A Report on Existing and Potential Tree Canopy in the City of South Burlington, VT

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 by 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 and the amount of tree canopy that could theoretically be established.

How Much Tree Canopy Currently Exists?

An analysis of South Burlington, VT based on land cover data derived from high-resolution satellite imagery (Figure 2) found that 3,428 acres of the city were covered by tree canopy (termed Existing TC), representing 33% of all land in the study area (Figure 1). An additional 50% (5,180 acres) of the total land area could theoretically be modified to accommodate tree canopy (termed Potential Tree Canopy). In the Potential TC category, 41% (4,324 acres) of total land area was classified as Vegetated Potential TC and another 8% as Impervious Potential TC (856 acres). Vegetated Potential TC, or grass/shrub, is more conducive to establishing new tree canopy, but establishing tree canopy on areas classified as Impervious Potential TC will have a greater impact on water quality and summer temperatures.

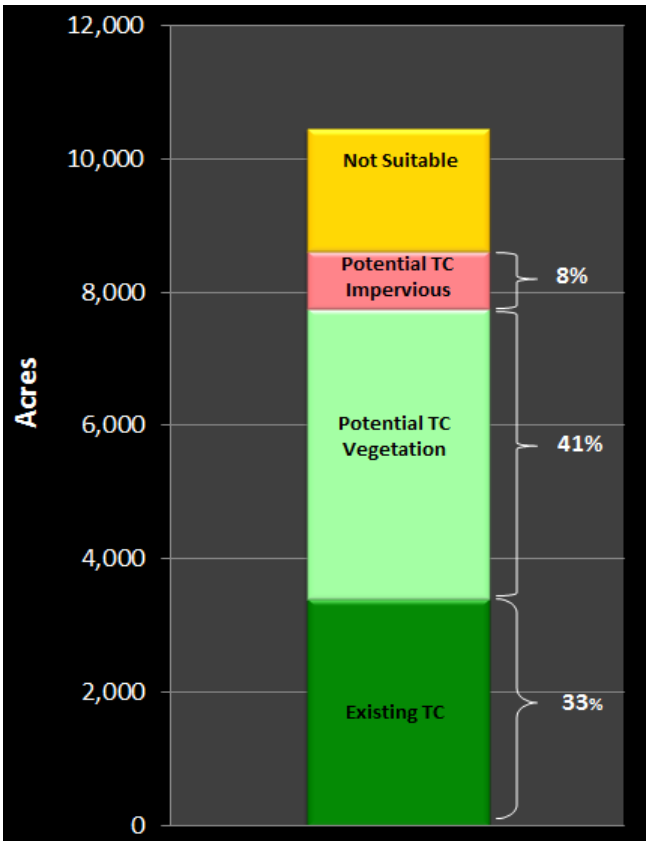


Figure 1: Tree Canopy metrics for South Burlington based on % of land area covered by each TC type.

Project Background

The goal of the project was to apply the USDA Forest Service's Tree Canopy Assessment protocols to the City of South Burlington, Vermont The analysis was conducted using imagery acquired in 2010. This project was made possible through funding from the City of South Burlington. 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 the USDA Forest Service's Northern Research Station.

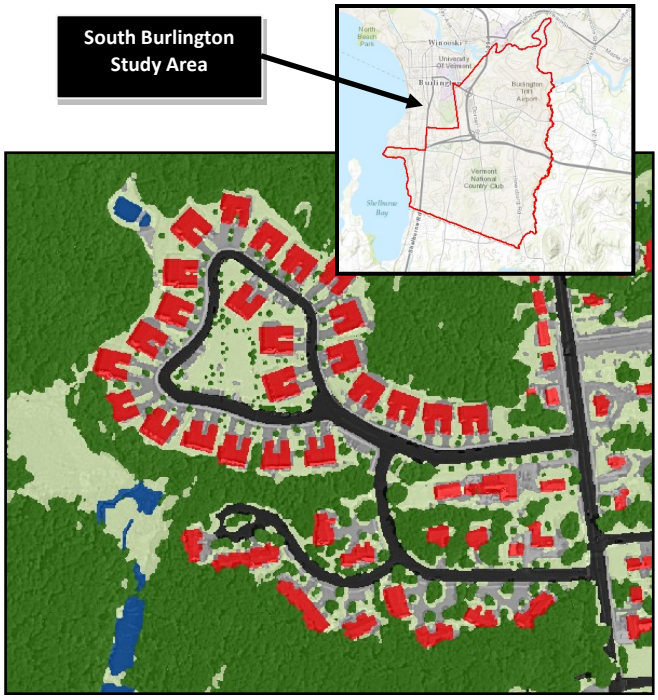


Figure 2: Study area and example of the land cover derived from high-resolution imagery for this project.

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.

Potential TC: Land theoretically available for establishing new tree canopy, excluding certain lands deemed "off limits" due to other priorities (e.g. agricultural preservation areas).

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

Vegetated Potential 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 South Burlington's Trees

Tree canopy estimates for the city are available from other sources, such as the National Land Cover Database (NLCD) for 2011. NLCD puts the tree canopy at 26%, substantially lower than the estimate obtained as part of this study. This large difference was attributable to the low resolution of the NLCD 2001 (Figure 3a), which only accounted for relatively large patches of tree canopy. Using high-resolution satellite imagery acquired in the summer of 2012 (Figure 3b), and LiDAR acquired in 2010, in combination with advanced automated processing techniques, land cover for South Burlington was mapped with such detail that trees as short as 8ft tall were detected (Figure 3c).

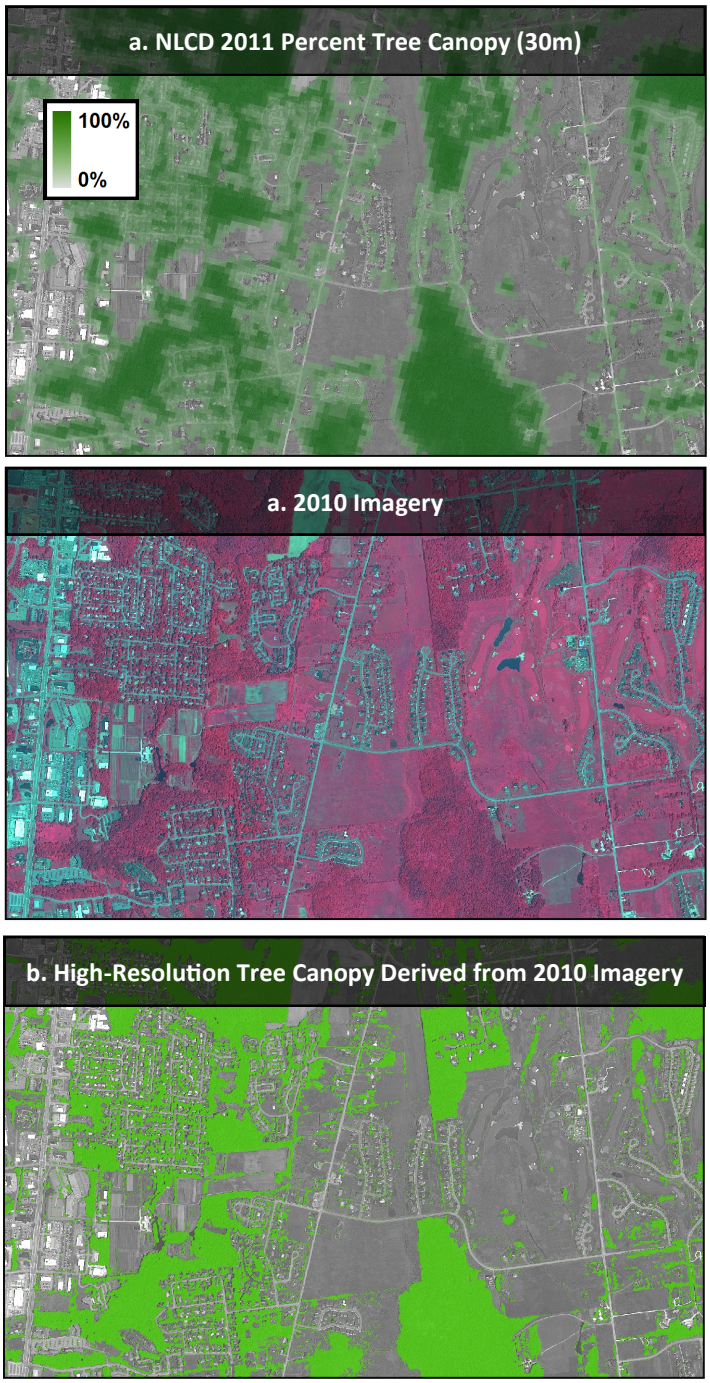


Figure 3: Comparison of NLCD 2011 (a) to high-resolution imagery (b) and tree canopy derived for this study (c).

Parcel Summary

Tree Canopy (TC) metrics were summarized for each property in the study area's parcel database using the high-resolution land cover (Figure 4). Existing TC and Potential TC metrics were calculated for each parcel, both in terms of total area (square meters) 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 the city of South Burlington.

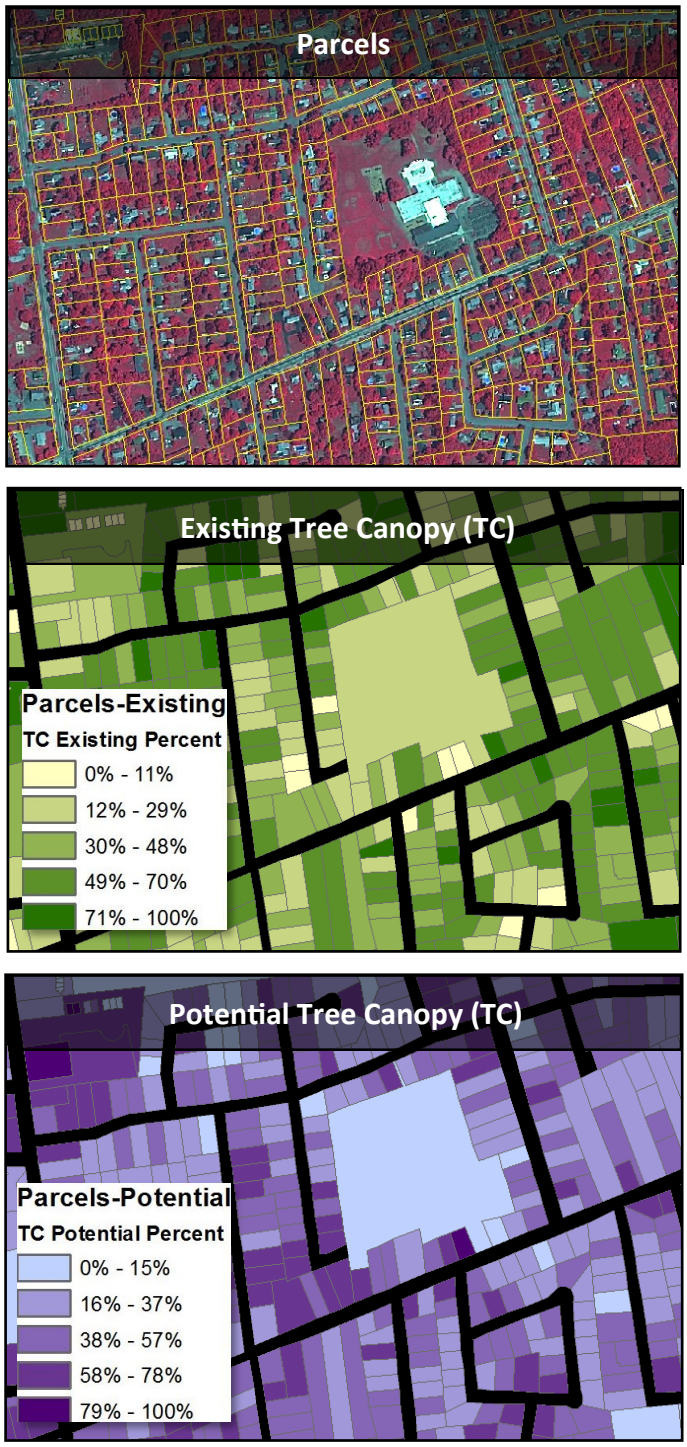


Figure 4: Parcel-based TC metrics. TC metrics generated at the parcel level allow each property to be evaluated according to its Existing TC and Potential TC.

Tree Canopy Planting Exclusion Zones—Computing Potential TC

When assessing tree canopy some lands will not necessarily be desirable for establishing new canopy. These areas include vegetated lands that are prioritized for other uses, such as recreational fields, and areas where establishing tree canopy would pose a hazard, such as airports. Areas where increased tree plantings are not desirable are considered "exclusion zones." For this assessment, 119 exclusion zones were included. These exclusion zones included agricultural land, the airport, golf courses, recreational fields, solar farms, school grounds, and utility rights-of-way. The lands in these exclusion zones were excluded when computing the Potential TC.

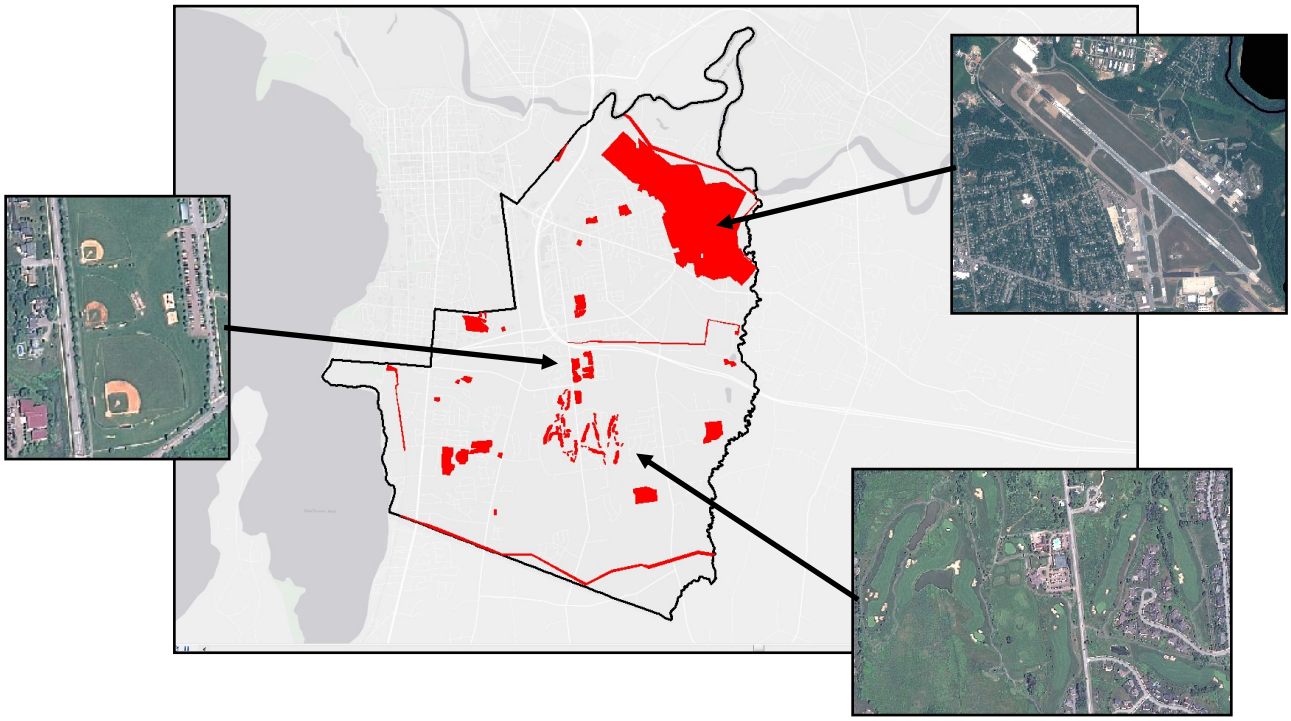


Figure 5: The exclusion zones used to compute Potential Tree Canopy for this study along with some specific examples.

Stream Buffers

Within stream buffers the percentage of Existing Tree Canopy (50%) is much higher than the city average. Nevertheless there is still room for improvement with over 204 acres of grass/shrub vegetation (Potential TC—Vegetated) on which new tree canopy could be established to help filter runoff and lower stream temperatures.

Figure 6: Stream buffers

Socio-Demographic Analysis

US Census block groups contain a wealth of socio-demographic information that, when combined with tree canopy metrics, provide new insights into the relationship between the citizens of South Burlington and their tree canopy. Using 2012 population estimates (18,400), it was determined that there is approximately 0.186 acres of tree canopy per capita in the city.

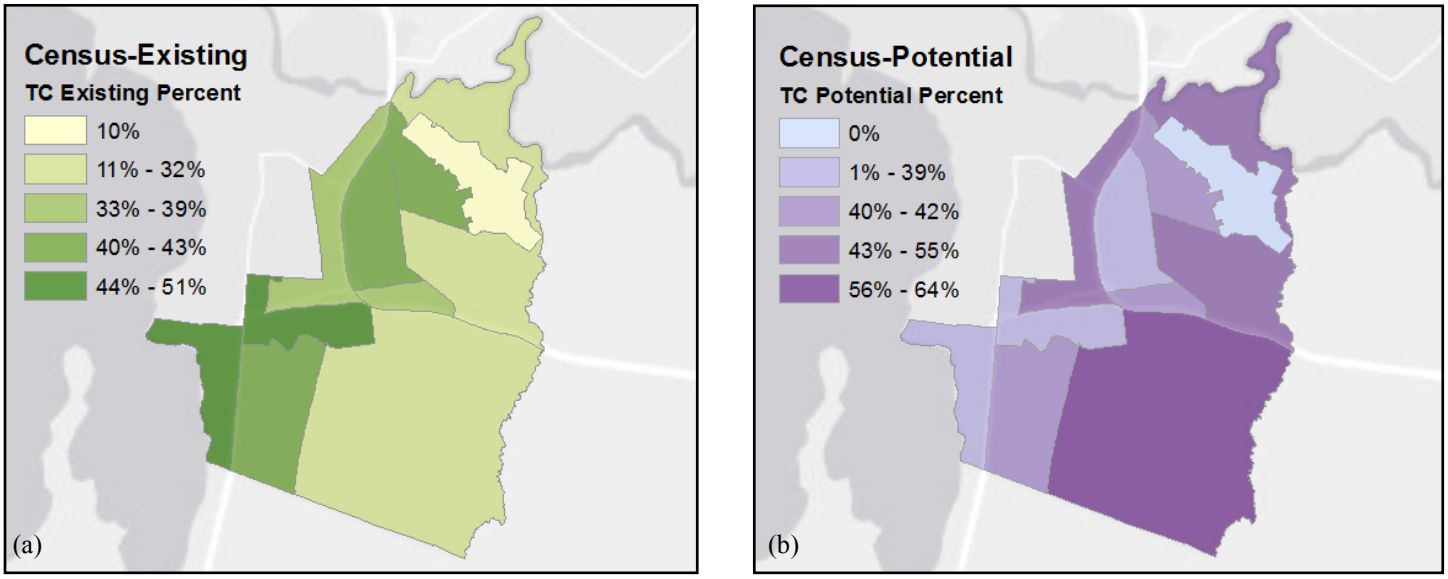


Figure 7: (a) Percent Existing TC; (b) Percent Potential TC by Census Block Groups.

Neighborhoods

South Burlington's residents manage a large portion of city's overall tree canopy. Summarizing tree canopy by neighborhood provides a way to directly connect people to the trees in the vicinity of where they live and to highlight those residential areas that have room to establish new tree canopy. Residential neighborhoods occupy approximately 21% of South Burlington's total land area. As is to be expected the new developments, in which trees were removed during the construction process, have noticeably lower amounts of Existing TC and higher amounts of Potential TC. A prime example is the Cider Mill neighborhood, which was still under construction when the imagery was acquired in 2010. The Cider Mill Neighborhood has only 6% Existing TC, but 85% Potential TC. These younger neighborhoods are prime candidates for tree planting initiatives. If successful, such initiatives could have a measurable impact on the city's overall tree canopy in the decades to come.

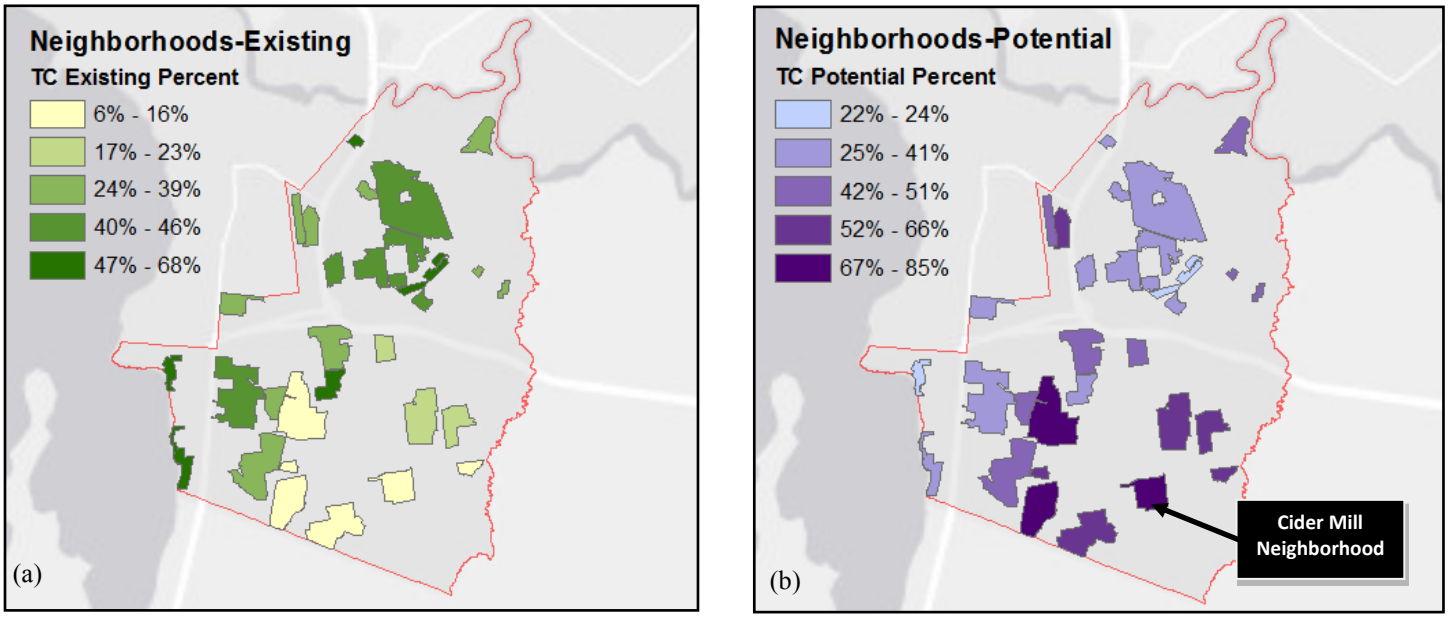


Figure 8: (a) Percent Existing TC; (b) Percent Potential TC by Neighborhood.

Soils

Soil type is an important factor when considering the locations for future tree planting sites. 50 different soil types were identified in this analysis. VeB (Vergennes clay, 2 to 6 percent slopes) represents the most common soil type, occupying 22% (2392 acres) of the total study area. AdA (Adams and Windsor loamy sands, 0 to 5 percent slopes) was found to be the second most prevalent soil type within the study area, occupying 17% (1794 acres) of the total land cover area. Soil characteristics such as composition, stability, and permeability are important considerations when assessing potential sites for future plantings because not all soil types and conditions are suitable for trees. Tree canopy can also assist in the strengthening of steep slopes and unstable river banks which aid in preventing erosion and sediment loading. The resulting data from this analysis can be used to help decision makers identify the most desirable locations for future tree plantings.

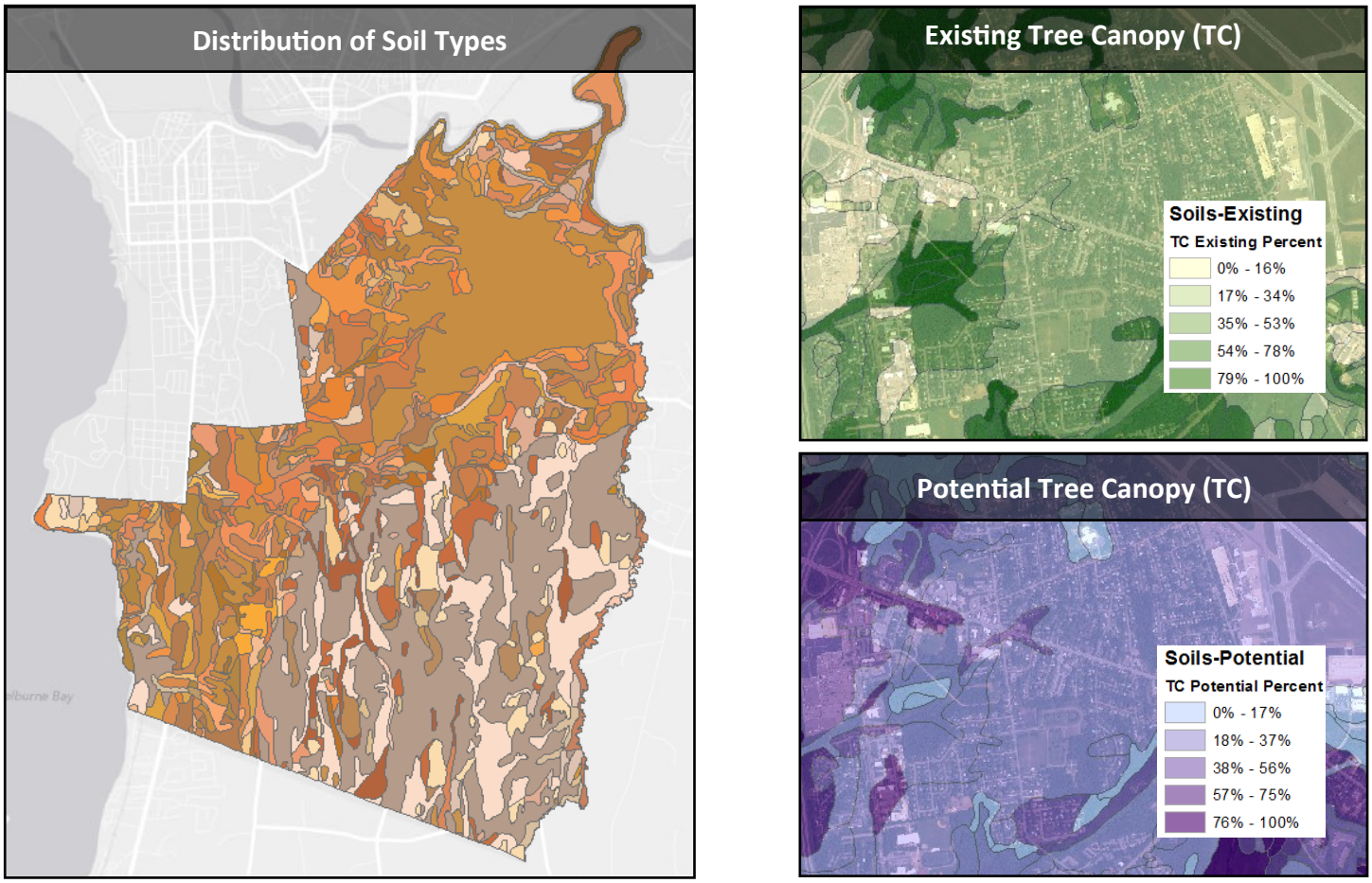


Figure 9: Soil-based TC metrics. TC metrics are generated for each soil type, allowing for evaluation according to its Existing and Potential TC.

Open Space

The City of South Burlington has 29 areas designated as "open space," comprising 11% (1175 acres) of South Burlington's total land area. Open spaces are classified by "type" and include locations such as proposed parks, common open land, agricultural land, as well as property owned by the University of Vermont. Open spaces are important because they represent large patches of land where existing infrastructure does not limit the expansion of new tree canopy.

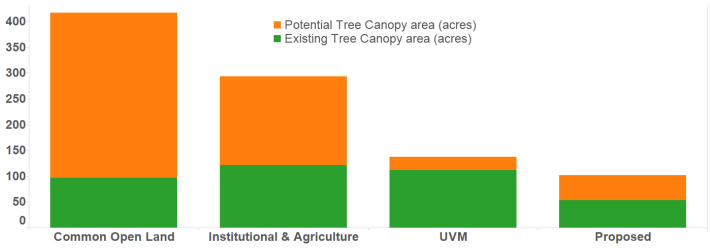


Figure 10: Acreage summaries for the open land types.

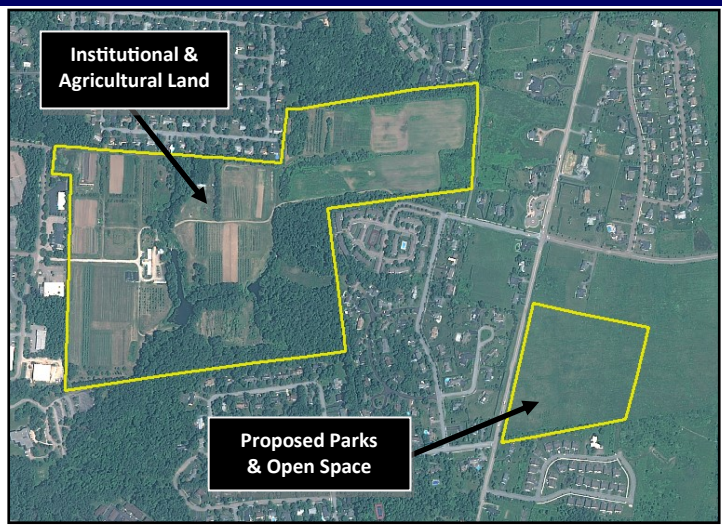


Figure 11: Examples of areas classified as open space within the City of South Burlington.

Zoning Districts

South Burlington has 104 zoned areas throughout the city that are assigned to one of 37 unique zoning districts. For each one of these zone areas, the Existing TC and Potential TC were calculated (Figure 9). Within the individual zoning polygons Existing and Potential estimates vary widely. To better understand the relationship between zoning and tree canopy, the 37 zoning district classes were aggregated into 9 general classes (Figure 10). Of these nine aggregated zoning classes, Residential, Parks & Natural Resource Protection, and Commercial make up 75% of all the land in the city. These three aggregated zoning classes also contain the majority of the Existing TC and the majority of the Potential TC. The relative amount of land covered by tree canopy tends to vary by class. On average, residential land is 34% tree canopy whereas Institutional Agricultural is 49%. Potential TC also varies by class. Tree canopy could be established on 59% of Commercial lands, but as much of this is impervious surfaces, there are considerable challenges. Conversely, Residential lands, which have a similar percentage of land available for new tree canopy at 53%, have a higher proportion of vegetated surfaces in the Potential category.

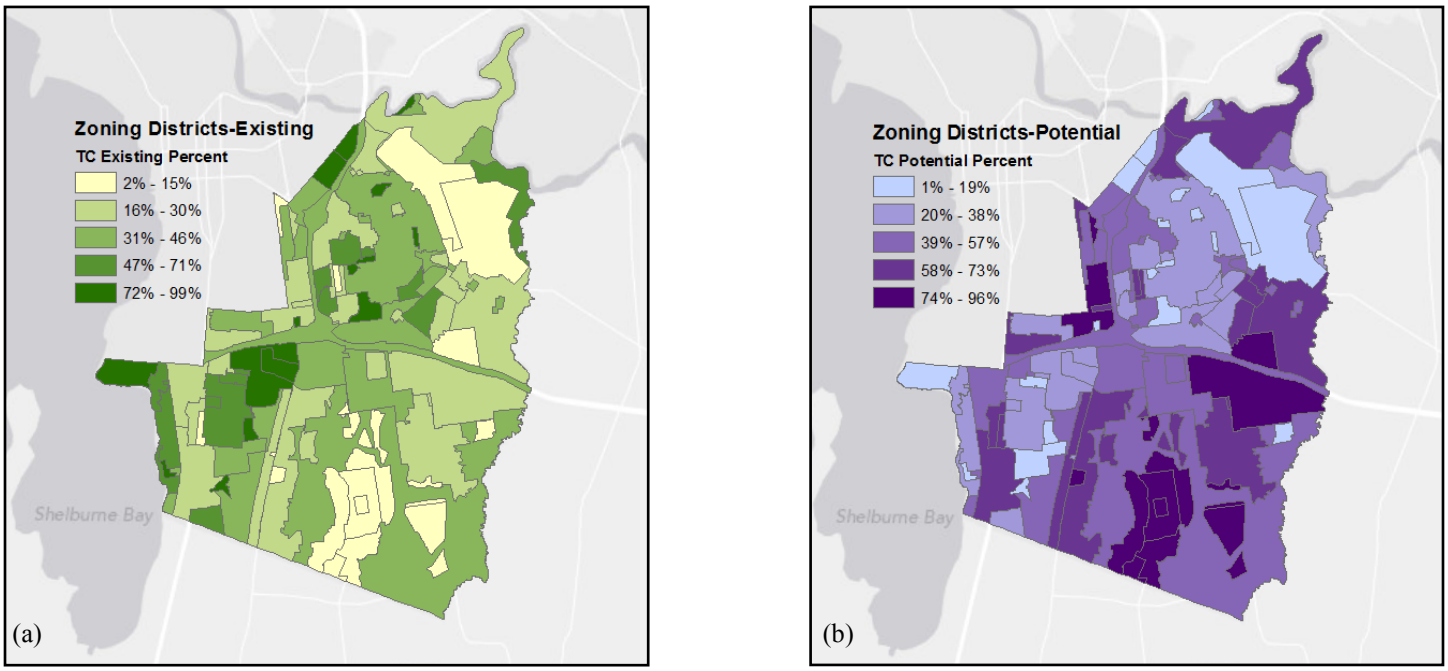


Figure 9: (a) Percent Existing TC; (b) Percent Potential TC by Zoning area.

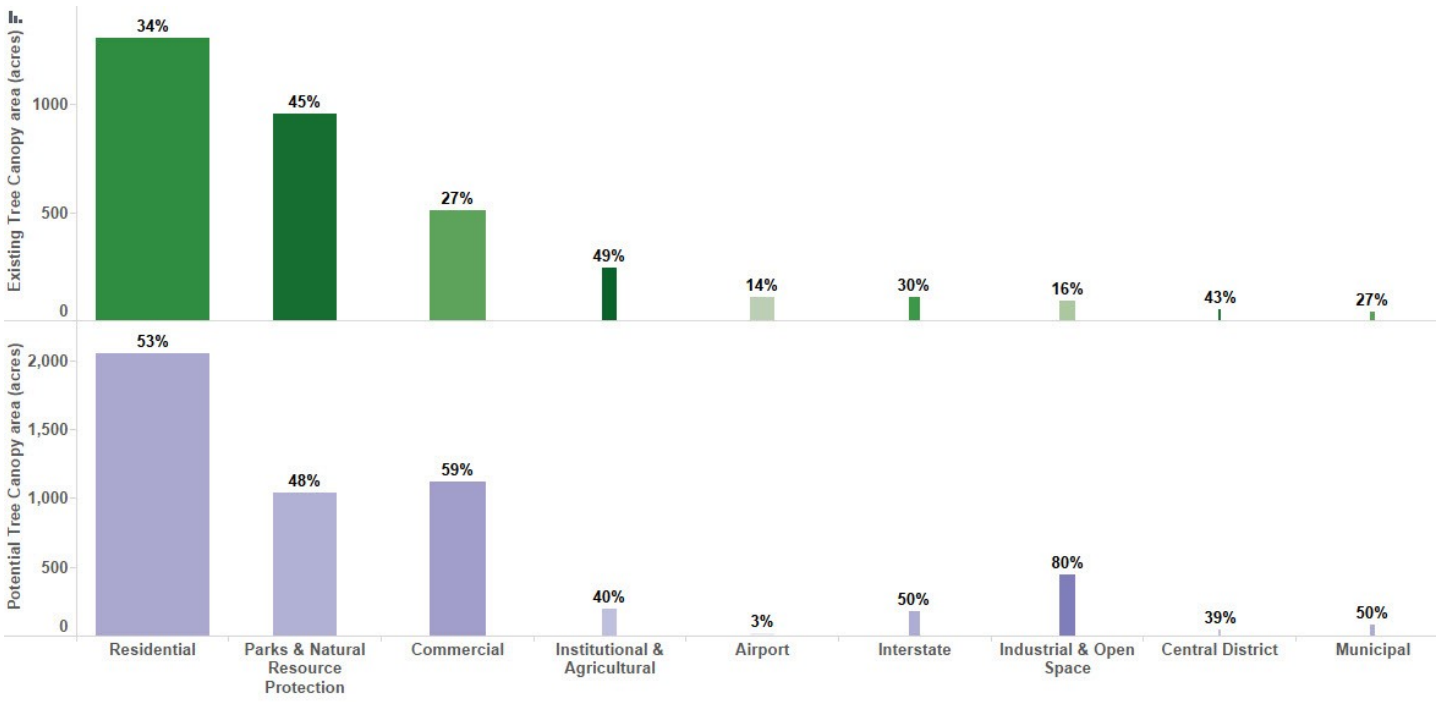


Figure 10: Existing TC and Potential TC summarized by the 9 aggregate zoning classes. The percentage values indicate the relative amount of Existing/Potential TC within each class. The bar width is proportional to the total land area of each class.

Rights of Way

Street trees in the right-of-way help to reduce noise, filter air pollutants, and intercept rainfall. Transportation rights-of-ways comprise roughly 10% of the city's total land base. The rights-of-way are nearly evenly split between those managed by the city and those managed by the Vermont Agency of Transportation (VTrans). Existing TC within the ROW in lower than the city average (16% for city ROW and 27% for VTrans ROW). The City ROW has over 250 acres of Potential TC and the VTrans ROW has just over 200 acres, indicating there is considerable room for more street trees.

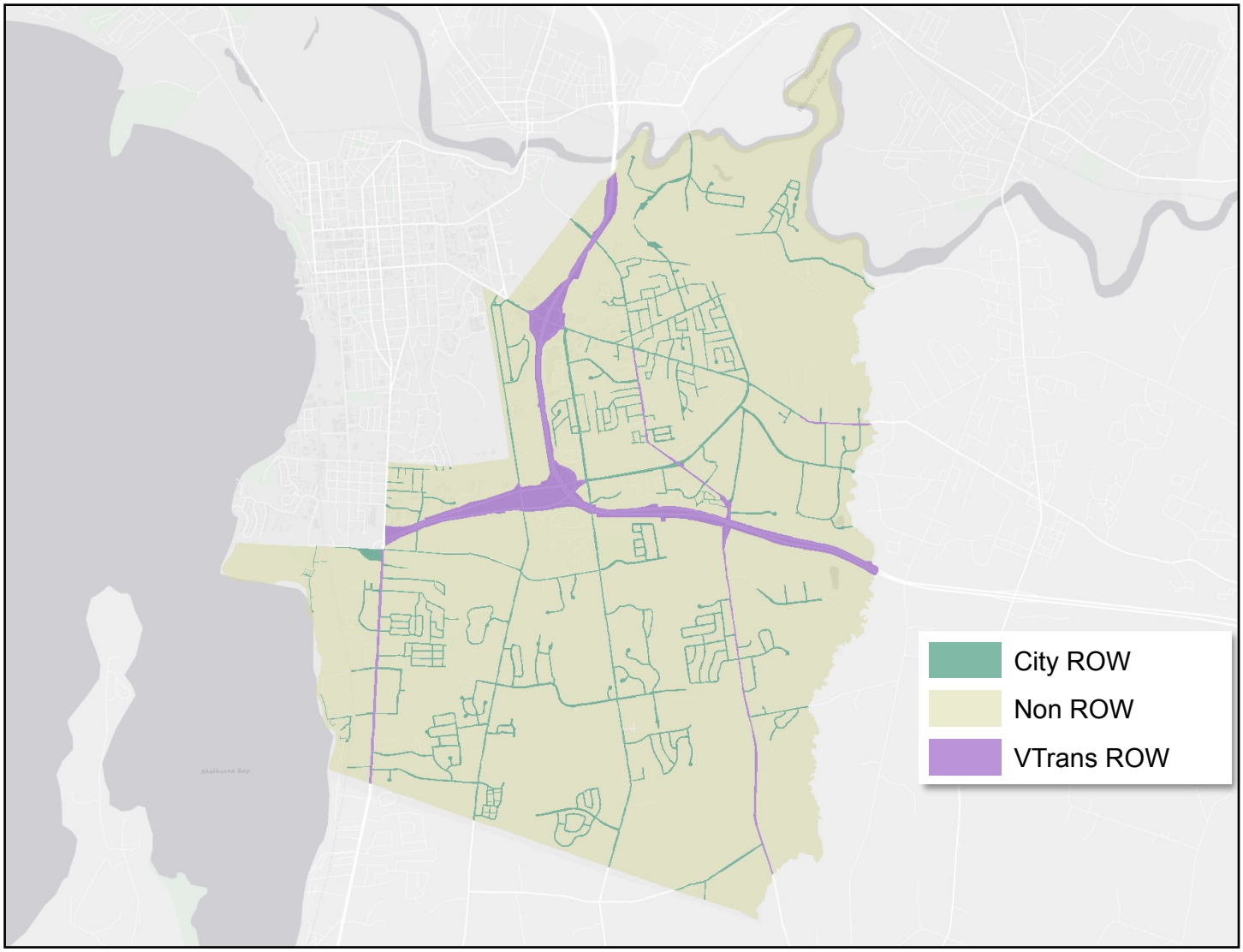


Figure 11: Spatial distribution of the rights-of-way categories within South Burlington.

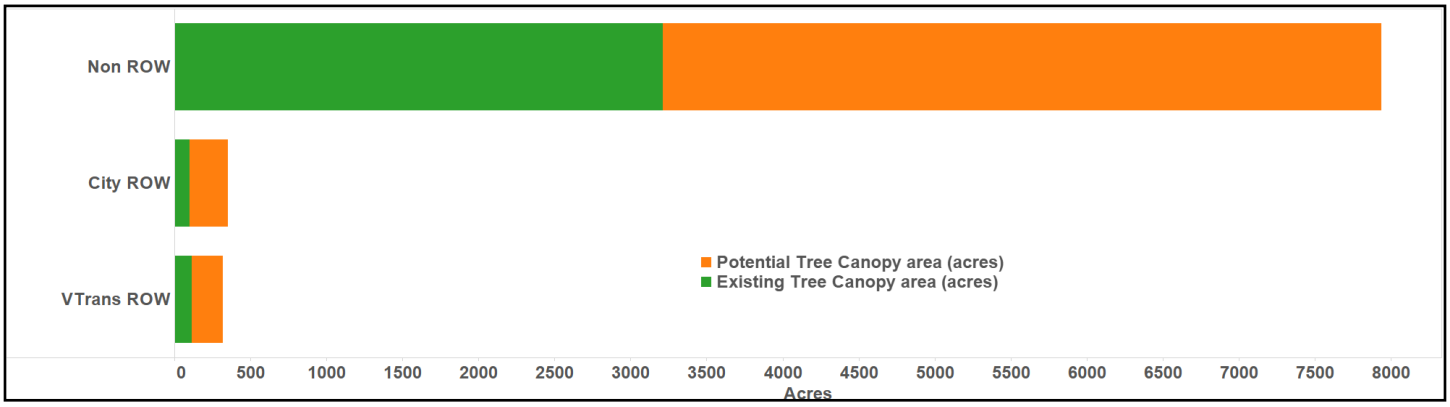


Figure 12: Existing TC and Potential TC summarized by rights-of-way category.

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 satellite data (Landsat, August 28, 2010) illustrated this effect in the town of South Burlington (Figure 16). Areas with low amounts of tree canopy and high amounts of impervious surface include the Route 7 corridor, airport, and mall. This relationship was confirmed by plotting surface temperature versus Existing Tree Canopy, summarized at evenly-spaced 300 meter grid cells (Figure 17). A statistically-significant inverse relationship was apparent, with surface temperatures increasing as tree canopy decreased, and impervious area increased.

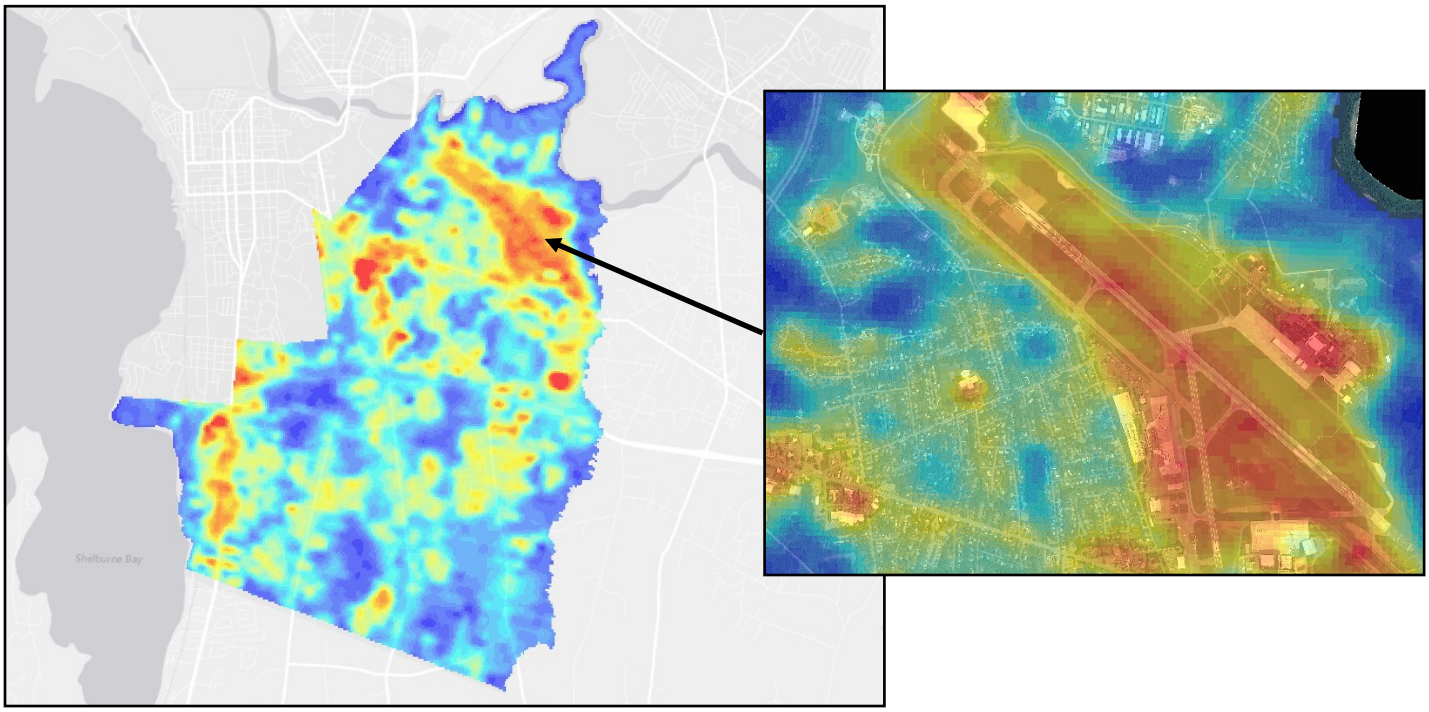


Figure 16: Landsat-derived surface temperatures for South Burlington, VT, August 28, 2010.

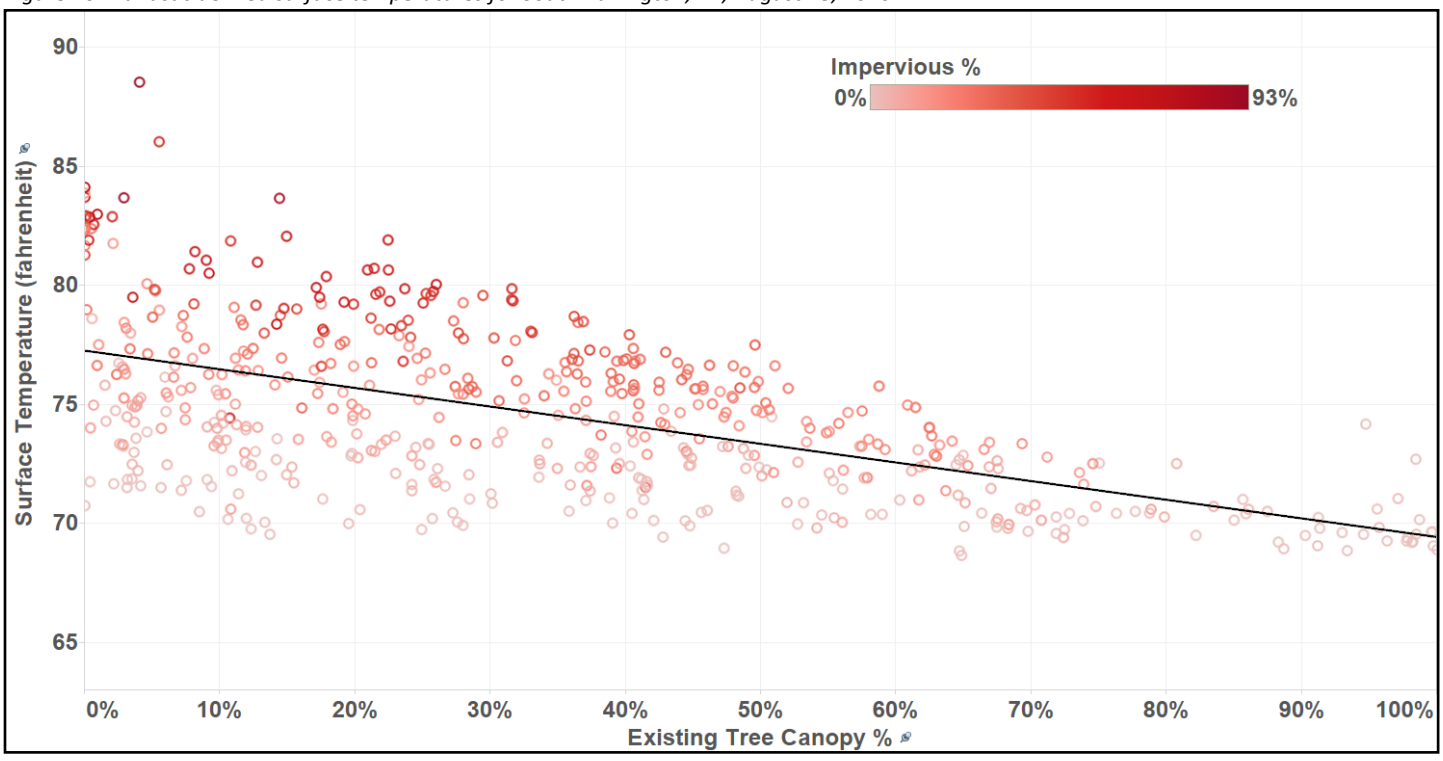
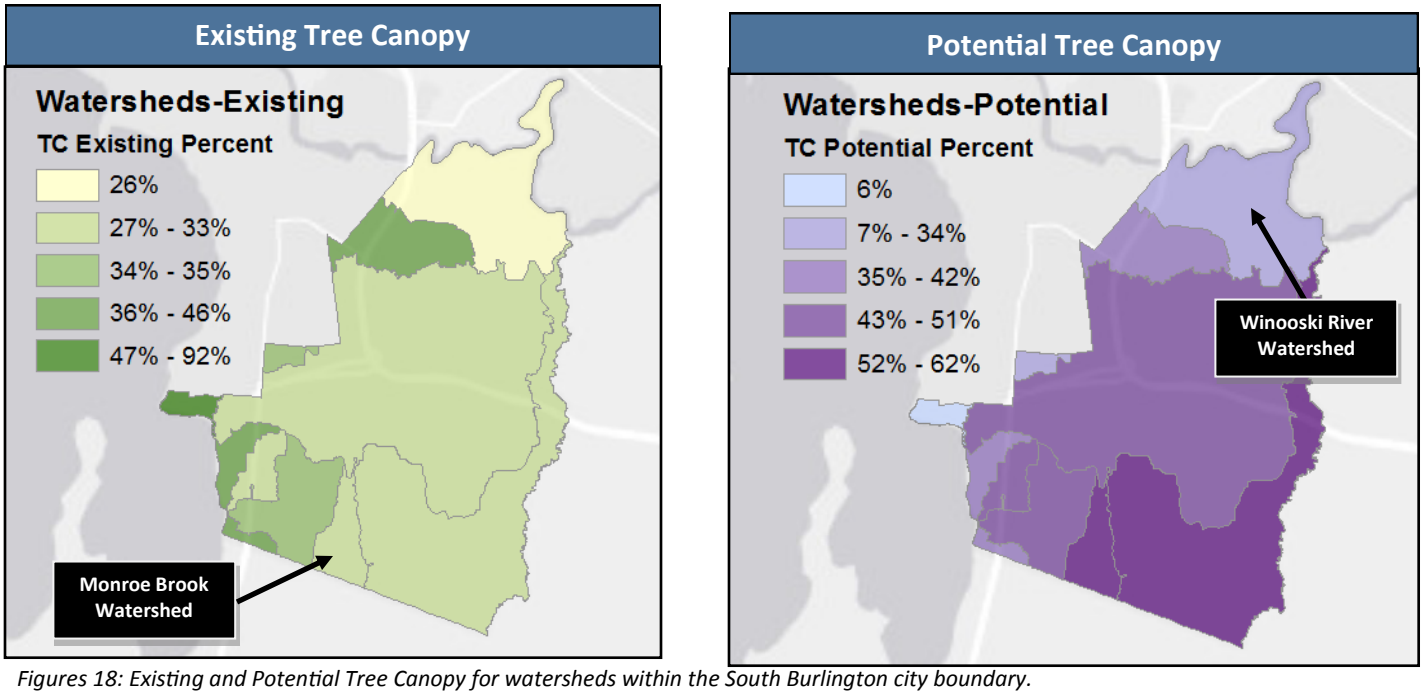


Figure 17: Plot of surface temperatures versus percent Existing Tree Canopy. Each circle represents a 300 meter area. The color gradient indicates the percent impervious for each 300 meter area.

Watersheds

Trees can help to reduce stormwater runoff, lower water treatment costs and help the city to comply with state and federal water quality mandates. TC metrics summarized by watershed boundaries show the city's distribution of tree canopy as it affects the hydrologic environments of the study area. Figures 18 and 19 show the Existing and Potential TC percentages for the portions of the ten watersheds that fall within the South Burlington town boundary. These areas flow into the Winooski River, Muddy Brook, Potash Brook, Centennial Brook, Bartlett Brook, North Brook, and Munroe Brook. The Munroe Brook Watershed contains the highest percentage of tree canopy in the study area, but also has the largest potential for increased tree canopy area, reflecting the fact that the watershed is undeveloped in comparison. The more urbanized Winooski River watershed has the lowest percentage of Existing TC, but maintains a fairly high percentage of Potential TC, indicating that tree canopy programs could be used to improve water quality in even some of the more urbanized watersheds.



Figures 18: Existing and Potential Tree Canopy for watersheds within the South Burlington city boundary.

GIS Database Decision Support

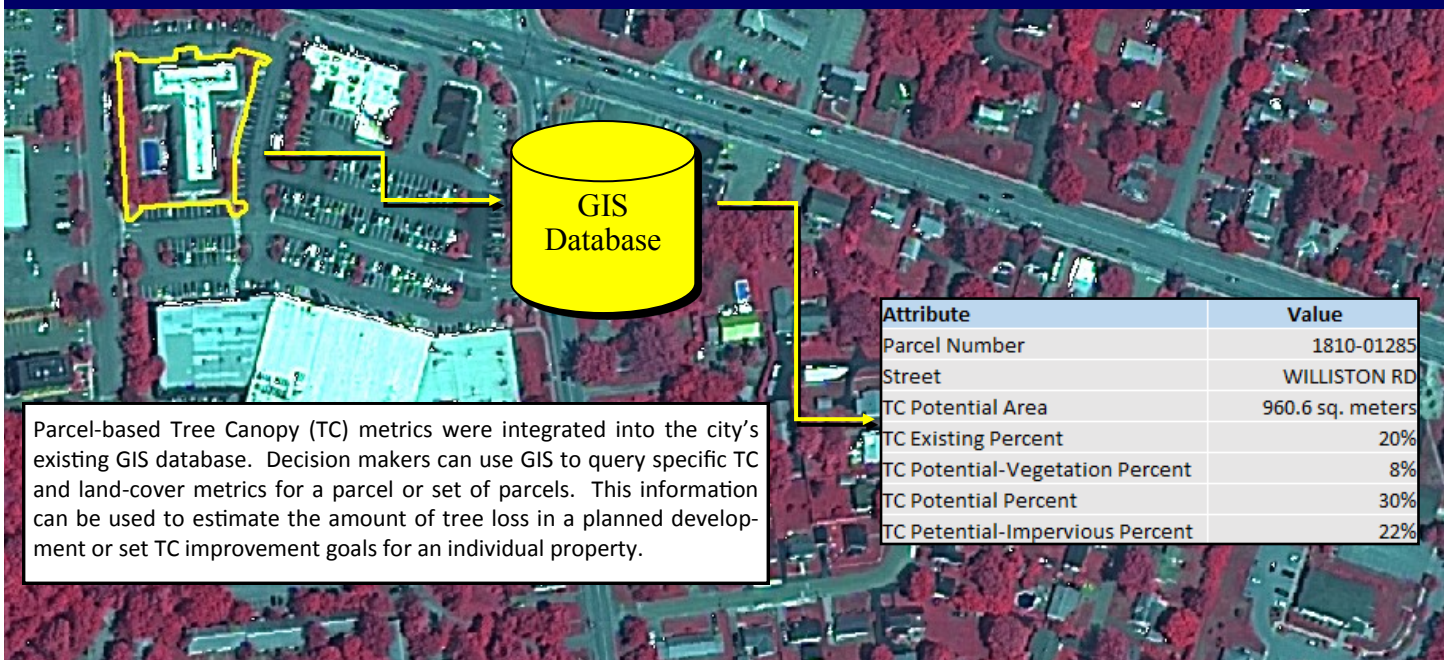


Figure 19: GIS-based analysis of parcel-based TC metrics for decision support. In this example, GIS is used to select an individual parcel. The attributes for that parcel, including the parcel-based TC and land-cover metrics, are displayed in tabular form providing instant access to relevant information.

Conclusions

- Tree canopy in South Burlington, VT is a vital asset that reduces stormwater runoff, improves air quality, reduces the town's carbon footprint, enhances quality of life, contributes to savings on energy bills, and serves as habitat for wildlife.
- The town of S. Burlington should consider setting tree canopy goals, not only for increasing the overall tree canopy, but to focus on increasing tree canopy in urban areas and residential property parcels that have low Existing Tree Canopy and high Potential 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 South Burlington 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.
- Some land uses will not necessarily be appropriate for planting trees, including vegetated lands that are occupied by cemeteries, airports, golf courses, and wetlands. Efforts to increase tree canopy in these areas and other highly-developed zones might be most efficiently focused on extensive impervious surfaces such as parking lots and industrial sites, where tree canopy must be limited in areal extent yet often offer important reductions in stormwater runoff. The shade produced by trees in developed areas also help reduce the urban heat island effect.
- 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.
- South Burlington's residents are key to preserving the town's 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 S. Burlington'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.

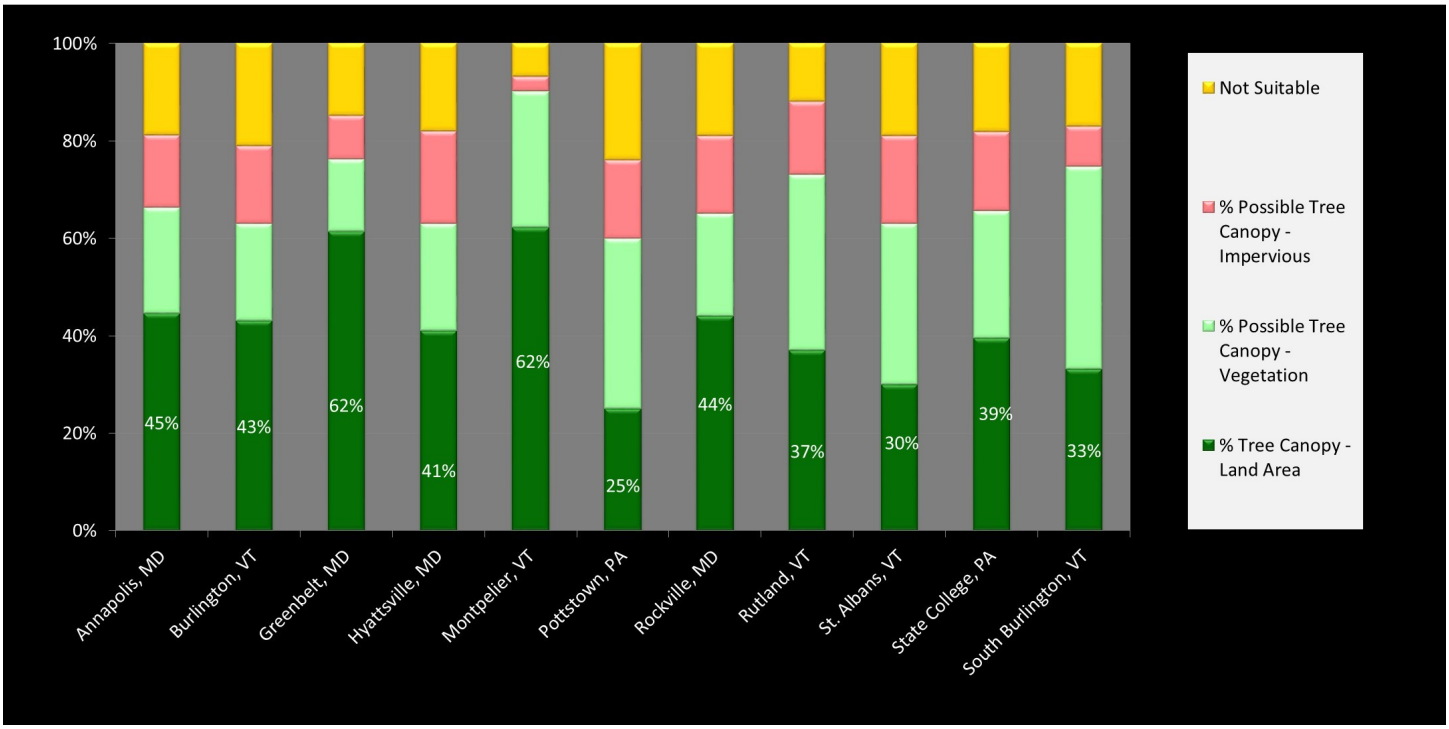


Figure 20: Comparison of South Burlington to similar cities. Note that for South Burlington Potential TC was computed as opposed to Possible TC.

Prepared by:

Jarlath O'Neil-Dunne
University of Vermont
Spatial Analysis Laboratory
joneildu@uvm.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: Noah Ahles, Ernie Buford, Paige Cornell, James Clark, Mike Franck, Daniel Hedges, Jon Liebherr, Sarah Leidinger, Laura Kim, Sean MacFaden, Amy Mietkiewicz, Thomas Nieuwenhuis, Jarlath O'Neil-Dunne, Tim Pede, Max Reis, Bradley Roy, Anna Royar, Henry Schmid, and Benjamin Whitney.