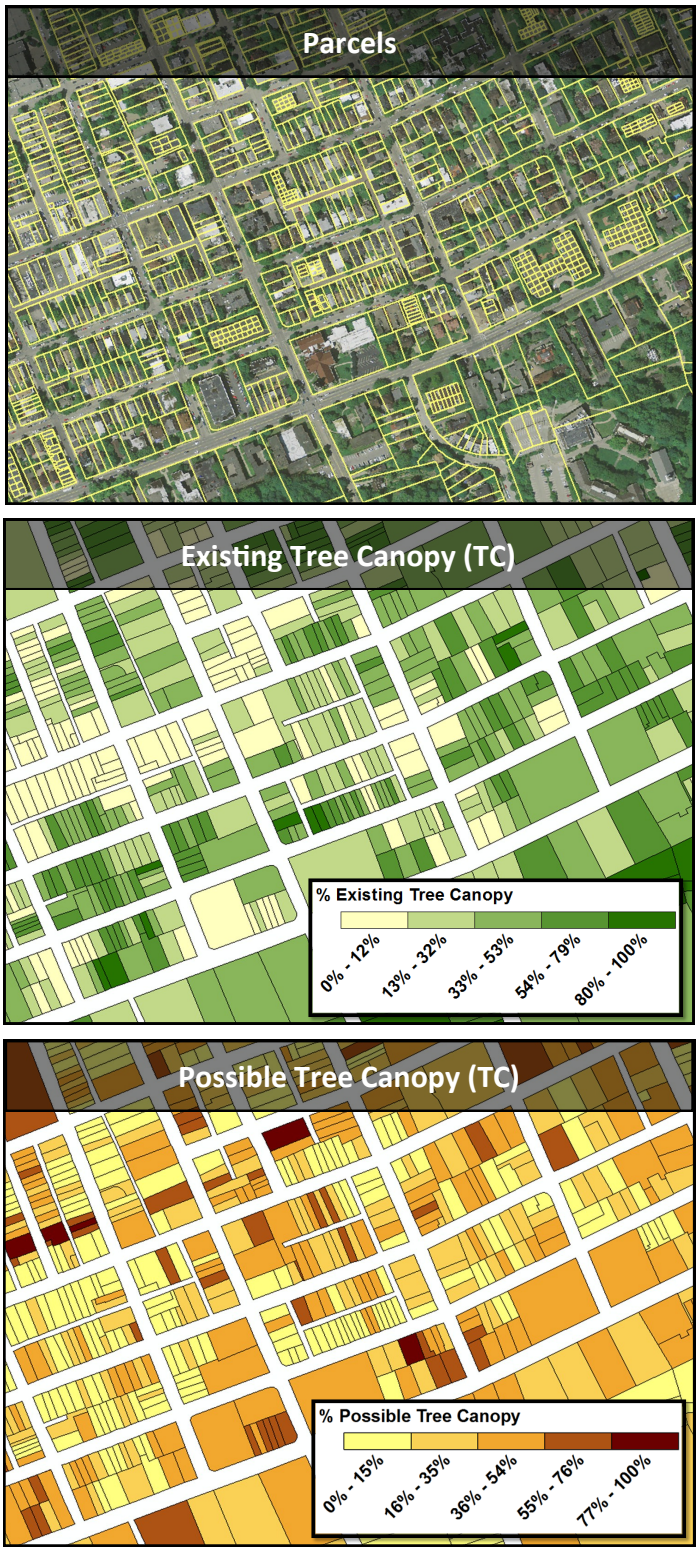


Figure 4a, 4b, 4c: Parcel-based TC metrics. TC metrics are generated at the parcel level, allowing each property to be evaluated according to its Existing TC and Possible TC.

Land Use

Allegheny County maintains a comprehensive land use layer for the region. Existing and Possible Tree Canopy (TC) were summarized for eight aggregated land use classes (Figure 5, Table 1). For each land use class, Tree Canopy (TC) metrics were calculated as a percentage of all land in the city (% Land), as a percentage of land area in the specified land use category (% Category), and as a percentage of the area for a given TC type (% TC Type). Residential land is the largest land use type within the county and is covered by 61% (% Category) tree canopy. Residential land is also the largest contributor to the county's overall tree canopy, with 54% of all of the county's tree canopy controlled by its residents. With 71% of its land covered by tree canopy, agricultural land it is the clear leader in the % Category field for Existing TC. Government land use also had a high percentage of land covered by Existing TC (63%). Residential land also accounts for the greatest amount of Possible TC in the county, at 53% (% TC Type), but Commercial, Industrial, and Other land use all have over 40% of their land area available for tree canopy (% Category). The challenge in establishing tree canopy on industrial land is that much of the available space for planting trees falls into the Possible TC Impervious category (paved surfaces that are not buildings or roads). Establishing new tree canopy on lands considered to be residential or other should theoretically be easier as they have relatively high percentages of land in the Possible TC Vegetation category.

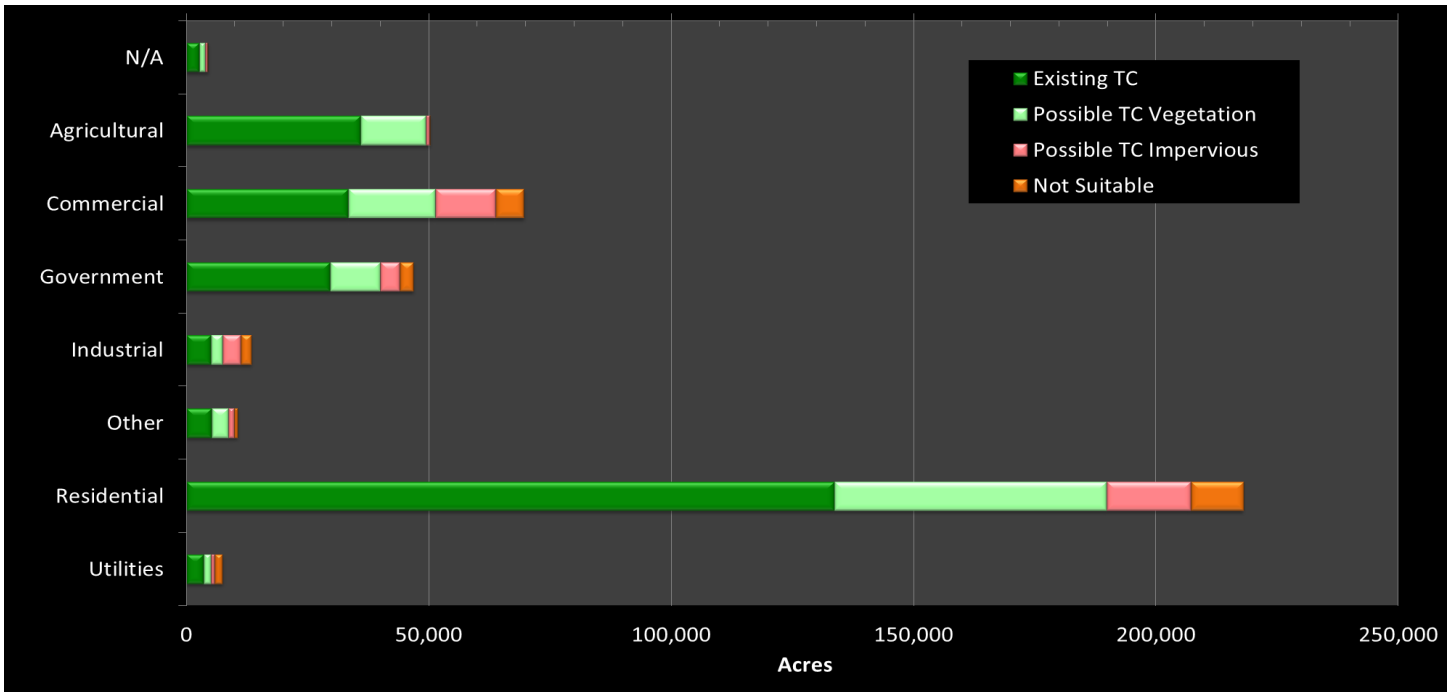


Figure 5: Tree Canopy (TC) metrics summarized by land use.

Land Use	Existing TC			Possible TC Vegetation			Possible TC Impervious		
	% Land	% Category	% TC Type	% Land	% Category	% TC Type	% Land	% Category	% TC Type
N/A	1%	60%	1%	0%	25%	1%	0%	10%	1%
Agricultural	9%	71%	14%	3%	27%	13%	0%	1%	2%
Commercial	8%	48%	13%	4%	26%	17%	3%	18%	31%
Government	7%	63%	12%	2%	22%	10%	1%	9%	10%
Industrial	1%	38%	2%	1%	18%	2%	1%	27%	9%
Other	1%	49%	2%	1%	32%	3%	0%	13%	3%
Residential	32%	61%	54%	13%	26%	53%	4%	8%	43%
Utilities	1%	48%	1%	0%	19%	1%	0%	11%	2%

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

The % Land Area value of 32% indicates that 32% of Allegheny County's land area is covered by tree canopy in the Residential land use class.

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

The % Land value of 61% indicates that 61% of land in the Residential land use class is covered by tree canopy.

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

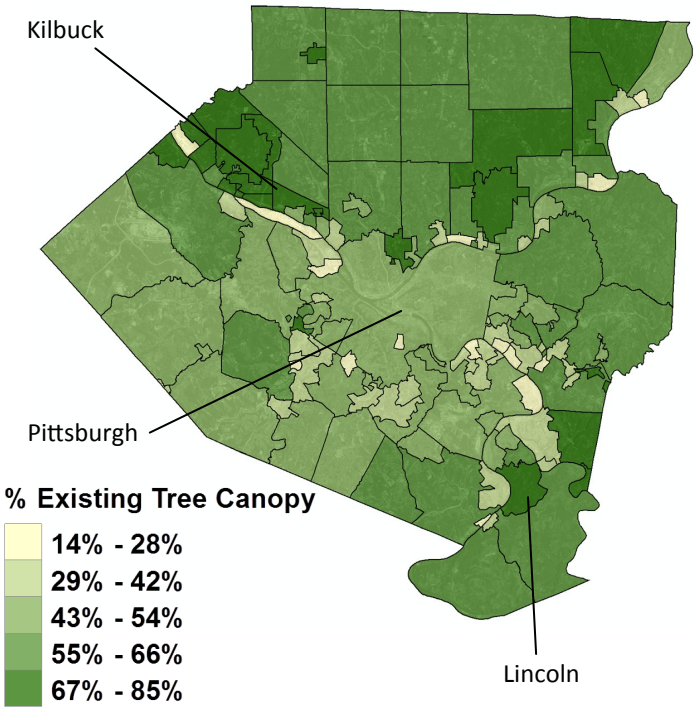
The % TC Type value of 54% indicates that 54% of all tree canopy is in Residential land use.

Table 1: 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 land use class (% Category), and as a percentage of the area for a given type (% TC Type).

Municipalities

The Existing and Possible Tree Canopy were analyzed for all municipalities within the Allegheny County boundary. There are 67 of the 130 municipalities that had greater than 50% Existing TC, with some, such as Trafford, Haysville, Bradford Woods, Kilbuck and Lincoln exceeding 80% Existing TC. Six municipalities (Neville, Graddock, Homestead, West Elizabeth, Sharpsburg, and Heidelberg) had less than 20% Existing TC and a total of fifteen municipalities had less than 30% Existing TC. Increased tree canopy is biophysically feasible on all municipalities. The municipalities of Neville, Heidelberg, Rankin, Springdale, and McDonald all had the most room to plant trees with over 50% Possible TC.

Existing Tree Canopy



Possible Tree Canopy

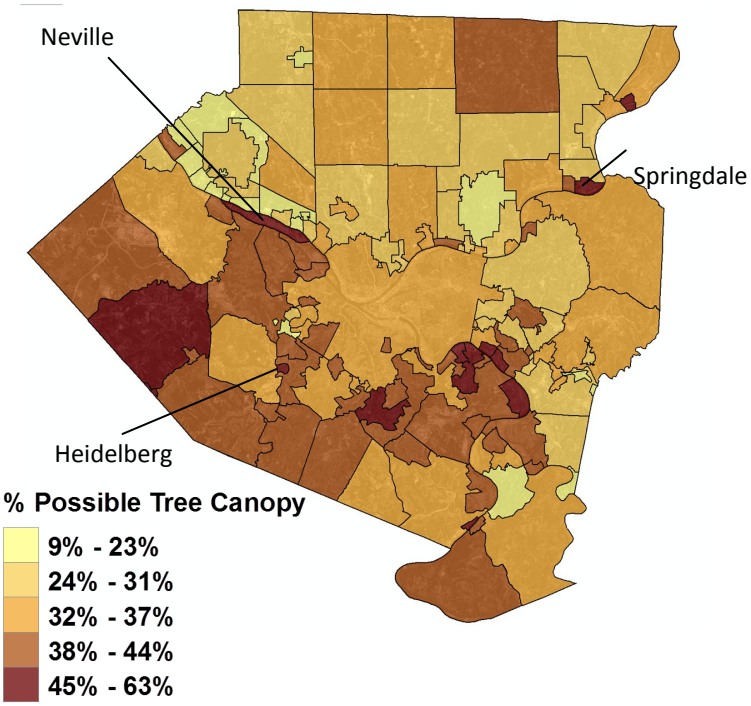
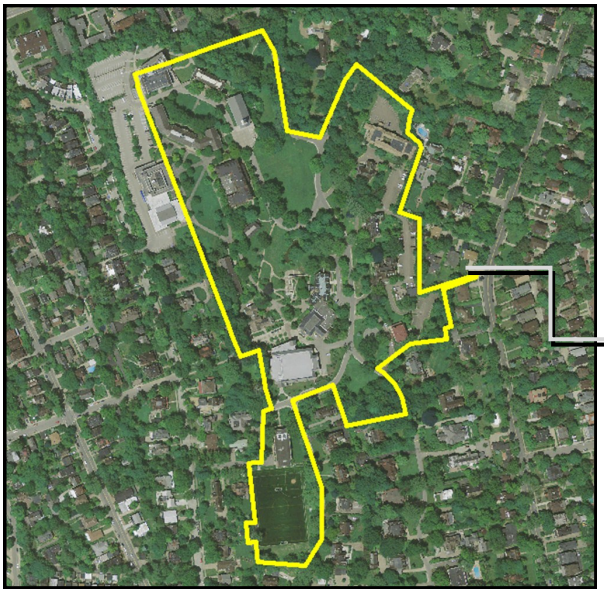
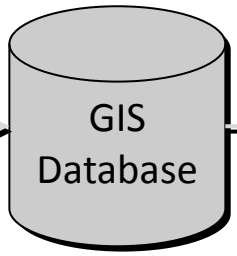


Figure 6 Existing TC (left) and Possible TC (right) as a percentage of land area by municipality.

Decision Support



Parcel-based Tree Canopy (TC) metrics were integrated into the county's existing GIS database (Figure 7). Decision makers can use GIS to query specific tree canopy 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 tree canopy improvement goals for an individual property.



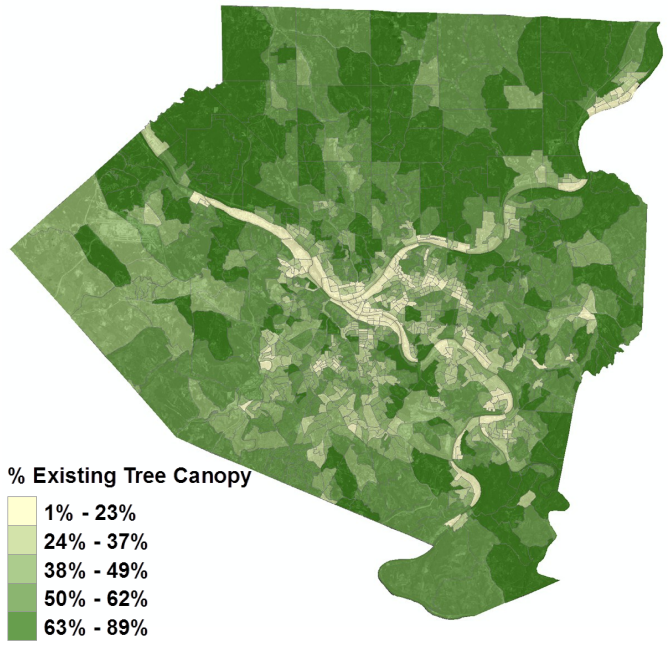
Attribute	Value
Owner	Chatham College
Land Use	Other
Address	121 Woodland Road
Tax Status	Exempt
Market Value	$3,0440,900
Existing Tree Canopy	49%
Possible Tree Canopy	33%
Pervious Surfaces	74%
Impervious Surfaces	26%

Figure 7: GIS 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.

Census Block Group Analysis

Despite Allegheny County's relatively high Existing Tree Canopy overall, the tree canopy is not evenly distributed. Typically, block groups with high population density have relatively low amounts of both overall Existing TC and tree canopy per person. The trend is most evident in Eastern Pittsburgh and several block groups surrounding the city. Block groups along the rivers, that are heavily industrialized, have high amounts of Possible TC, but given that much of this Possible TC is impervious there are challenges to increasing tree canopy in these areas.

Existing Tree Canopy



Possible Tree Canopy

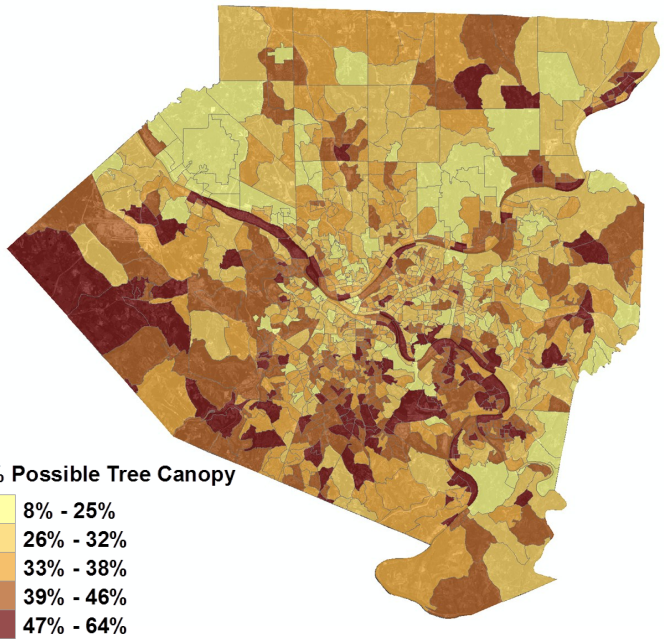


Figure 8. Existing TC (left) and Possible TC (right) as a percentage by Census Block Group.

Population Density

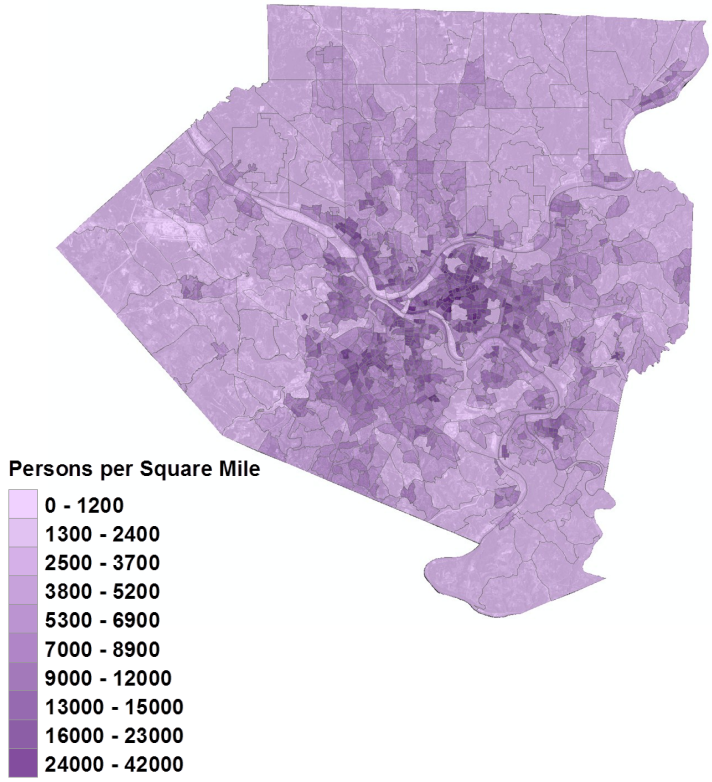


Figure 9. Population density in Allegheny county based on Census Block Groups.

Tree Canopy per Person

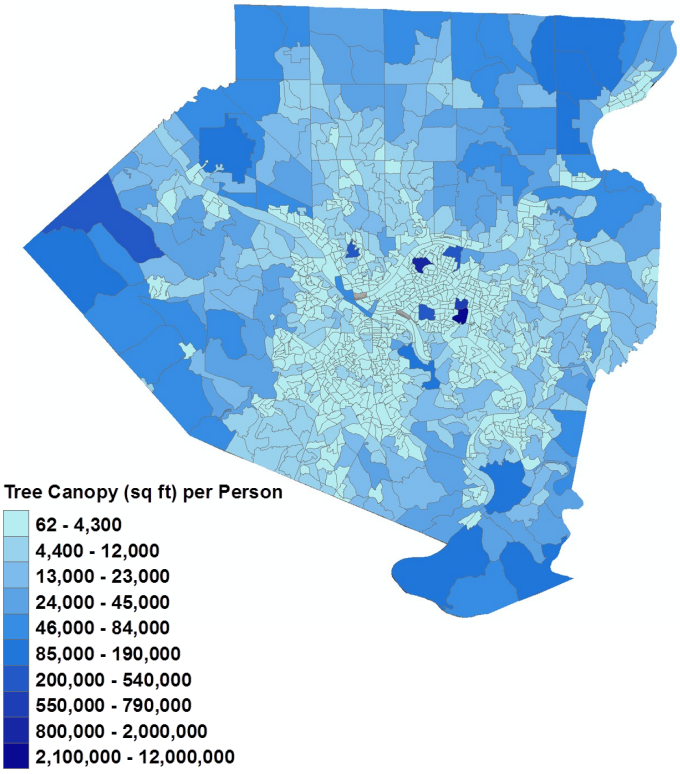


Figure 10. Tree Canopy per person based on Census Block Groups for Allegheny County.

Hydrography Buffer

Tree Canopy (TC) metrics were computed for a 100ft buffer surrounding all rivers. Within the river buffer zone 72% of the land is tree canopy and 23% of the land is available for the establishment of tree canopy.

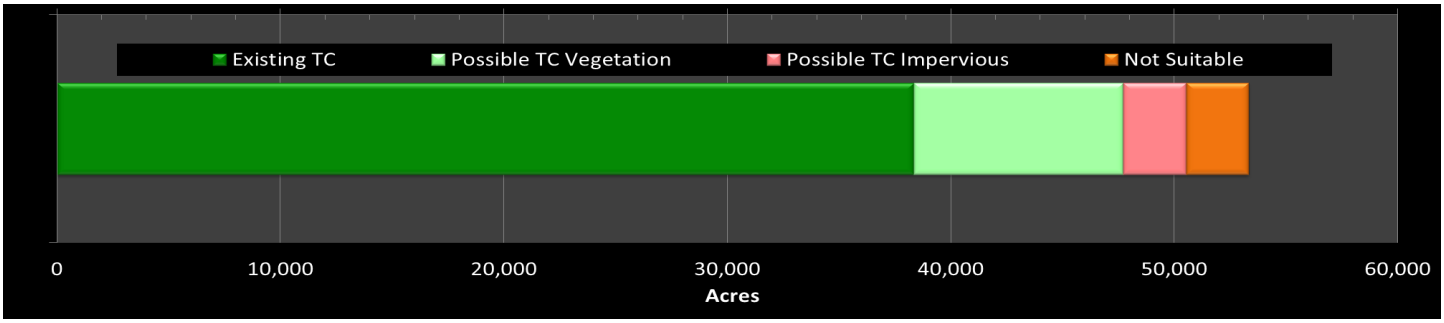
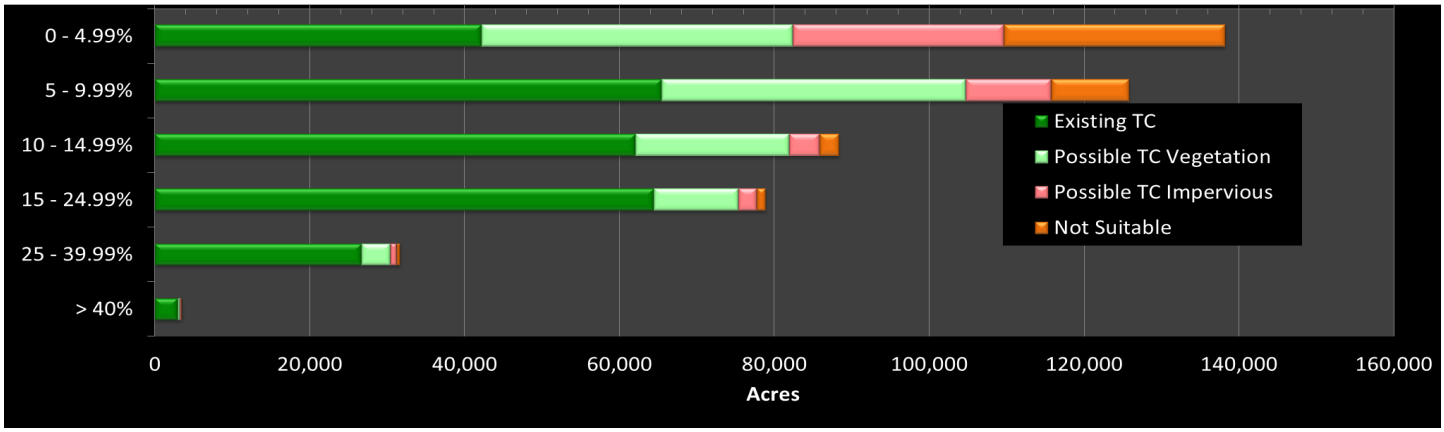


Figure 11: TC metrics summarized by a 100ft buffer around all rivers in Allegheny County.

Slope Code

Tree Canopy (TC) metrics were computed for slope codes area within the county. As slope increases there is a corresponding increasing in Existing TC, largely due to the limited development. Most opportunities for increasing tree canopy are in the lower slope areas.



DESCR Watersheds

Tree Canopy (TC) metrics were computed for DESCR watersheds within the county. Watersheds are highly variable with some having as little as 17% and others having over 90% Existing TC. The range of Possible TC is similarly variable, but the majority fell within the 20%-40% range.

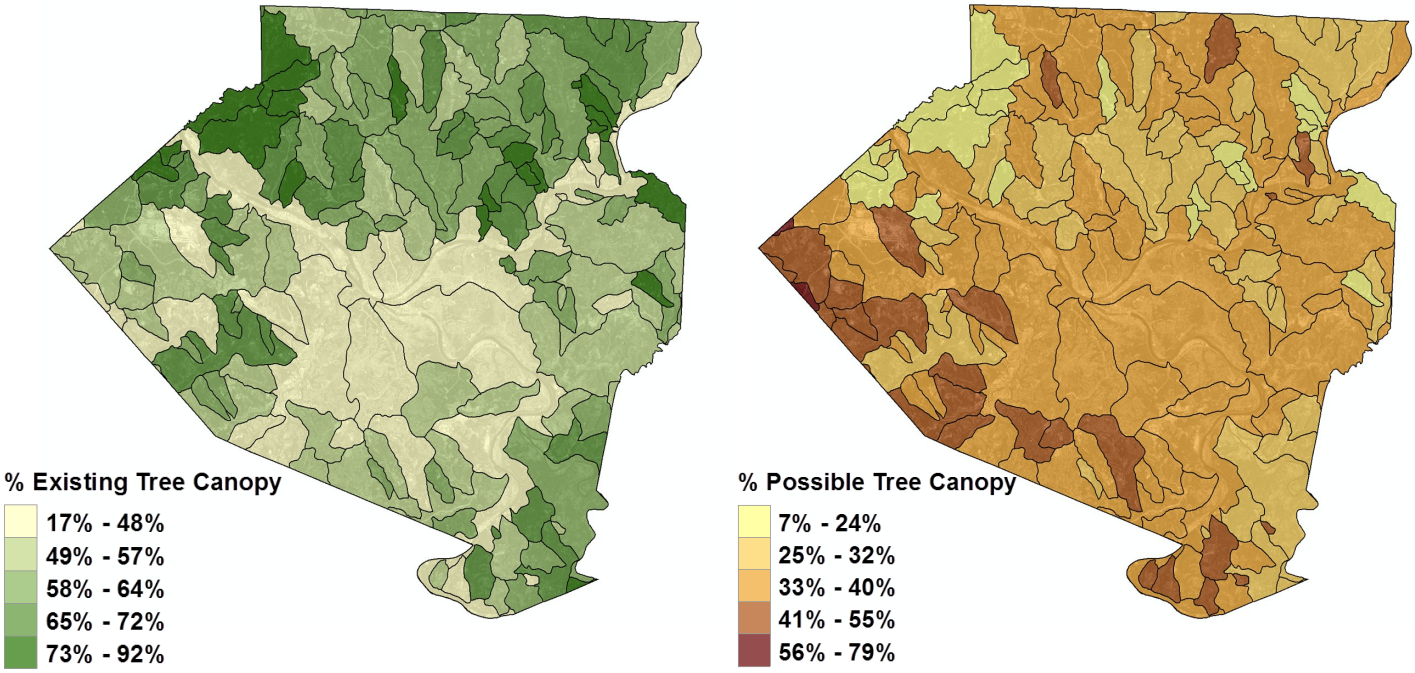


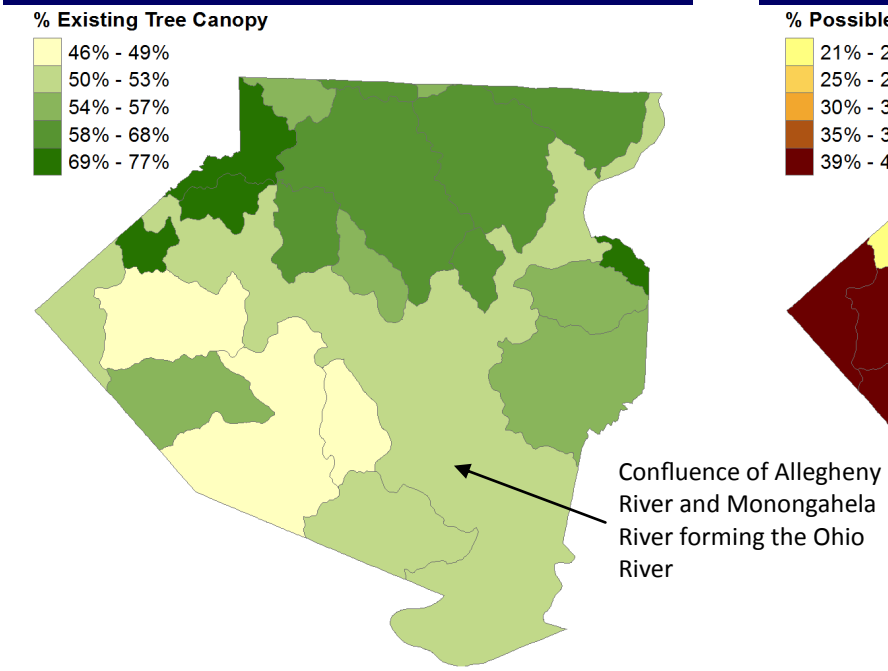
Figure 12: TC metrics summarized by DESCR watersheds.

Subwatershed Analysis

Tree canopy metrics were computed for the portions of the 20 subwatersheds that fall within the county boundary. The unnamed subwatershed covering the confluence of Allegheny and Monongahela Rivers, which form the Ohio River, is the largest subwatershed and has 53% Existing TC and 34% Possible TC. Pucketa Creek, Big and Little Sewickley Creeks, and Flaugherty Run all have greater than 70% Existing TC. Raccoon Creek, Montour Run, Chartiers Creek and Robinson Run watersheds had the highest Possible TC (> 40%)%. Big Sewickley Creek, which is heavily forested, has the lowest Possible Tree Canopy at 21%. In general, watersheds with a lower percentage of tree canopy are clustered in the Southwestern area of the county, while those with a higher percentage of tree canopy are in the Northwestern area of the county. Research in the Mid-Atlantic states indicate that tree canopy percentages of 45% in a watershed are associated with "good" stream health. All of the watersheds within Allegheny County had 46% or more Existing TC, but as indicated by the DESCR analysis, tree canopy metrics are much more variable at a finer scale.

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.

Existing Tree Canopy



Possible Tree Canopy

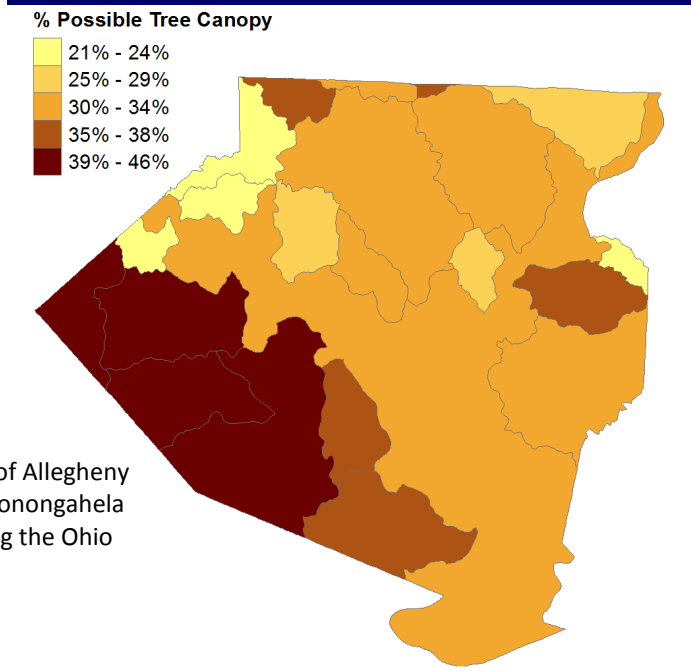


Figure 13: Existing TC (left) and Possible TC (right) as a percentage of area for each subwatershed.

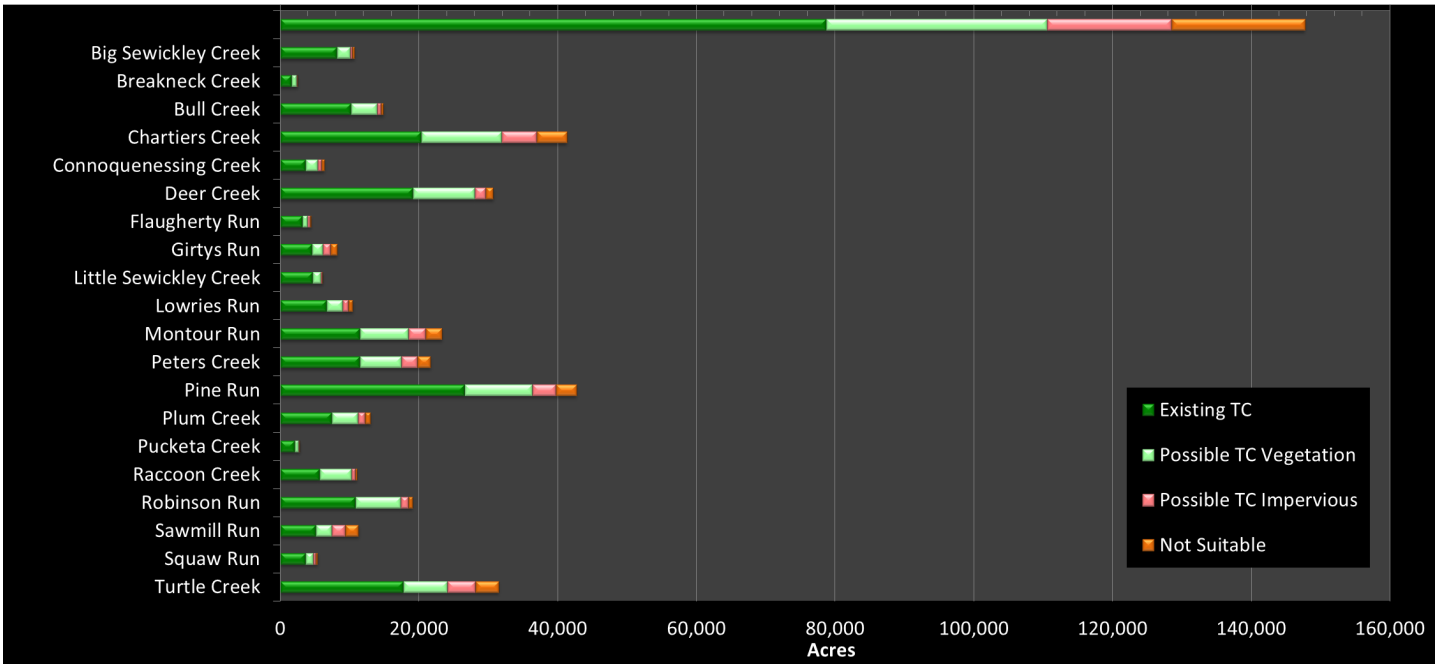


Figure 14. Graphical representation of the tree canopy metrics for the subwatersheds. The unnamed subwatershed with the largest land area is labeled in Figure 13.

Conclusions

- Allegheny County's tree canopy is a vital city asset that reduces stormwater runoff, improves air quality, reduces the city's carbon footprint, enhances quality of life, contributes to savings on energy bills, and serves as habitat for wildlife.
- With 57% of its land area covered by tree canopy, Allegheny County has an overall higher percentage compared to similar counties, but the majority of the county's residents live in Block areas with substantially less tree canopy. Some areas have as little as 5% of their land area covered by tree canopy.
- The amount of Existing Tree Canopy and Possible Tree Canopy also vary widely by municipality.
- Although this assessment indicates that 34% of the land in Allegheny County could theoretically support tree canopy, planting new trees on much of this land may not be socially desirable (e.g. recreation fields and actively farmed agriculture) or financially feasible (e.g. parking lots). Setting a realistic goal requires a detailed feasibility assessment using the geospatial datasets generated as part of this assessment.
- 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 tree canopy improvement. Of particular focus 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 runoff during periods of peak overland flow. Vacant lands should also be a focus as they present a unique opportunity.
- Allegheny County's residents are the largest steward of the county's tree canopy and have most of the land to plant tees. Programs that educate residents on tree stewardship and provide incentives for tree planting are crucial if Allegheny County is going to sustain its tree canopy in the long term.
- Consideration should be given for establishing tree canopy goals for individual watersheds. 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."

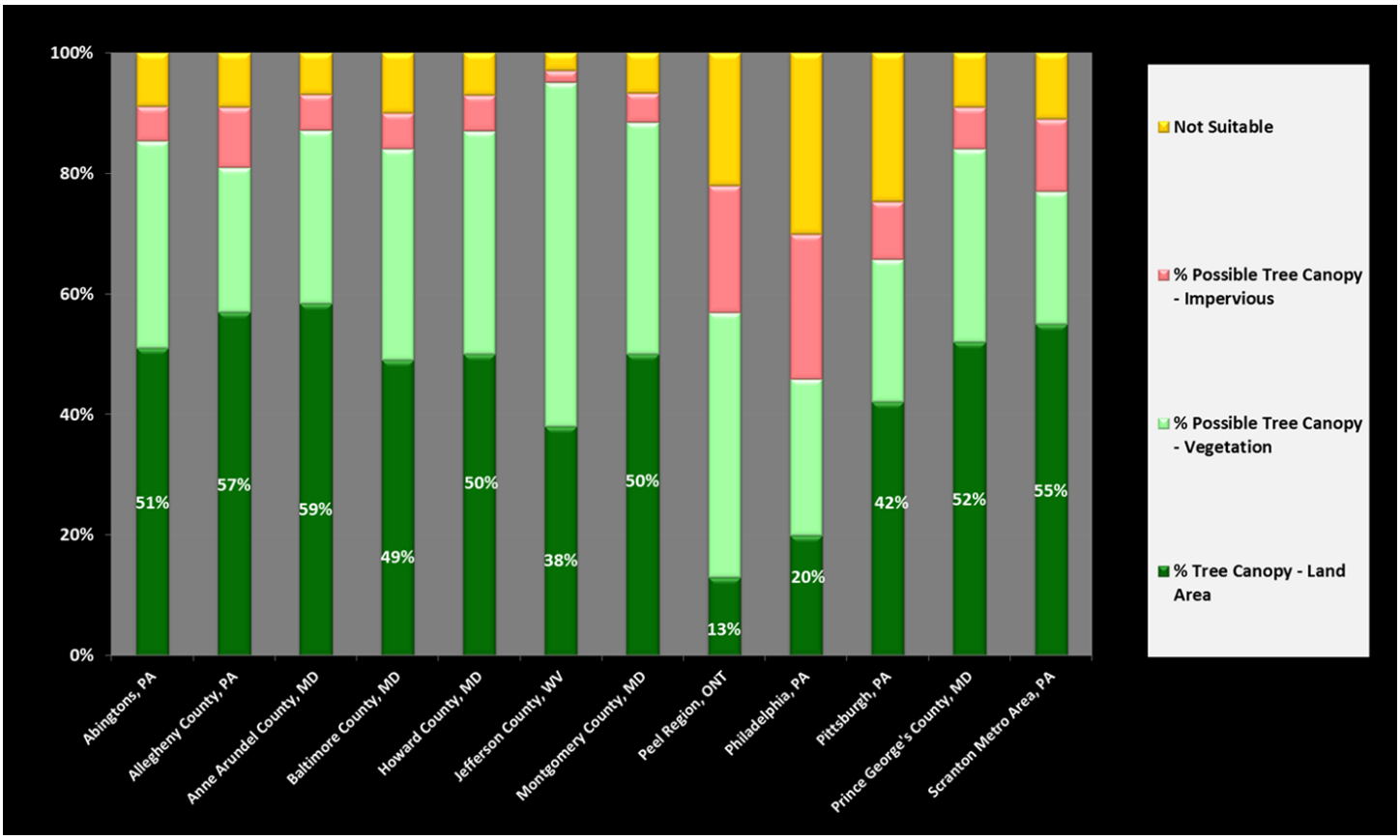


Figure 15: Comparison of Existing and Possible Tree Canopy with other selected counties and cities that have completed Tree Canopy Assessments.

Prepared by:

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

Additional Information

More information on Urban Tree Canopy Assessments can be found at the following web site:

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

Spatial Analysis Lab Tree Canopy Assessment Team: Brian Beck, 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