A Report on the City of Hartford, Connecticut'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 TC goal is crucial for communities seeking to improve their green infrastructure. A TC assessment is the first step in this goal-setting process, providing estimates for the amount of tree canopy currently present in a municipality as well as the amount of tree canopy that could theoretically be established.

How Much Tree Canopy Does Hartford Have?

An analysis of Hartford's tree canopy based on land cover derived from high-resolution aerial imagery (Figure 1) found that more than 2,870 acres of the city were covered by tree canopy (termed Existing TC), representing 26% of all land in the city. An additional 49% (5,488 acres) of the city could theoretically be modified (Possible TC) to accommodate tree canopy (Figure 2). In the Possible TC category, 25% (2,778 acres) of the city was classified as Impervious Possible TC and another 24% was Vegetated Possible TC (2,711 acres). Vegetated Possible TC, or grass and shrubs, is more conducive to establishing new tree canopy, but establishing tree canopy on Impervious Possible TC will have a greater impact on water quality.

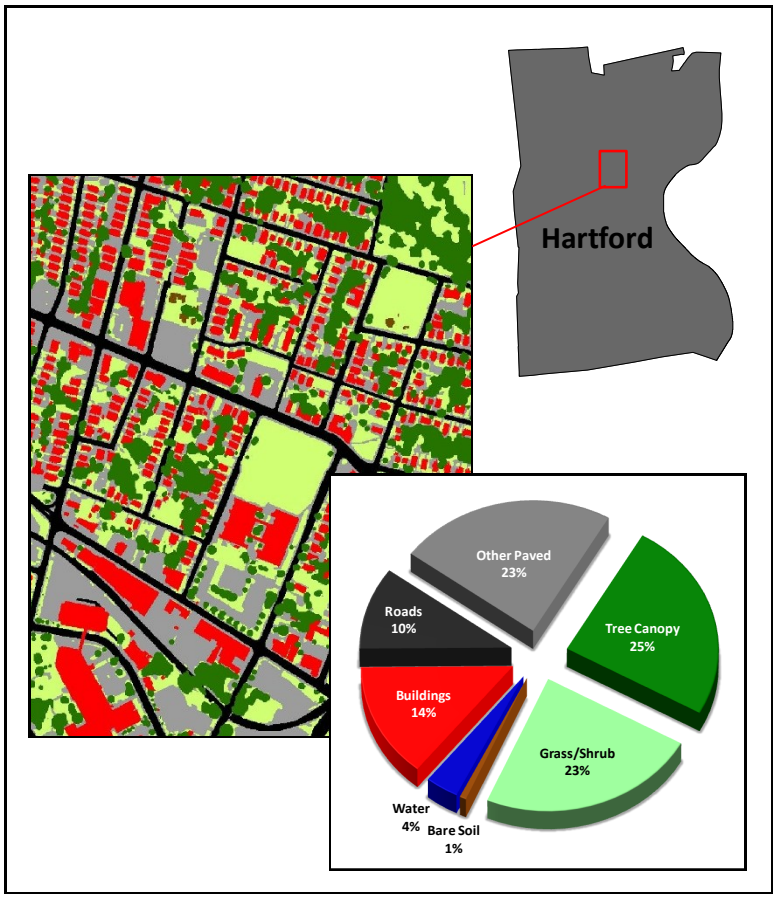


Figure 1: Land cover derived from high-resolution aerial imagery for the City of Hartford.

Project Background

This analysis of Hartford's tree canopy (TC) was conducted in collaboration with the City of Hartford and the USDA Forest Service. It was performed by the Spatial Analysis Laboratory (SAL) at the University of Vermont's Rubenstein School of the Environment and Natural Resources, in consultation with the USDA Forest Service's Northern Research Station.

The goal of the project was to apply the USDA Forest Service's TC assessment protocols to the City of Hartford. The analysis was conducted based on year 2008 data.

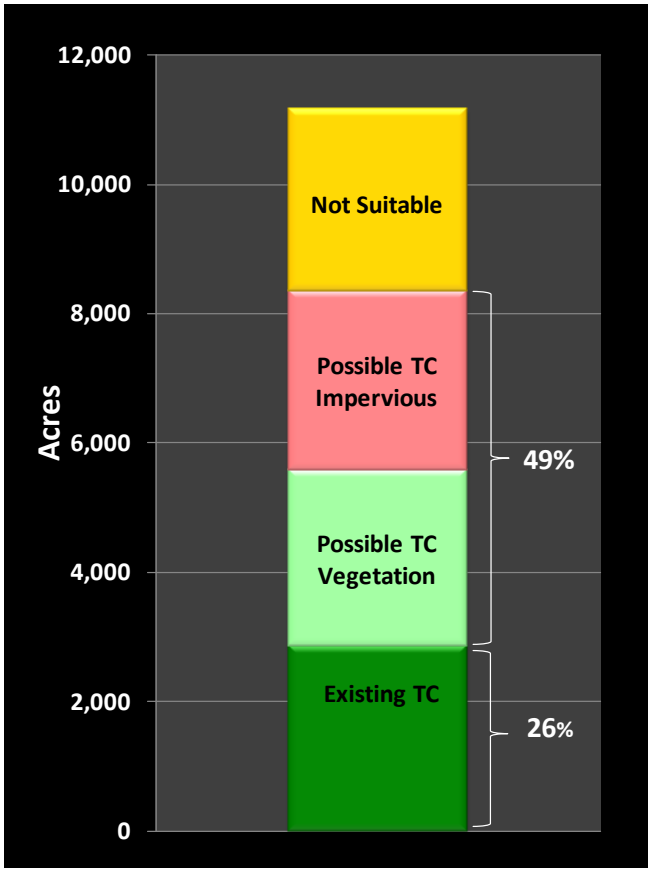


Figure 2: TC metrics for Hartford based on % of land area covered by each TC type.

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.

Mapping Hartford's Trees

Prior to this study, the only available estimates of tree canopy for Hartford were from the 2001 National Land Cover Dataset (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 (1 meter) aerial imagery acquired in the summer of 2008 (Figure 3b), in combination with advanced automated processing techniques, land cover for the city was mapped with such detail that single trees were detected (Figure 3c). NLCD 2001 estimated a mean percent tree canopy of 15% for Hartford, failing to capture many isolated trees.

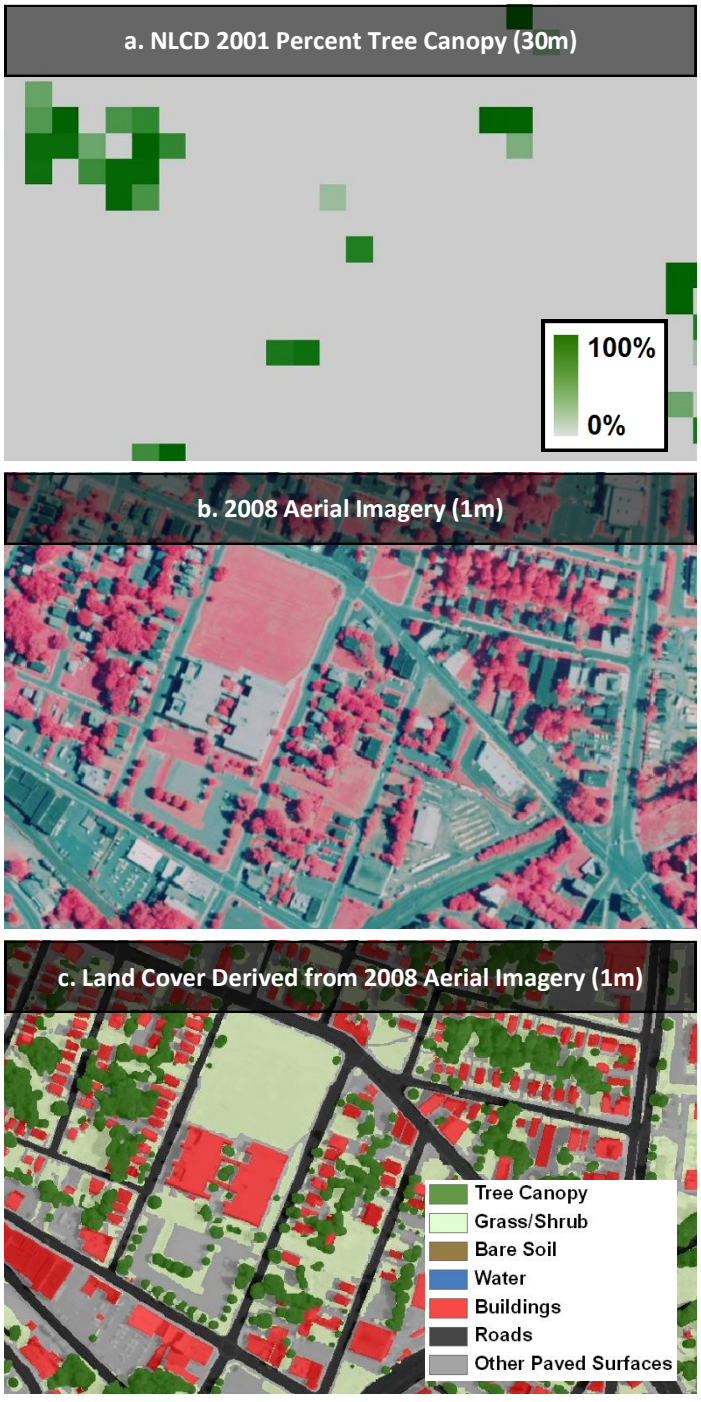


Figure 3a, 3b, 3c: Comparison of NLCD 2001 to high-resolution land cover.

Parcel Summary

After land cover was mapped city-wide, TC metrics were summarized for each property in the city's parcel database (Figure 4). Existing and Possible TC land areas were calculated for each parcel, along with the percent composition of these metrics (TC area/area of the parcel).

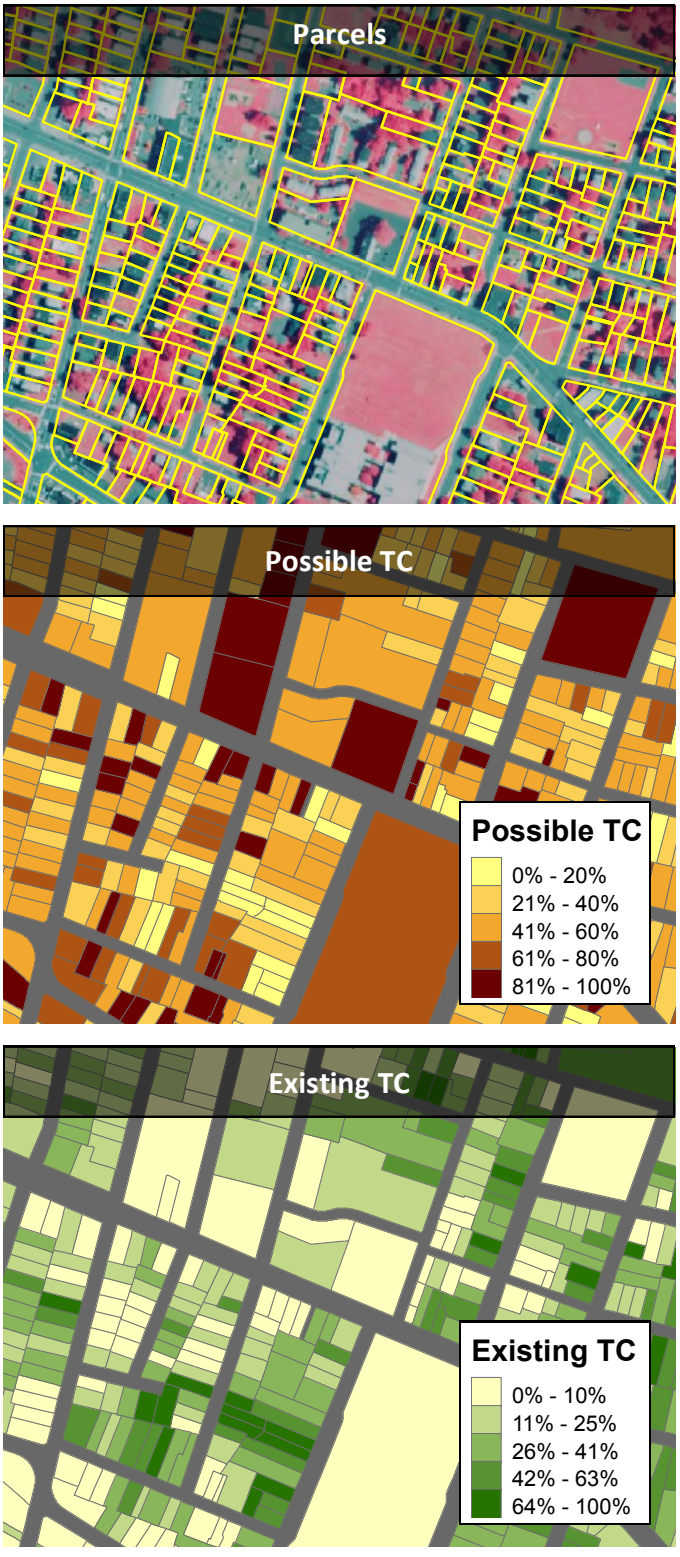


Figure 4: Parcel-based TC metrics. TC metrics are generated at the parcel level, allowing each property to be evaluated according to its Existing TC and Possible TC.

Zoning

An analysis of Existing and Possible TC by zoning category was conducted using the most recent zoning layer for the city (Figure 5, Table 1). For each zoning district, TC metrics were calculated as a percentage of all land in the city (% Land), as a percentage of land area in the specified zoning district (% Category), and as a percentage of the area for TC type (% TC Type). The Public Property (P) and combined Residence (R) districts have the greatest amount of existing tree canopy (9% and 13% of the city's total land area). The second Industrial district (I-2) has only slightly more Possible TC (12%) than the Public Property district (9%) relative to the percentage of land area, but the industrial districts comprise a much larger proportion of Possible TC by category.

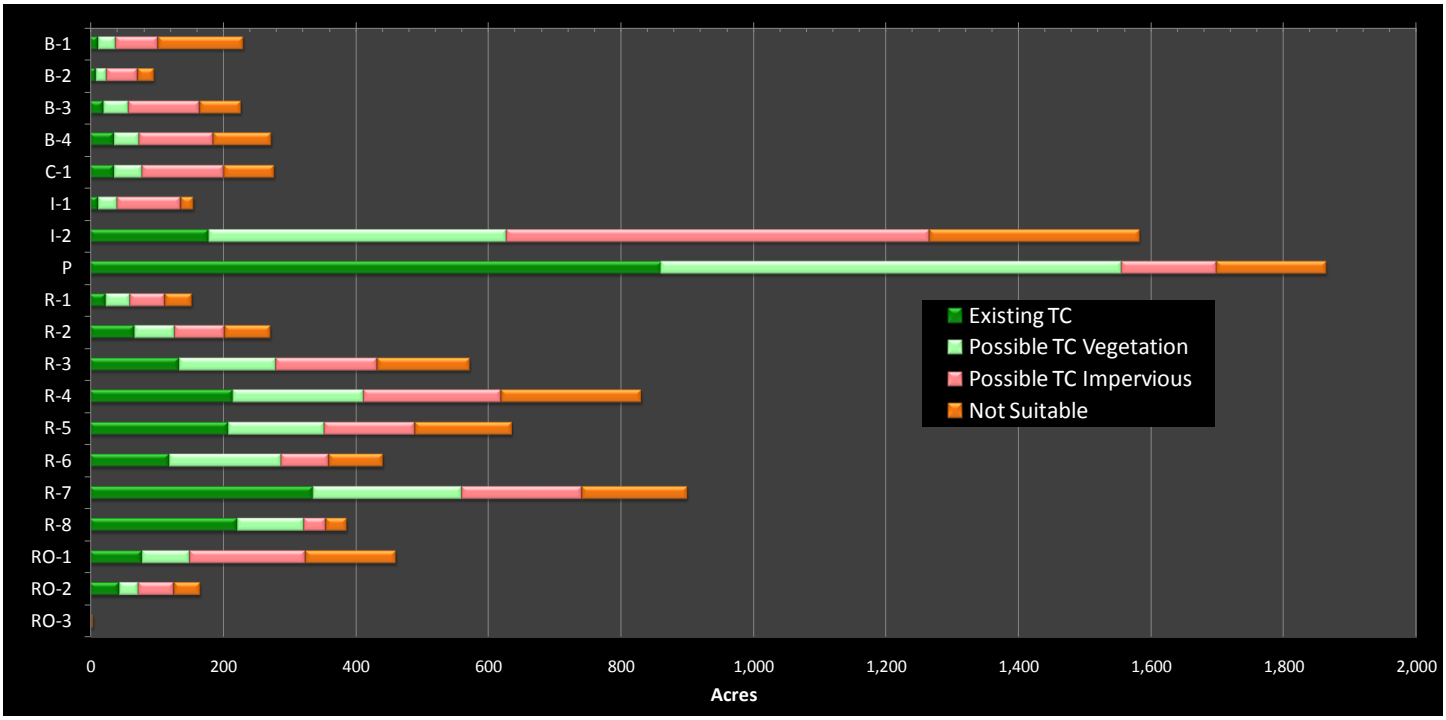


Figure 5: TC metrics summarized by zoning district.

Land Use	Existing TC			Possible TC Vegetation			Possible TC Impervious		
	% Land	% Category	% TC Type	% Land	% Category	% TC Type	% Land	% Category	% TC Type
B-1	0%	5%	0%	0%	11%	1%	1%	28%	3%
B-2	0%	10%	0%	0%	16%	1%	0%	48%	2%
B-3	0%	9%	1%	0%	16%	1%	1%	47%	4%
B-4	0%	13%	1%	0%	13%	1%	1%	41%	4%
C-1	0%	13%	1%	0%	15%	2%	1%	44%	5%
I-1	0%	8%	0%	0%	18%	1%	1%	62%	4%
I-2	2%	11%	7%	5%	28%	18%	7%	40%	25%
P	9%	46%	33%	7%	37%	28%	2%	8%	6%
R-1	0%	16%	1%	0%	24%	1%	1%	34%	2%
R-2	1%	25%	3%	1%	22%	2%	1%	28%	3%
R-3	1%	23%	5%	2%	26%	6%	2%	27%	6%
R-4	2%	26%	8%	2%	24%	8%	2%	25%	8%
R-5	2%	33%	8%	2%	23%	6%	1%	21%	5%
R-6	1%	27%	5%	2%	38%	7%	1%	16%	3%
R-7	4%	37%	13%	2%	25%	9%	2%	20%	7%
R-8	2%	57%	8%	1%	26%	4%	0%	8%	1%
RO-1	1%	17%	3%	1%	15%	3%	2%	38%	7%
RO-2	0%	26%	2%	0%	18%	1%	1%	32%	2%
RO-3	0%	19%	0%	0%	15%	0%	0%	27%	0%

% Land = Area of TC type for zoning district / Area of all land

The % Land Area value of 2% indicates that 2% of Hartford's land area is covered by tree canopy in the R-8 Zoning class.

% Category = Area of TC type for zoning district / Area of all land for specified land use

The % Land value of 57% indicates that 57% of land in the R-8 Zoning district is covered by tree canopy.

% TC Type = Area of TC type for zoning district / Area of all TC type

The % TC Type value of 8% indicates that 8% of all "existing TC" is classified in the R-8 Zoning district.

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

Parks Analysis

As expected, parks in the city have relatively high existing tree canopy, but the TC assessment does reveal potential opportunities to increase coverage (Figure 6). For example, Colt Park has 85% possible TC. While the park is largely covered with ball fields, some open space exists in which trees might be planted.

Existing TC

Possible TC

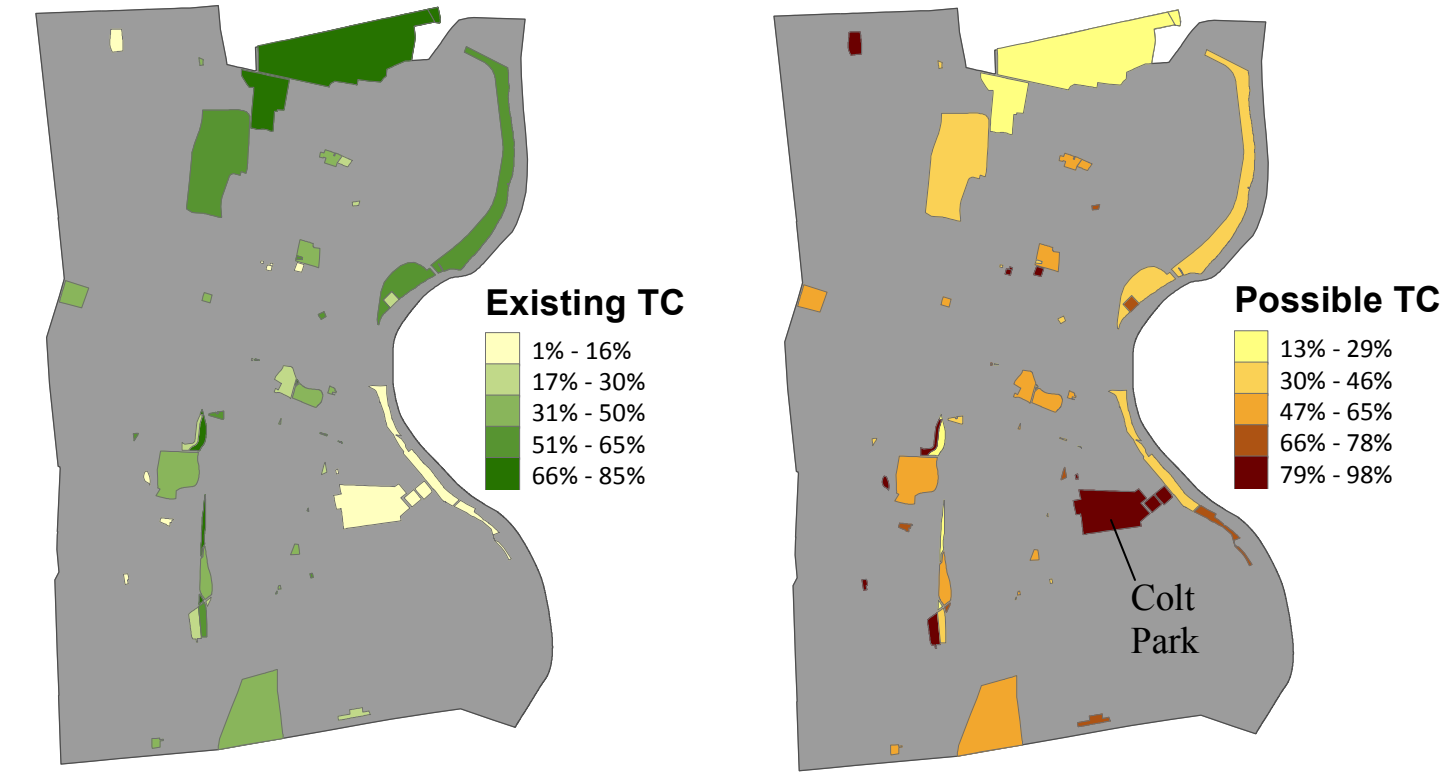
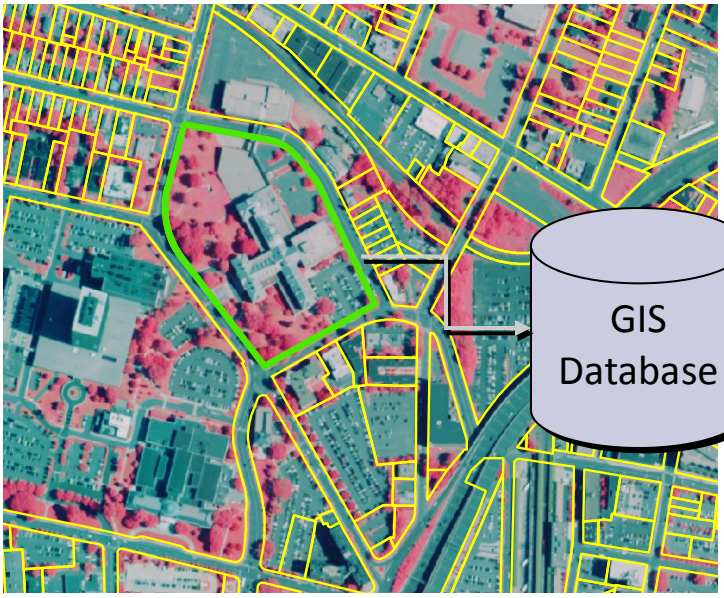


Figure 6. Existing TC (left) and Possible TC (right) as a percentage of land area by park.

Decision Support



Parcel-based TC metrics were integrated into the city's existing GIS database (Figure 7). Decision makers can use GIS to identify specific TC 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.

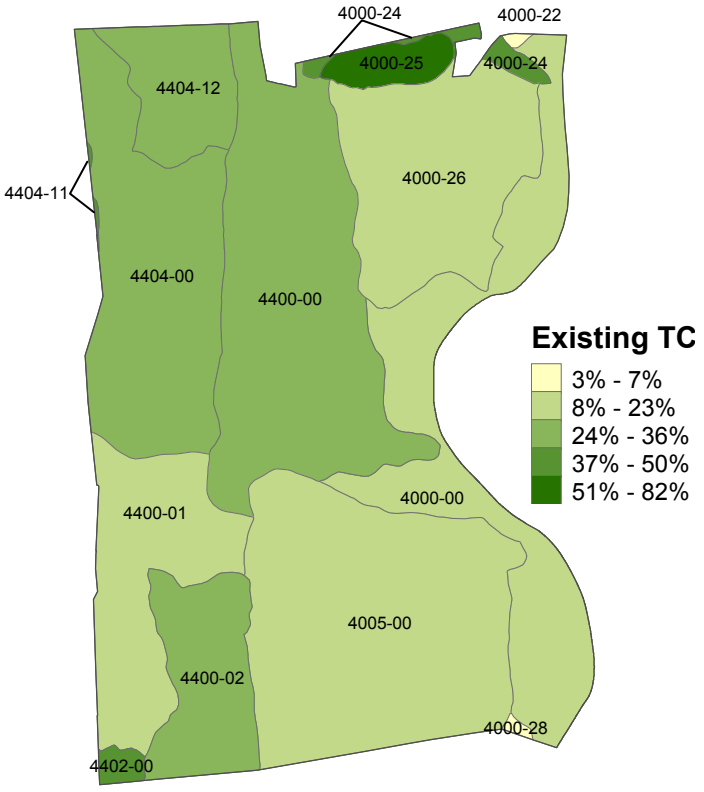
Attribute	Value
GIS_PIN	222275001
Zoning	RO-1
Existing UTC	23%
Possible UTC	48%
Possible UTC—Vegetation	24%
Possible UTC—Impervious	24%

Figure 7: 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 metrics, are displayed in tabular form providing instant access to relevant information.

Watershed Analysis

Analysis of Connecticut DEP local drainage basins show highest Possible TC in the Folly Brook (4005-00), Park River (4400-00), and North Branch Park River (4404-00) watersheds (Figures 8, 9). Watersheds farther from the Connecticut River generally have higher Existing TC percentages.

Existing TC



Possible TC

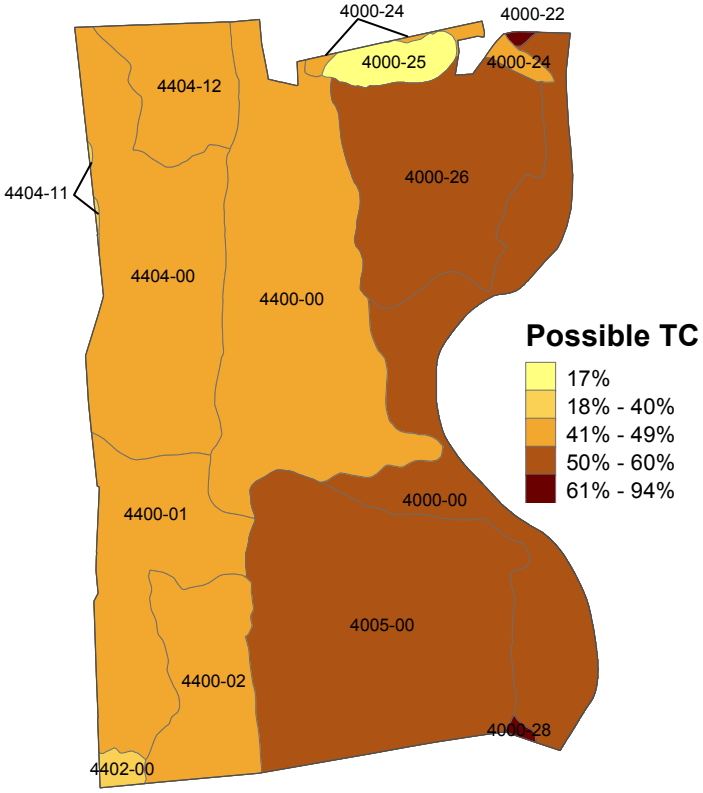


Figure 8. Existing TC (left) and Possible TC (right) as a percentage of land area by watershed.

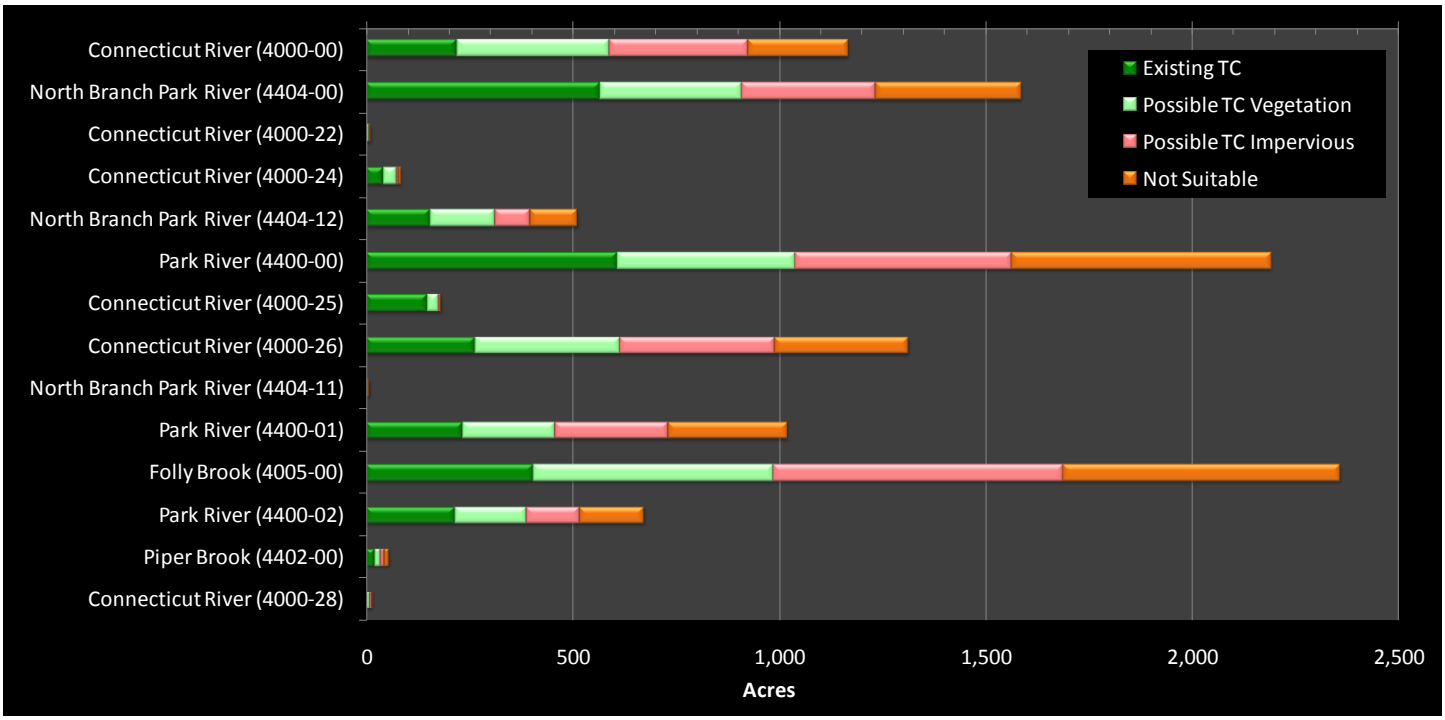
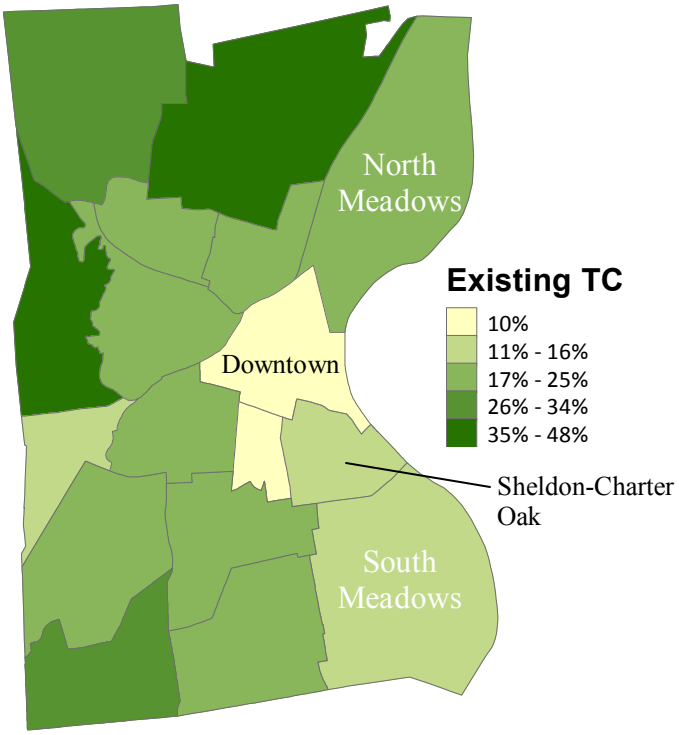


Figure 9: TC metrics summarized by watershed.

Neighborhood Analysis

The Downtown neighborhood has the lowest Existing TC (Figures 10, 11), but this densely-developed area also has relatively low Possible TC (just two other neighborhoods have lower Possible TC and both have higher Existing TC). In contrast, the North Meadows, South Meadows, and Sheldon-Charter Oak neighborhoods have slightly higher Existing TC than the Downtown neighborhood, but all have greater than 52% Possible TC.

Existing TC



Possible TC

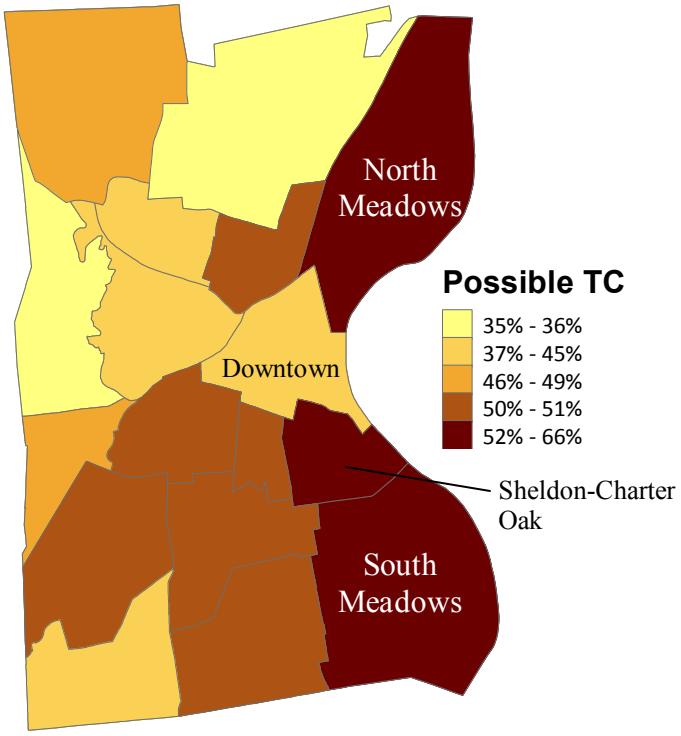


Figure 10. Possible TC (left) and Existing TC (right) as a percentage by neighborhood.

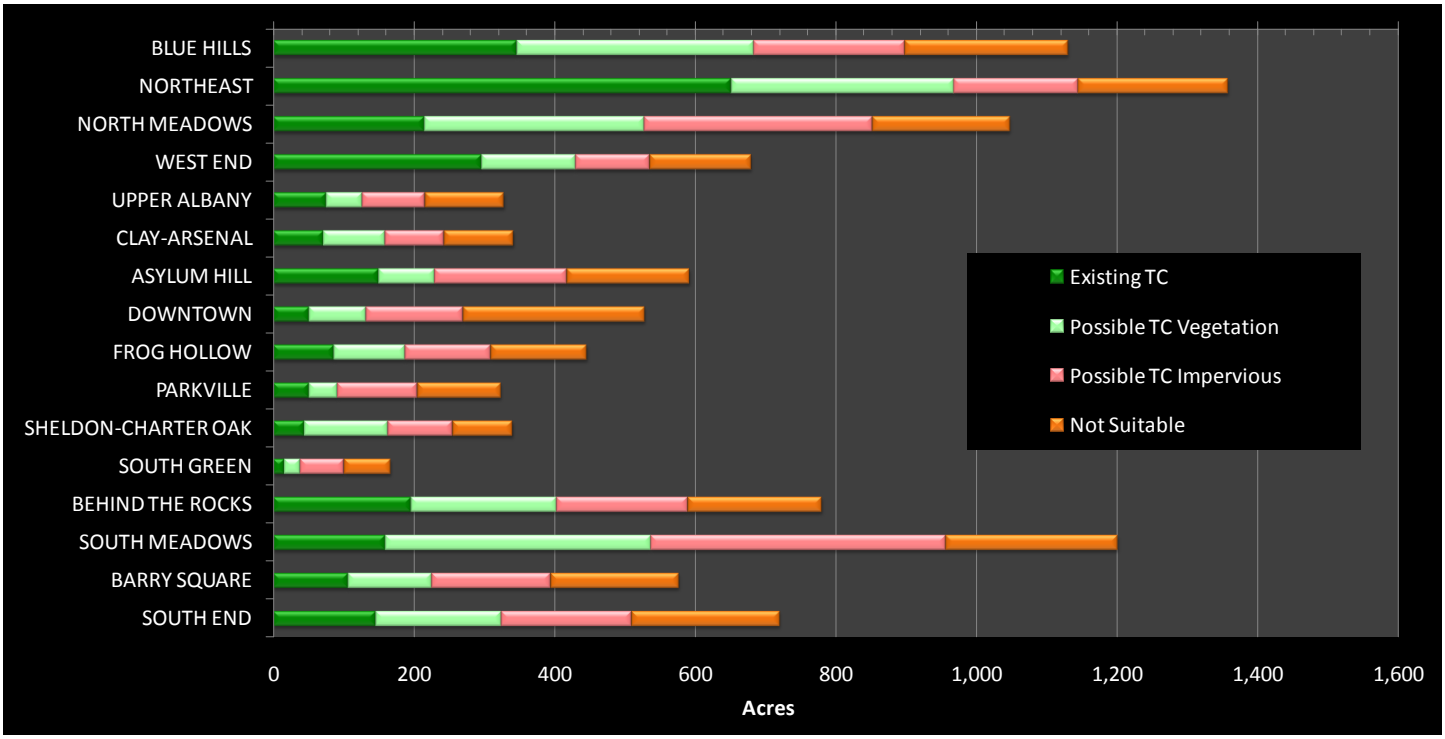


Figure 11: TC metrics summarized by neighborhood.

Conclusions

- Hartford's urban 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.
- Hartford should consider establishing a TC goal. This goal should not be limited to increasing the city's overall tree canopy; it should also focus on increasing tree canopy in parcels or blocks that have the lowest Existing TC and highest Possible TC.
- Zoning-level summaries can be used for targeting tree planting and preservation efforts in different regions of the City.
- With Existing and Possible TC summarized at the parcel level and integrated into the city's GIS database, individual parcels and subdivisions can be examined and targeted for TC improvement.
- Of particular focus for TC improvement should be parcels in the city 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.
- By ownership type, Hartford's residents control the largest percentage of the city's Possible TC. Programs that educate residents on tree stewardship and provide incentives for tree planting are crucial if Hartford is going to sustain its tree canopy in the long term.
- Neighborhood summaries can be used to examine the relationship between socio-economic conditions and the extent and distribution of tree canopy. These summaries can also be used to target tree planting and preservation efforts in different parts of the city.
- The city's rights-of-way (ROW) contain 16% Existing TC and 32% Possible TC, suggesting that opportunities exist for increasing the number of street trees.
- With TC metrics summarized at the drainage basin 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."

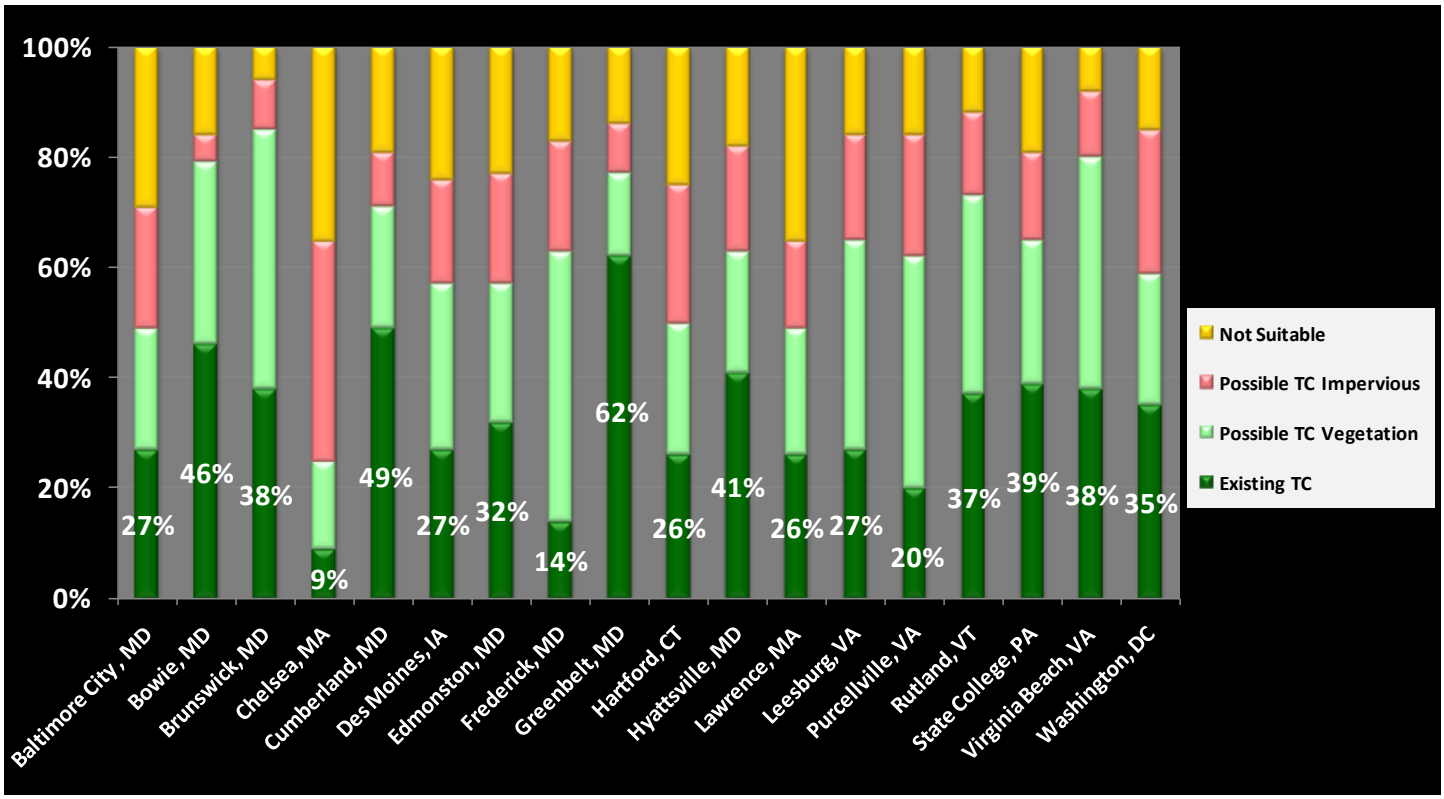


Figure 12: Comparison of Existing and Possible TC with other selected cities that have completed TC assessments.

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Additional Information

Funding for the project was provided by the USDA Forest Service under award 09-CA-41420004-026. More information on the TC assessment project can be found at the following web site:

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