Tree Canopy Assessment: Los Angeles Coastal Zone

Why is Tree Canopy Important?

Trees provide many benefits to communities, such as improving water quality, reducing stormwater runoff, lowering summer temperatures, reducing energy use in buildings, reducing air pollution, enhancing property values, improving human health, and providing wildlife habitat and aesthetic benefits[1]. Many of the benefits that trees provide are correlated with the size and structure of the tree canopy (TC) which is the layer of branches, stems, and leaves of trees that cover the ground when viewed from above. Therefore, understanding tree canopy is an important step in urban forest planning. A tree canopy assessment provides an estimate of the amount of tree canopy currently present as well as the amount of tree canopy that could theoretically be established. The tree canopy products can be used by a broad range of stakeholders to help communities plan a greener future.

[1]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 Los Angeles Have?

An analysis of the Los Angeles Coast based on land cover data (Figure 1) derived from high-resolution aerial imagery and LiDAR found that 12,389 acres of the study area were covered by tree canopy (termed Existing TC). This represents 13% of all land in the study area (Figure 2). An additional 55% (54,574 acres) of the county's land area could theoretically be modified to accommodate tree canopy (termed Possible TC). Within the Possible TC category, 20% (20,495 acres) of total land area was classified as Vegetated Possible TC and another 35% as Impervious Possible TC (34,074 acres). Establishing tree canopy on areas classified as Impervious Possible TC will have a greater impact on water quality and summer temperatures while Vegetated Possible TC, or grass/shrub, is more conducive to establishing new tree canopy (where such lands are not prairie and grassland habitat).

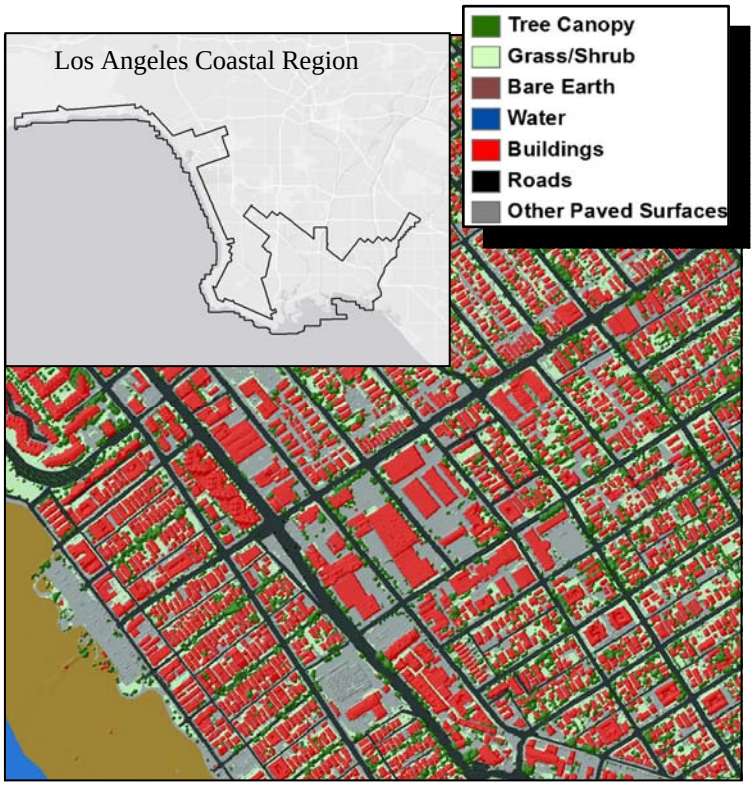


Figure 1: Study area and example of the land cover derived from high-resolution imagery for this project.

Project Partners

This project applied the USDA Forest Service's Tree Canopy Assessment protocols to the Los Angeles Coastal Region. The analysis was conducted using imagery that was acquired in 2014 and LiDAR data that was acquired in 2009. The project was a collaboration between Loyola Marymount University, SavATree, the University of Vermont and Clark University. Funding for the project was provided by Loyola Marymount University.

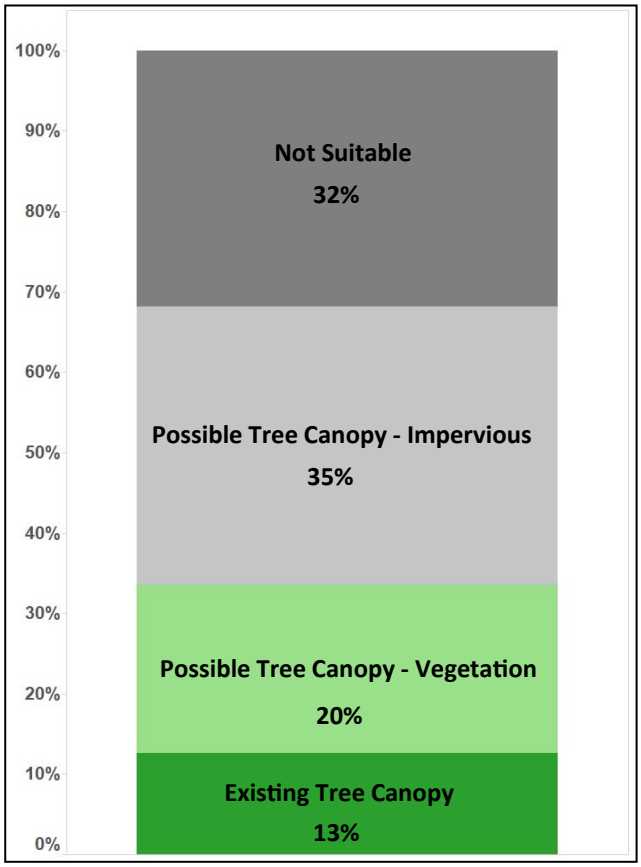


Figure 2: Tree Canopy metrics for Los Angeles, CA on percent of land area covered by each tree canopy type.

Key Terms

TC: Tree canopy (TC) is the layer of branches, stems, and leaves 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 Los Angeles' Trees

A previous estimate of tree canopy for the Los Angeles Coastline, derived from the 2011 National Land Cover Database (NLCD 2011), was 1.2%, notably lower than the 13% obtained in this study (these estimates are for the entire study area, including water). This large difference was attributed to the lower resolution of the NLCD 2011 dataset (Figure 3a), which only accounted for relatively large extents of tree canopy. Using high-resolution imagery (Figure 3b) from 2014 and LiDAR acquired in 2009 land cover for Los Angeles was mapped with such detail that individual trees were detected (Figure 3c). This new tree canopy dataset represents the most accurate accounting of tree canopy ever done for Los Angeles, with trees as small as 8ft mapped.

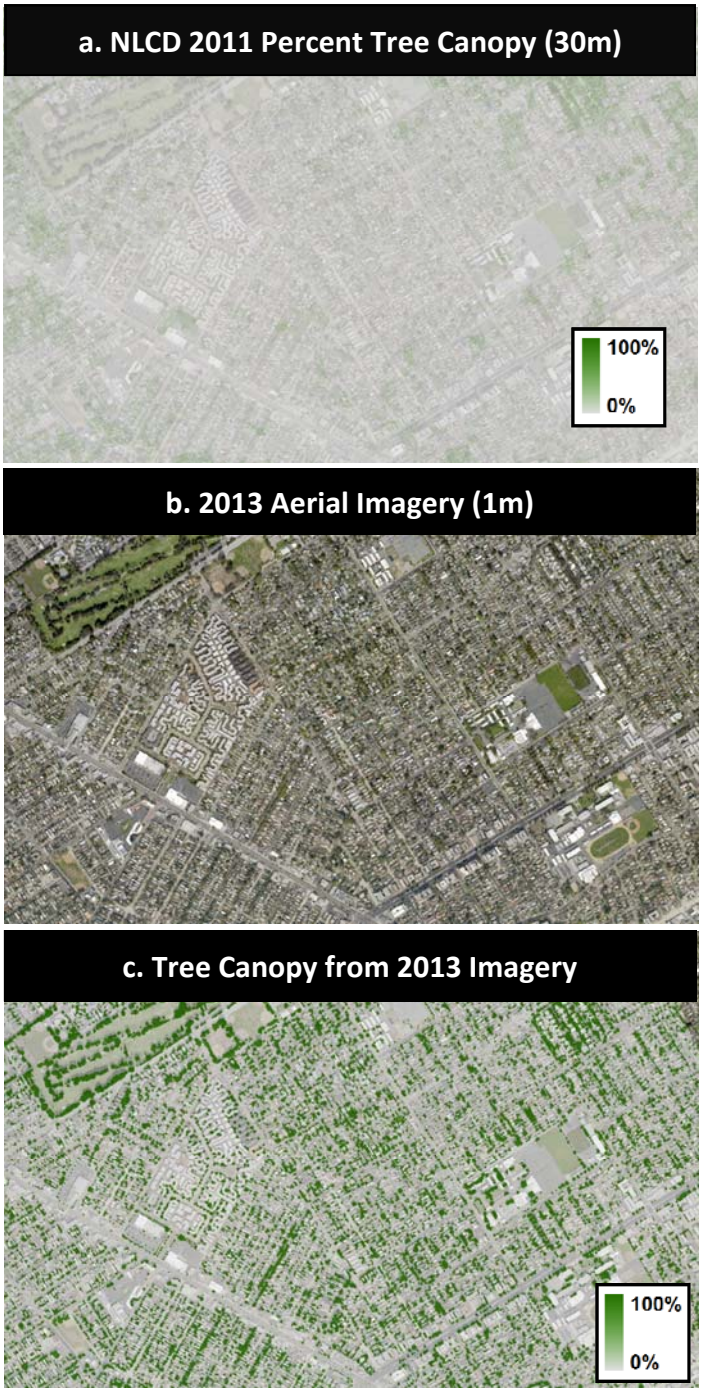


Figure 3: Comparison of NLCD 2011 (a) to high-resolution imagery (b) and tree canopy (c) derived for this study.

Parcel Summary

Tree Canopy (TC) metrics, produced from the land cover data, provide insight into the Existing and Possible tree canopy various units of analysis. 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 (Tree Canopy area divided by land area of the parcel) (Figure 4). These data can be used to understand the current tree canopy and tree planting opportunities for every property along the Los Angeles Coastline.

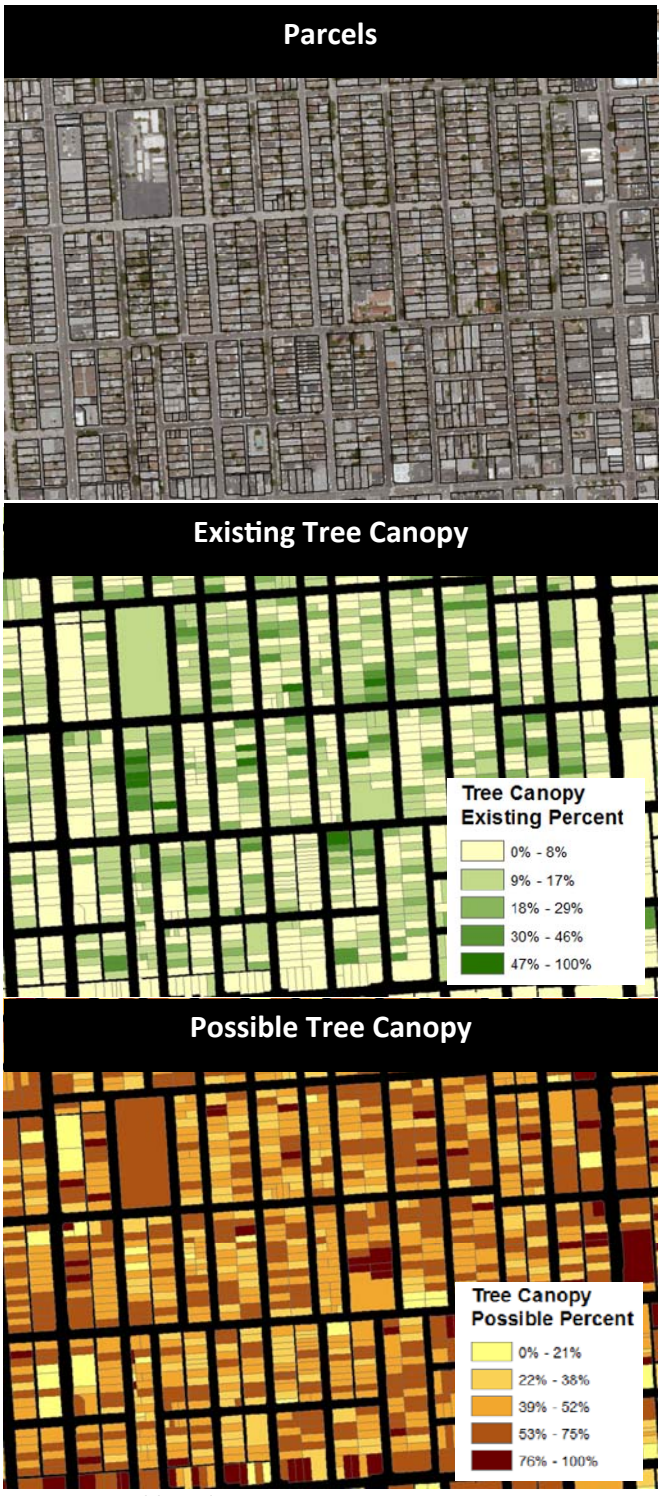


Figure 4: Parcel-based tree canopy metrics. Tree canopy metrics are generated at the parcel level, allowing each property to be evaluated according to its Existing TC and Possible TC.

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 then the percent of vegetated cover (trees, grass, and shrubs) in each land use category was computed (Figure 5). The strategy for greening will likely differ by land use class. For example, in residential areas, tree give-away programs for residents could increase canopy, while zoning regulations that limit the amount of impervious surfaces may be more effective in commercial areas. To better understand how to prioritize these efforts we examined the relationship between land use and vegetative cover. This analysis provides an understanding of how "green" each land use class is. The largest single land use category is Residential followed by ROW. Vacant & Unknown is the most green land use class, with 85% of its land area covered by vegetation. At the low end, 9% of the land in the Industrial land use category is covered by vegetation.

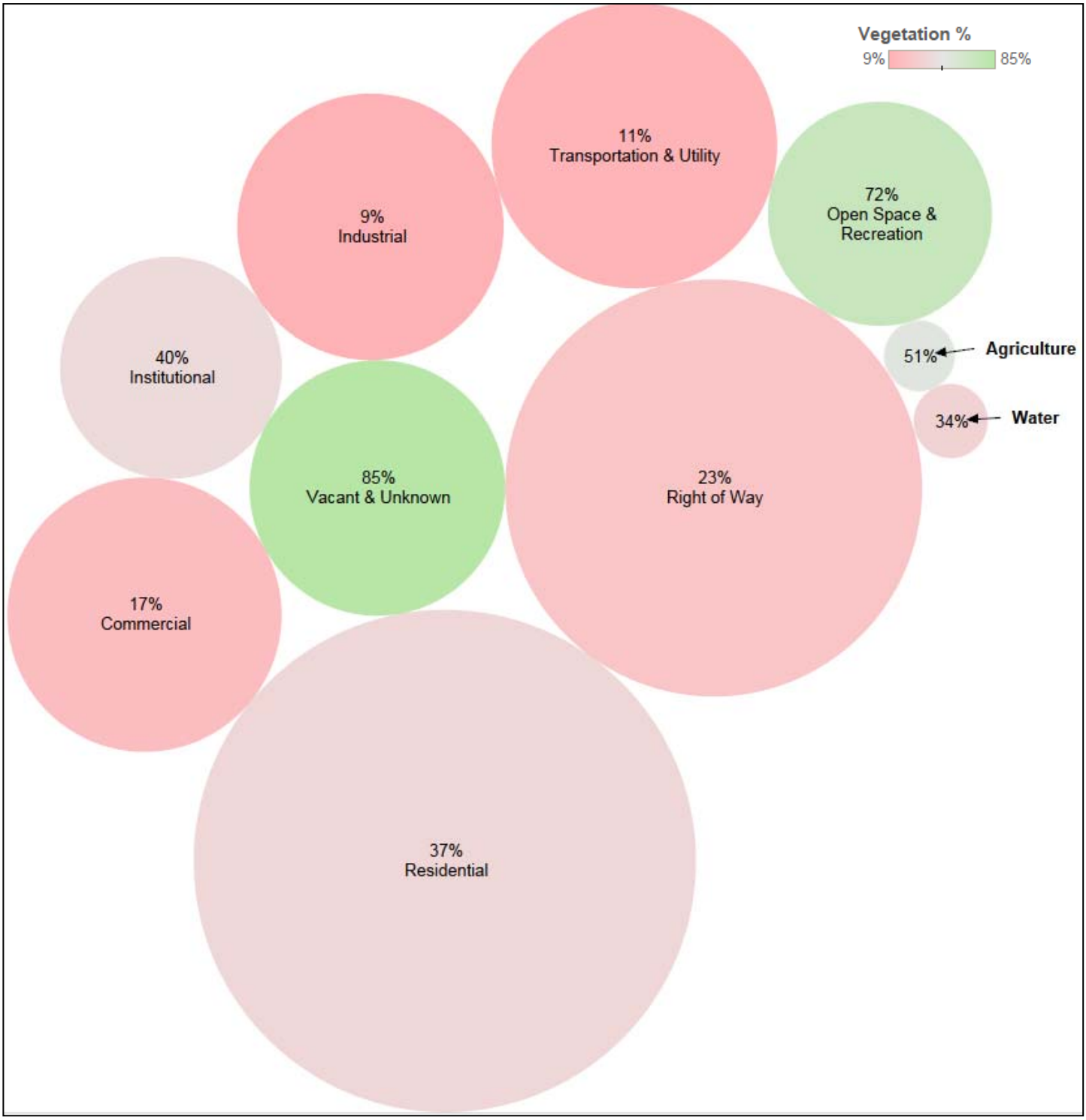


Figure 5: Percent of vegetated cover for each land use class in relation to total land area. The size of the circle represents the total land area, the color gradient represents the percentage of vegetation. Percentages are calculated based on the amount of vegetation relative to land area (i.e. water is excluded).

Land Use

Tree Canopy metrics at the property parcel were grouped according to land use. Residential is the dominant land use along the Los Angeles Coast and thus, has the most Existing and Possible Tree Canopy by total area (Figure 6). On average, 16% of Residential land is covered by tree canopy, which is the third highest percentage out of the Land Use groups (Figure 6). Vacant and Unknown has the highest percentage of tree canopy at 19%, and has the second greatest percentage of its land available for establishing new tree canopy with 78% Possible Tree Canopy. For all land uses there is an inverse relationship between Existing Tree Canopy and Possible Tree Canopy (Figure 7). This indicates that land uses with large amounts of tree canopy generally have less open space to plant new trees, but this relationship does not always hold true in more urbanized areas where select parcels with low Existing Tree Canopy also have low Possible Tree Canopy. An approach that considers all land use types is crucial for Los Angeles to maintain and increase its tree canopy, with governments, residents, non-profits, and the private sector all playing a role.

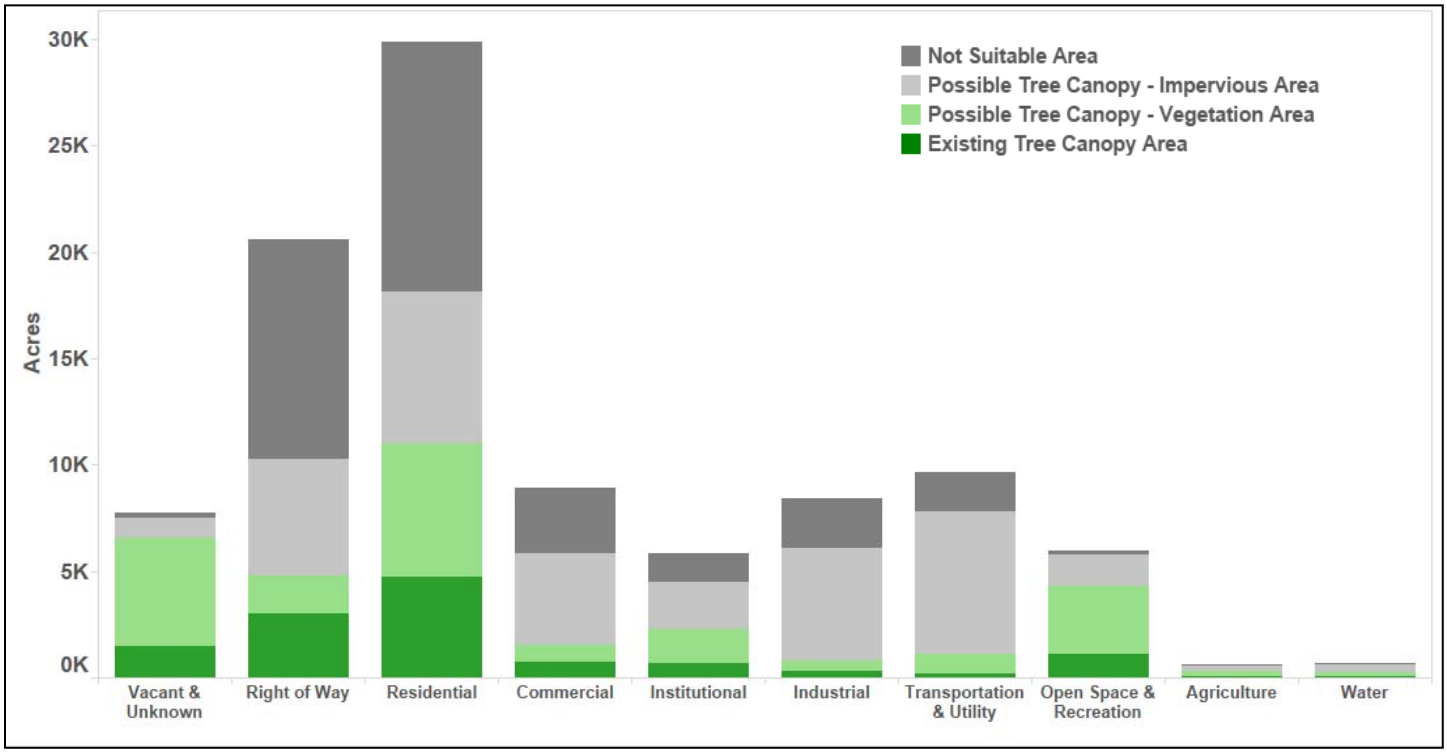


Figure 6: Tree canopy metrics derived from the parcel dataset summarized by land use.

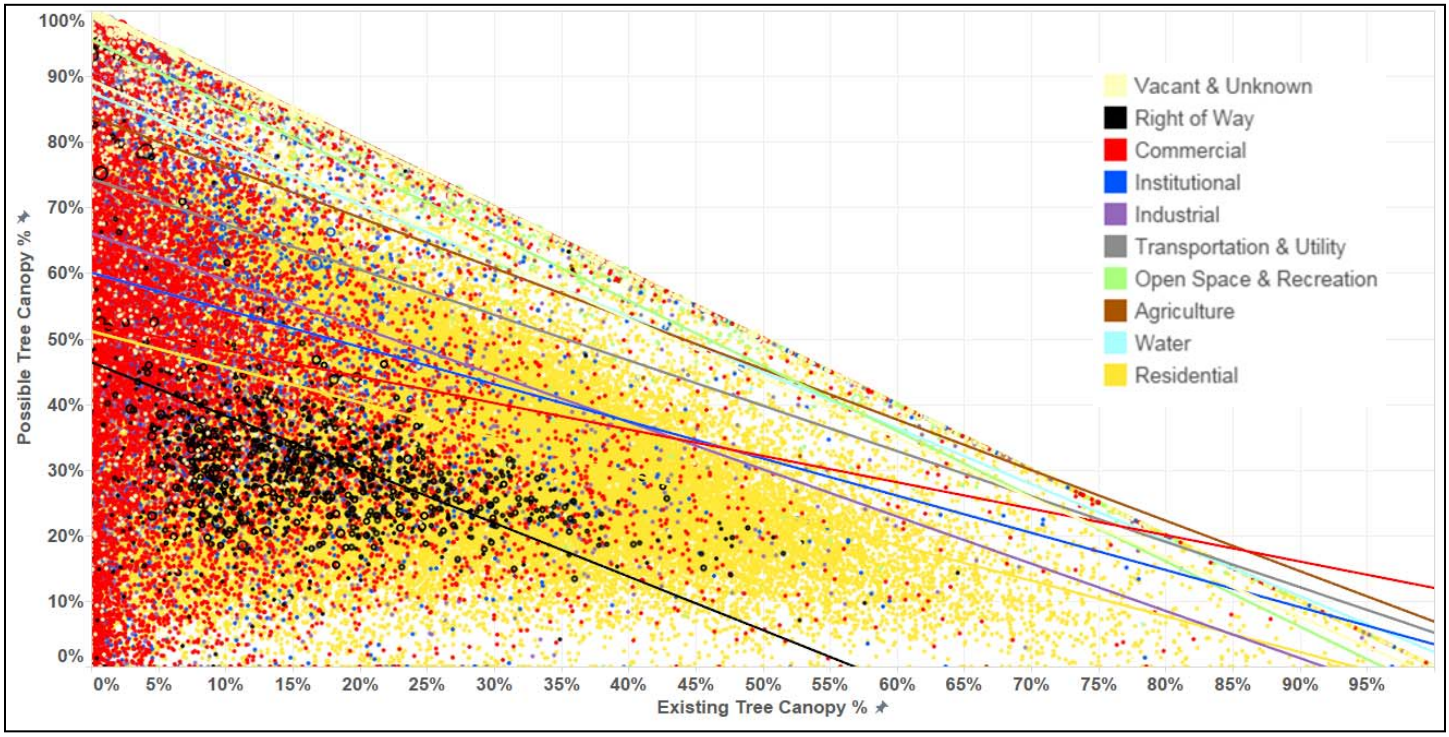


Figure 7: Relationship between Existing Tree Canopy and Possible Tree Canopy for each parcel in the Los Angeles Coastal Region study area.

Urban Heat Island

Urbanized areas are typically substantially warmer than surrounding more rural locations. This effect, known as the urban heat island, has multiple negative impacts such as increased energy expenditures and higher mortality in vulnerable populations. Trees reduce ground-surface temperatures, through shading and transpiration. Impervious surfaces further increase surface temperatures because they absorb and hold thermal radiation from the sun. Analysis of recent thermal data (Landsat, September 8th, 2015) illustrated this effect in Los Angeles (Figure 8). The cooler temperatures provides a direct relationship between the tree canopy and surface temperature (Figure 9). For example, Terminal Island in the southeastern section of the study area, contains sparse tree canopy coverage, but has a temperatures 20 degrees cooler neighboring regions along the coast because of it's proximity to the water. The relationship was further confirmed by plotting surface temperature versus Existing Tree Canopy (Figure 9). The statistically significant inverse relationship between tree canopy and surface temperature provides clear evidence that trees help reduce the urban heat island effect. For example, Santa Monica has a relatively high tree canopy percentage and provides for substantially lower temperatures.

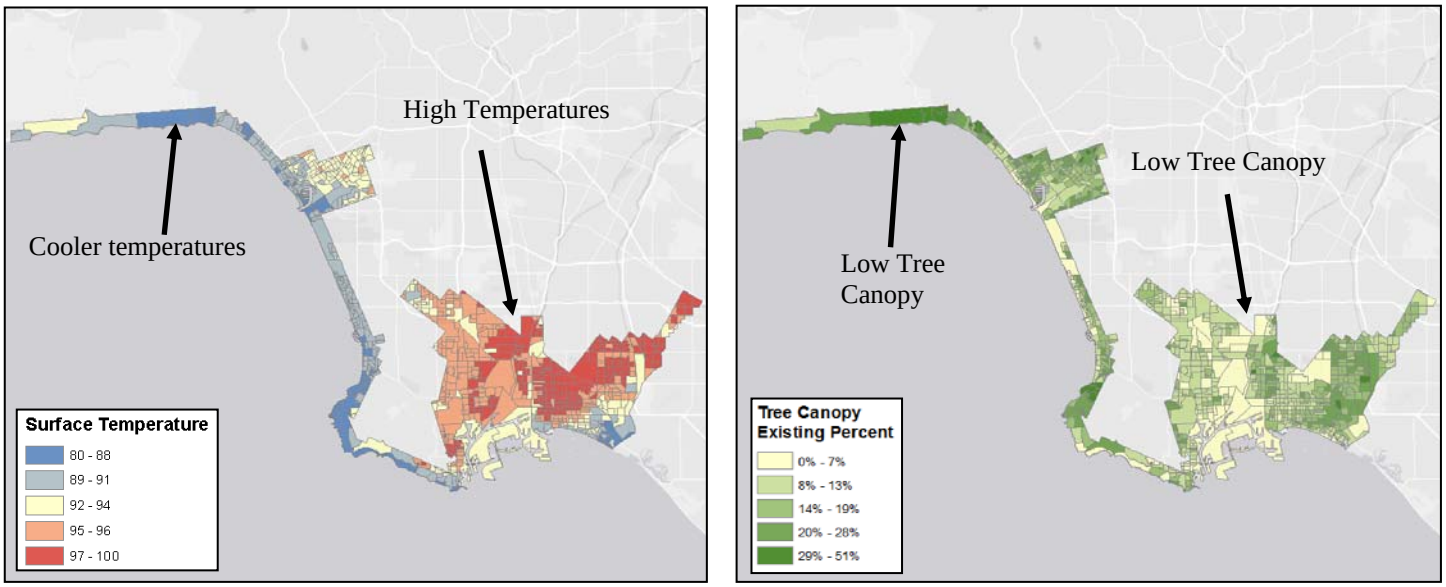


Figure 8: Surface temperature, degrees Fahrenheit on September 8, 2015 (left) in comparison with Existing Tree Canopy (right).

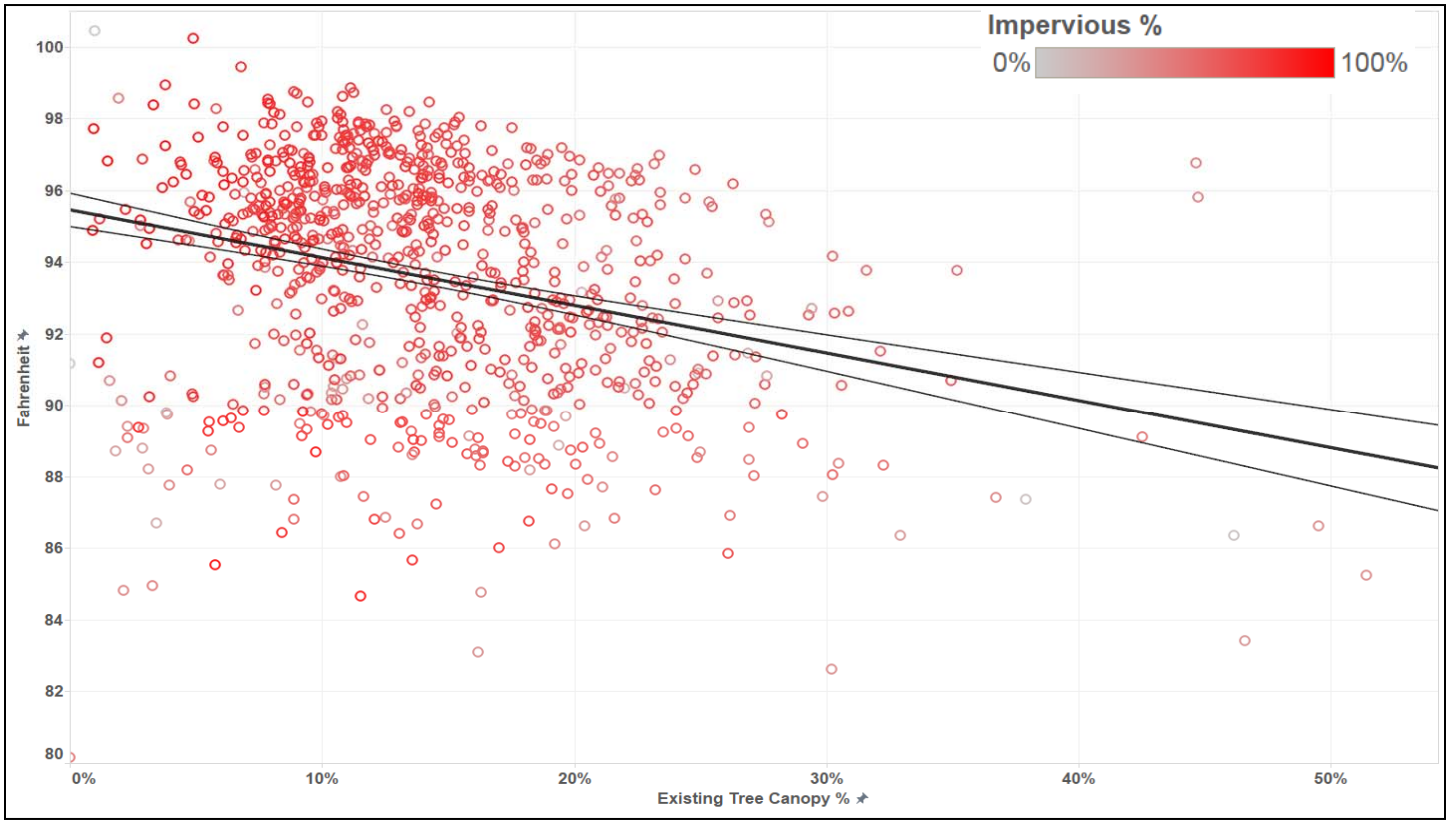


Figure 9: Surface temperature in relation to percent tree canopy. Each circle represents a census block group within the study area, percent impervious, and average surface temperature were summarized for each block group. Surface temperature was derived from Landsat satellite imagery acquired on September 8, 2015.

Watersheds

Analyzing the Existing and Possible TC by land use for each watershed allows for tree canopy planting plans to be tailored to ownership patterns in the watershed. Existing and Possible Tree Canopy were summarized for each watershed within the Los Angeles Coastal Region (Figure 10). Cold Creek-Malibu Creek Watershed has the highest percentage of Existing Tree Canopy (31%). This watershed, located in northern coastline, has large patches of forest and has comparatively little urban development. Solstice Canyon Watershed located on the northern coast, has the highest percentage of Possible Tree Canopy (77%). Long Beach Harbor-Frontal San Pedro Bay has the lowest percentage of Existing Tree Canopy(7%) and is comprised of industrial land uses with little tree canopy. Please note that watershed boundaries have been clipped down to the study area boundary and do not include the entirety of the existing watershed.

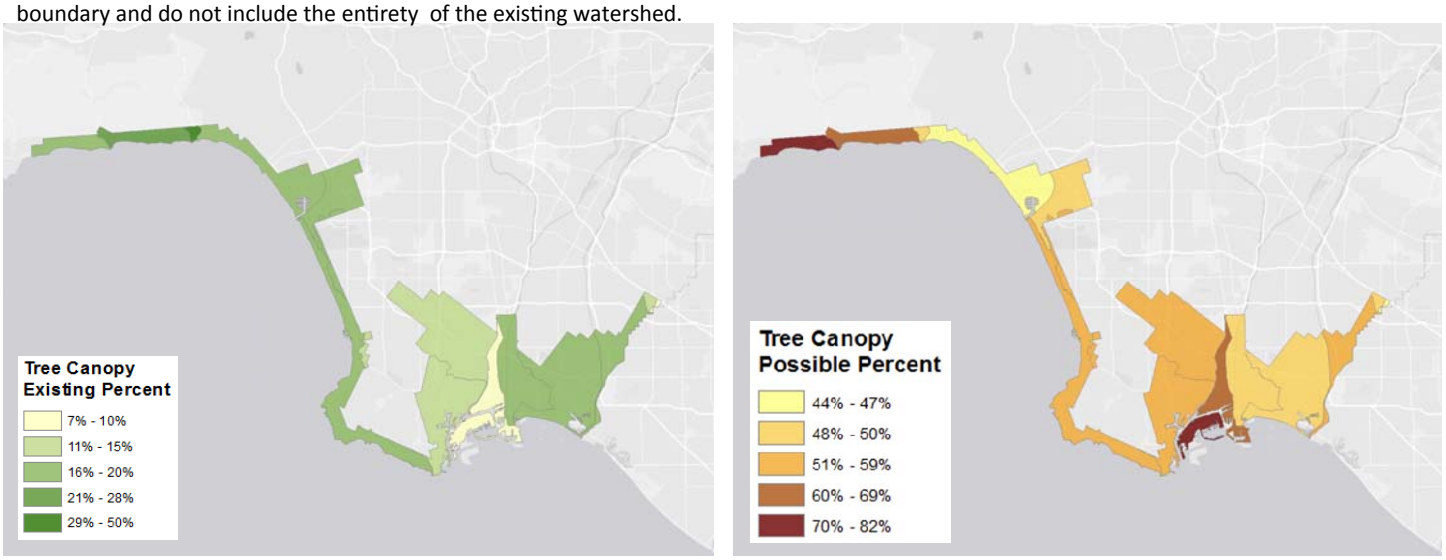


Figure 10: Percent Existing Tree Canopy by watershed in comparison to Percent Possible Tree Canopy by watersheds.

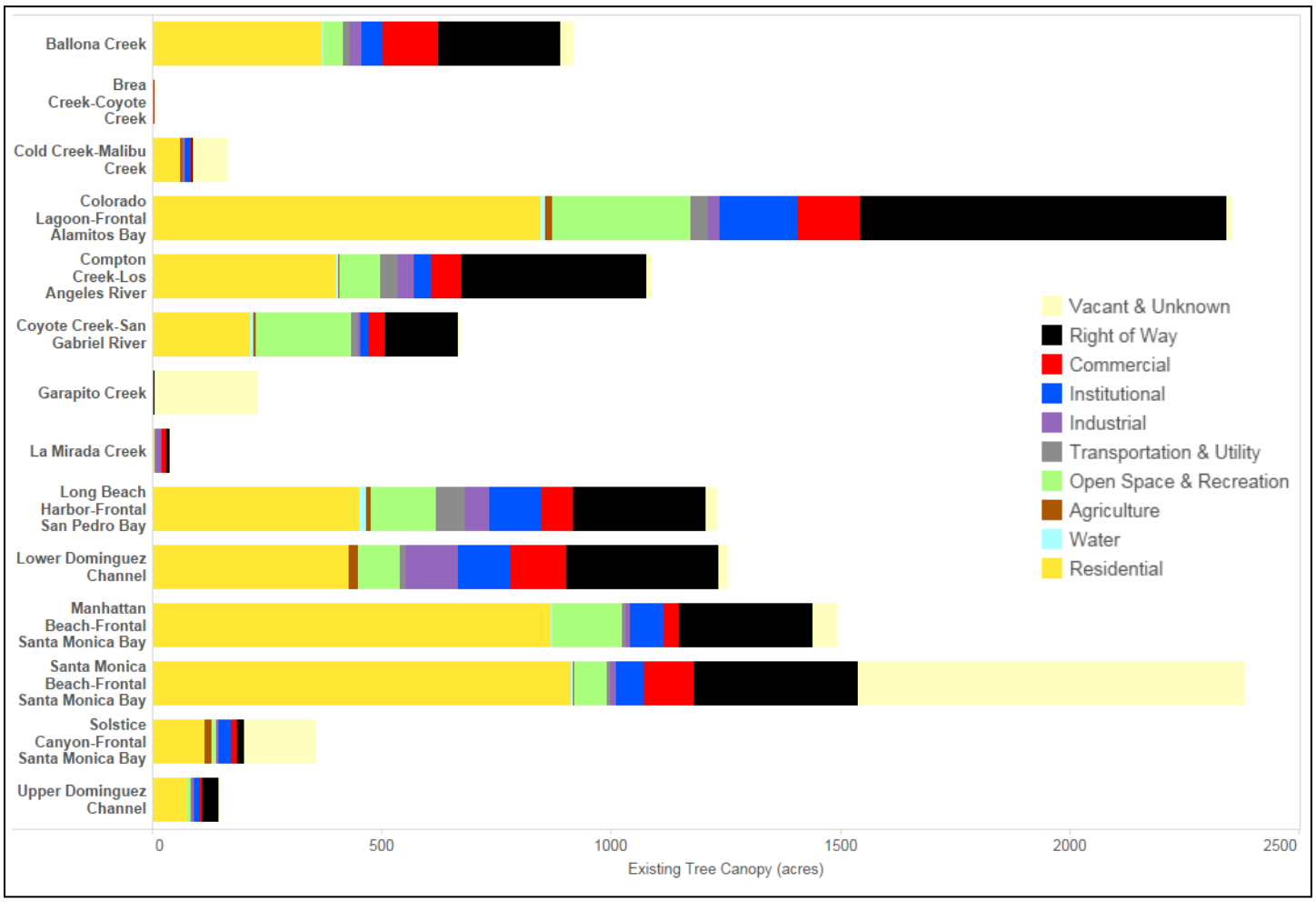


Figure 11: Total area (acres) of Possible Tree Canopy Vegetation for each watershed along the Los Angeles Coast and summarized by land use.

Urbanization

Tree Canopy metrics were computed using the Esri Urbanization Gradient classification which is a measure of the level of development in each Census block group. A majority of the Principal Urban Centers, the most urbanized block groups, are located in and around the City of Long Beach (Figure 14). Principal Urban Centers is the largest of the Urbanization categories and contains 11% Existing TC (Figure 15). Metro Cities have the highest percentage of Existing Tree Canopy at 18%. Urban Outskirts and Small Towns have low Existing TC percentages of 3% and 2%, repectively. Opportunities exist to plant trees in Small Towns and Metro Cities which have Possible TC percentages of 80% and 69%, respectively. The Metro Cities along the Los Angeles Coastline contain large sections of Possible Tree Canopy Vegetation within Residential and Vacant & Unknown Land Uses. More information: http://go.uvm.edu/cdpce

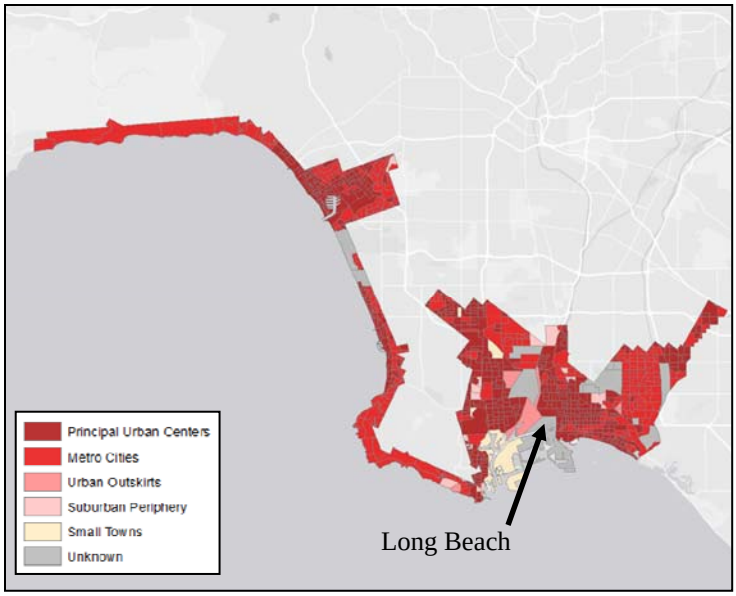


Figure 14: Urbanization Gradient displayed by Census block group.

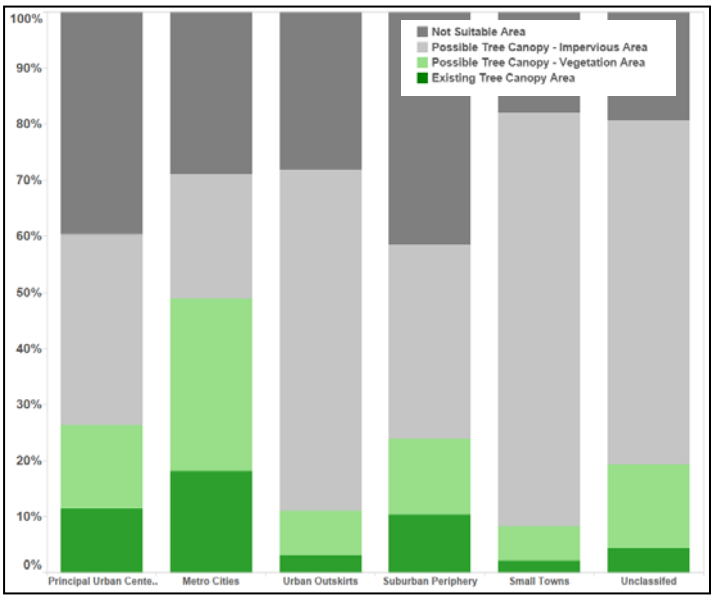


Figure 15: Tree Canopy Metrics percentages by urbanization group.

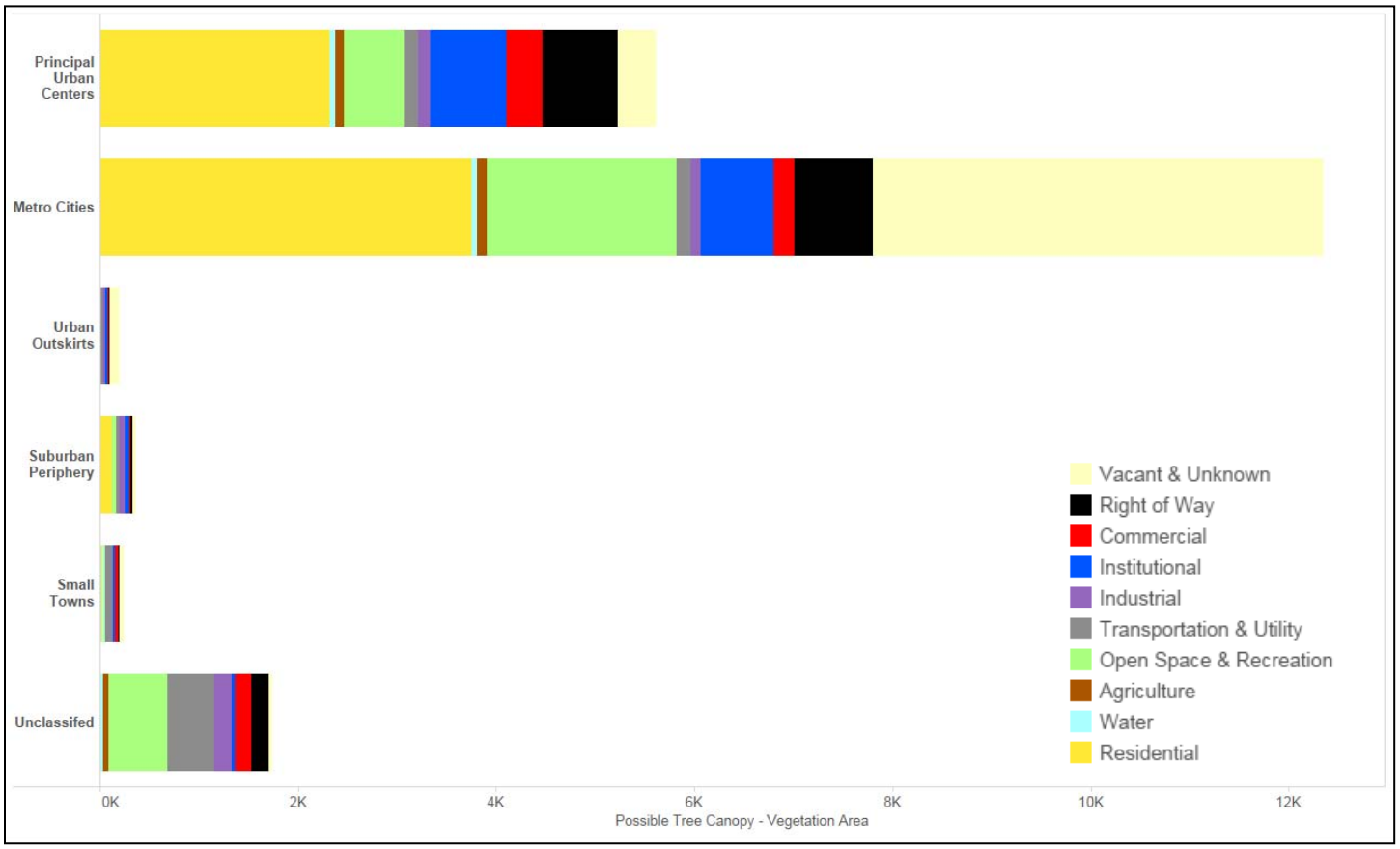


Figure 16: Total area (acres) of Possible Tree Canopy Vegetation for each Urbanization Group and summarized by land use.

Socio-Demographic-Market Analysis

Efforts to increase tree canopy can be more successful if they are tailored to specific social, economic or ethnic groups. Esri's LifeMode groups can be used to do just that (Figure 17). LifeMode groups were designed using data from the census, and each group shares an experience such as being born in the same time period or a trait such as affluence. For example, Upscale Avenues is characterized as prosperous married couples who generally live in older suburbs, frequently exercise and subscribe to premium movie channels. Variances in land cover by LifeMode groups can offer insights to increase tree canopy (Figure 18). Upscale Avenues encompasses the largest area (21,035 acres) and has a relatively high percentage of Existing Tree Canopy(15%)-High Society has the highest percentage of Existing Tree Canopy (20%). Patterns within LifeMode groups can be further explored by breaking them down by land use. For a majority of the Life Groups, Residential land encompasses the most Possible Tree Canopy Vegetation, making the residents of the Los Angeles Coastline essential to successfully increasing canopy (Figure 19) . More information: http://go.uvm.edu/cdpce

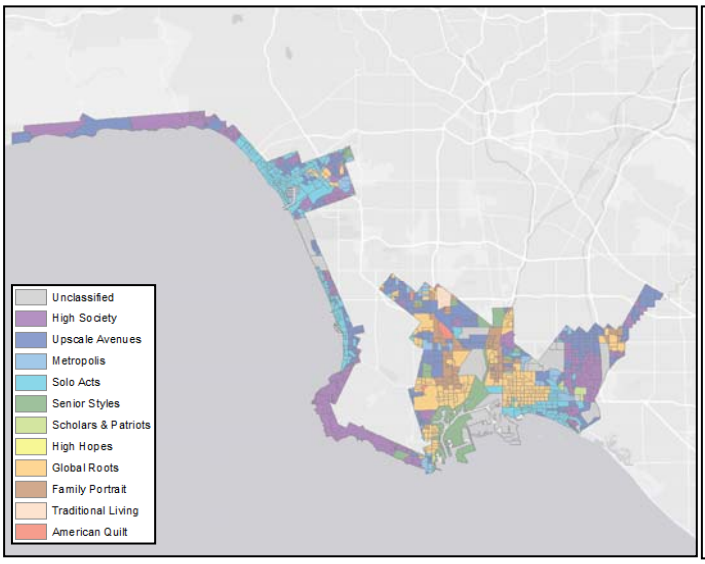


Figure 17: LifeMode groups displayed by Census Block Group.

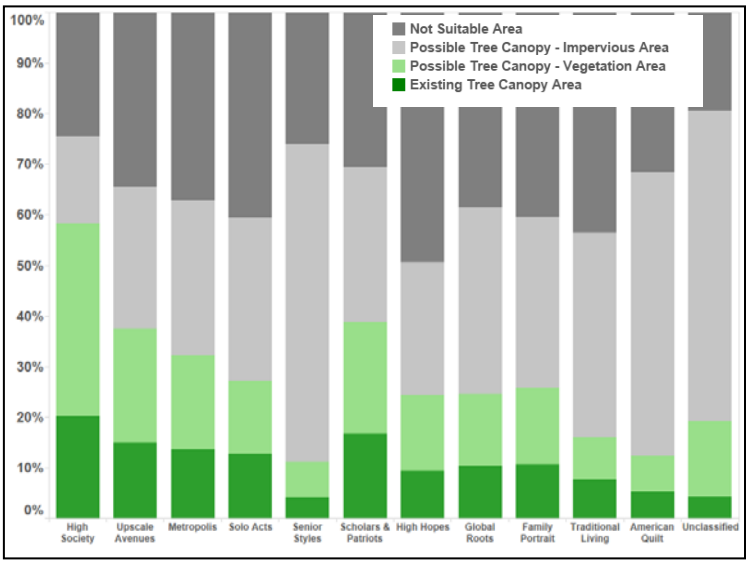


Figure 18: Tree Canopy Metrics percentages by LifeMode group.

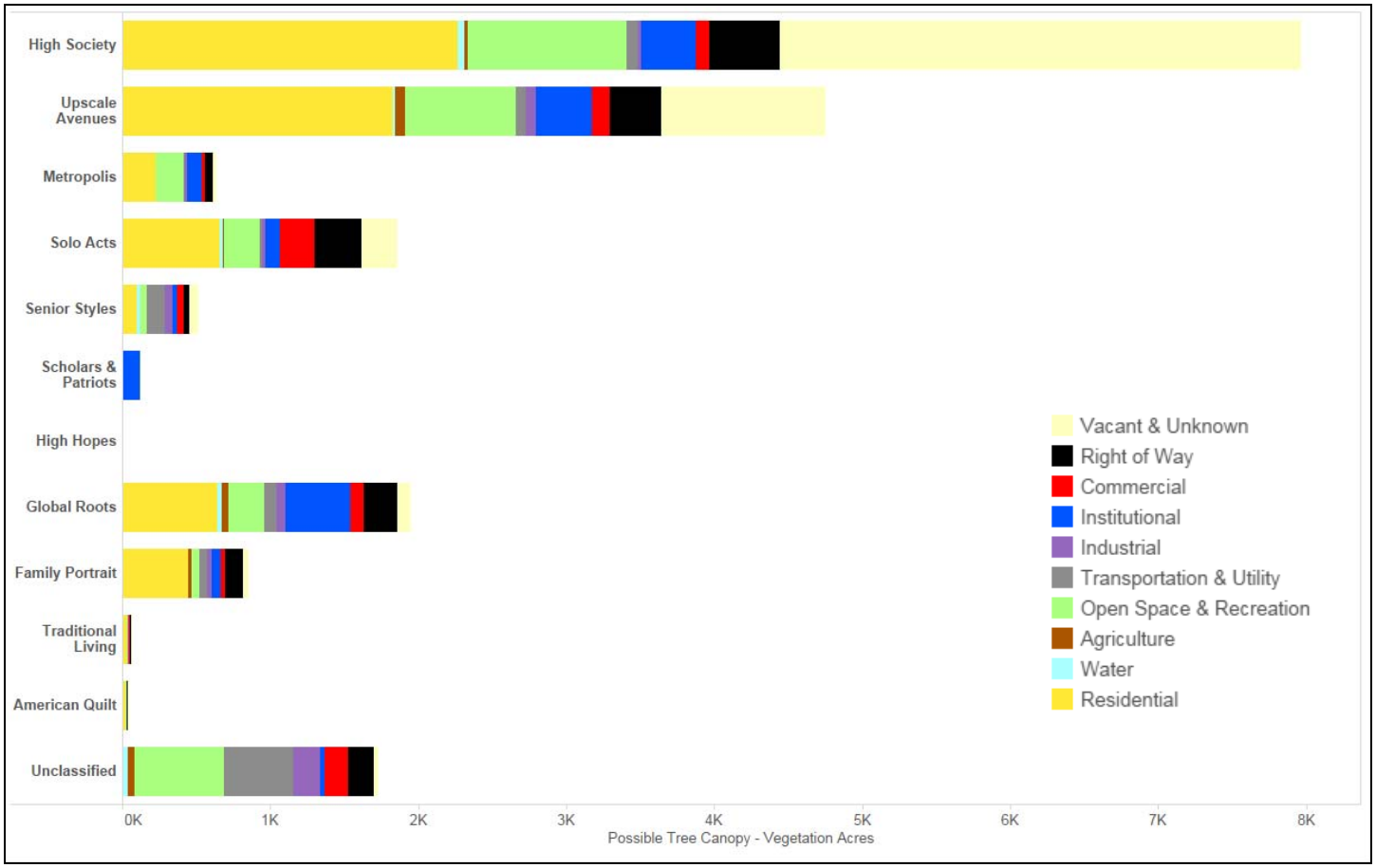
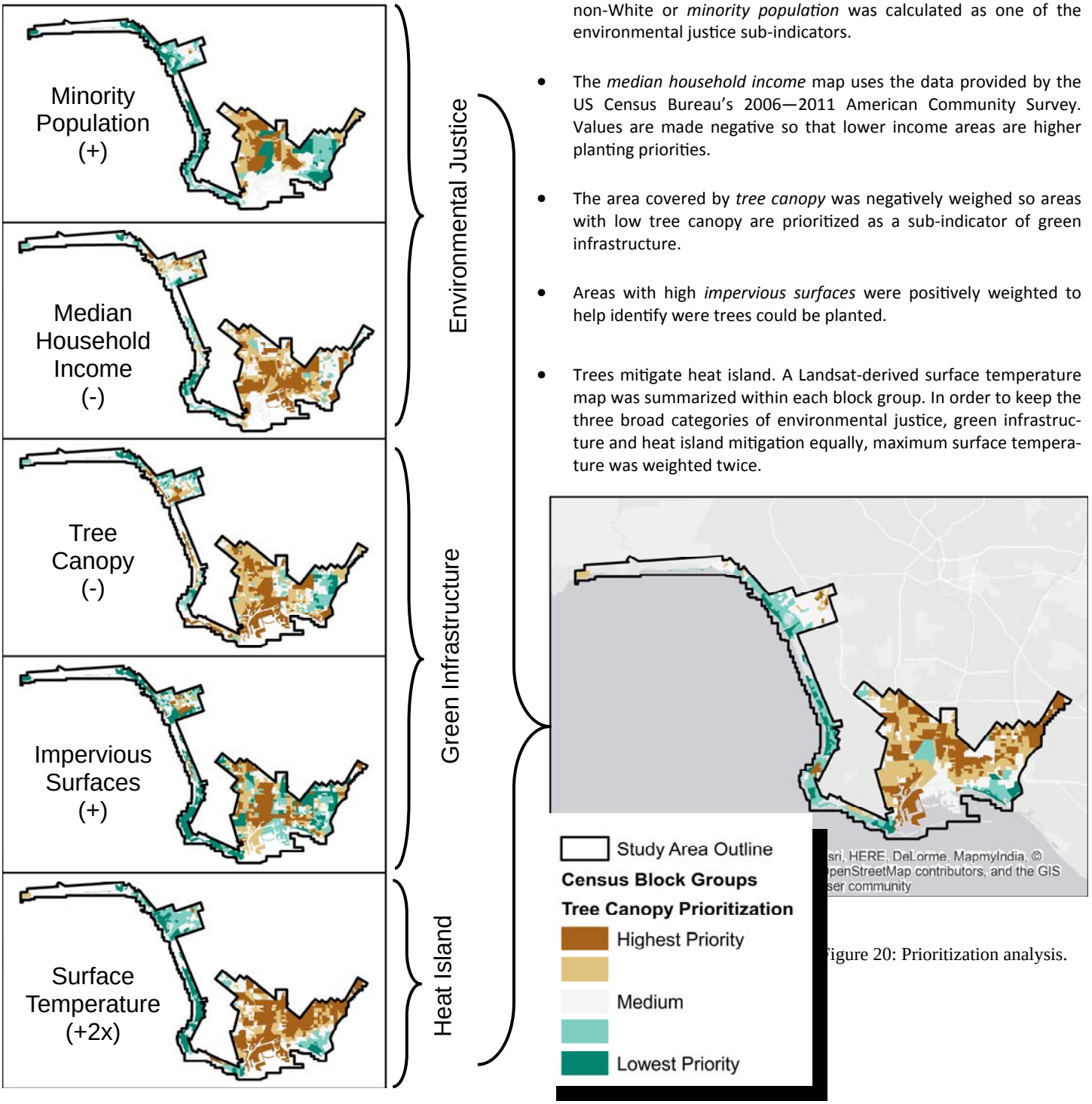


Figure 19: Percentages of Possible Tree Canopy Vegetation for each Lifestyle group along the Los Angeles Coast and summarized by land use.

Tree Planting Prioritization

To prioritize places to in need of additional tree canopy, Census block groups at least 50% contained by the mapped land cover area were selected. Those selected block groups were then clipped down to the land cover boundaries, which modified 19% of block groups. Experts at CURes wanted to identify areas potentially experiencing environmental injustice, places that could benefit from green infrastructure, and areas with acute heat island. Minority population and household income were chosen as sub-indicators for environmental justice. Similarly, tree canopy and impervious surface cover were selected as sub-indicators for green infrastructure need. Below are the five variables corresponding to management environmental justice, green infrastructure, and heat island, as well as their corresponding weights derived from CURes experts. A final UTC Prioritization map was created by standardizing and combining the weighted maps.

Prioritization Criteria



- Using the Census Bureau's year 2010 data, the percentage of the non-White or *minority population* was calculated as one of the environmental justice sub-indicators.
- The *median household income* map uses the data provided by the US Census Bureau's 2006—2011 American Community Survey. Values are made negative so that lower income areas are higher planting priorities.
- The area covered by *tree canopy* was negatively weighed so areas with low tree canopy are prioritized as a sub-indicator of green infrastructure.
- Areas with high *impervious surfaces* were positively weighted to help identify were trees could be planted.
- Trees mitigate heat island. A Landsat-derived surface temperature map was summarized within each block group. In order to keep the three broad categories of environmental justice, green infrastructure and heat island mitigation equally, maximum surface temperature was weighted twice.

Figure 20: Prioritization analysis.

Conclusions

- Tree canopy in Los Angeles is a vital asset that reduces storm-water runoff, improves air quality, reduces the region's carbon footprint, enhances quality of life, contributes to savings on energy bills, and serves as a habitat for wildlife. These benefits are known as ecosystem services.
- Targeted increases in tree canopy would enhance the ecosystem services that trees provide and setting tree canopy goals would help Los Angeles maximize the benefits of trees. Canopy goals can be better implemented and more effective when they are targeted towards specific audiences (e.g. residents) or goals like reducing stormwater runoff.
- A key tactic to increase tree canopy is the preservation and growth of existing trees.
- Tree canopy is correlated with lower surface temperatures. Increasing canopy cover in Los Angeles will help reduce summer temperatures, thereby reducing energy use, improving health, and saving businesses and homeowners money by lowering energy bills. Targeting tree planting in sites with high surface temperatures would maximize these benefits.
- The Los Angeles Coastline's residents are paramount to preserving existing tree canopy and increasing canopy cover in the future, as residential land is the single largest land use type. While there is currently more tree canopy on residential land than any other land use type, there is also more room to plant trees on residential property than on any other land use type.
- Despite the dominance of residential land use within the study area, all land use types have vegetated or impervious surfaces that could host additional tree canopy. For example, institutional and industrial sites both contain large proportions of Possible Tree Canopy-Impervious. These changes would have meaningful impacts on water and heat island issues.
- The Urbanization gradient shows that Metro Cities and Small Towns could be the focus for increasing tree canopy. Both categories have low percentages of Existing Tree Canopy, but establishing new canopy is possible, as much of the land falls into the Possible Canopy-Vegetated category.
- When planning tree planting projects, the LifeMode groups may better inform strategies. For example, if working in an area classified as Global Roots, consider the residents' native language and culture. Residents of the more youthful and motivated LifeMode groups such as Solo Acts and Scholars and Patriots might be great targets for tree planting projects.
- New developments show a conspicuous lack of tree canopy. New urban development projects in the study area 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.

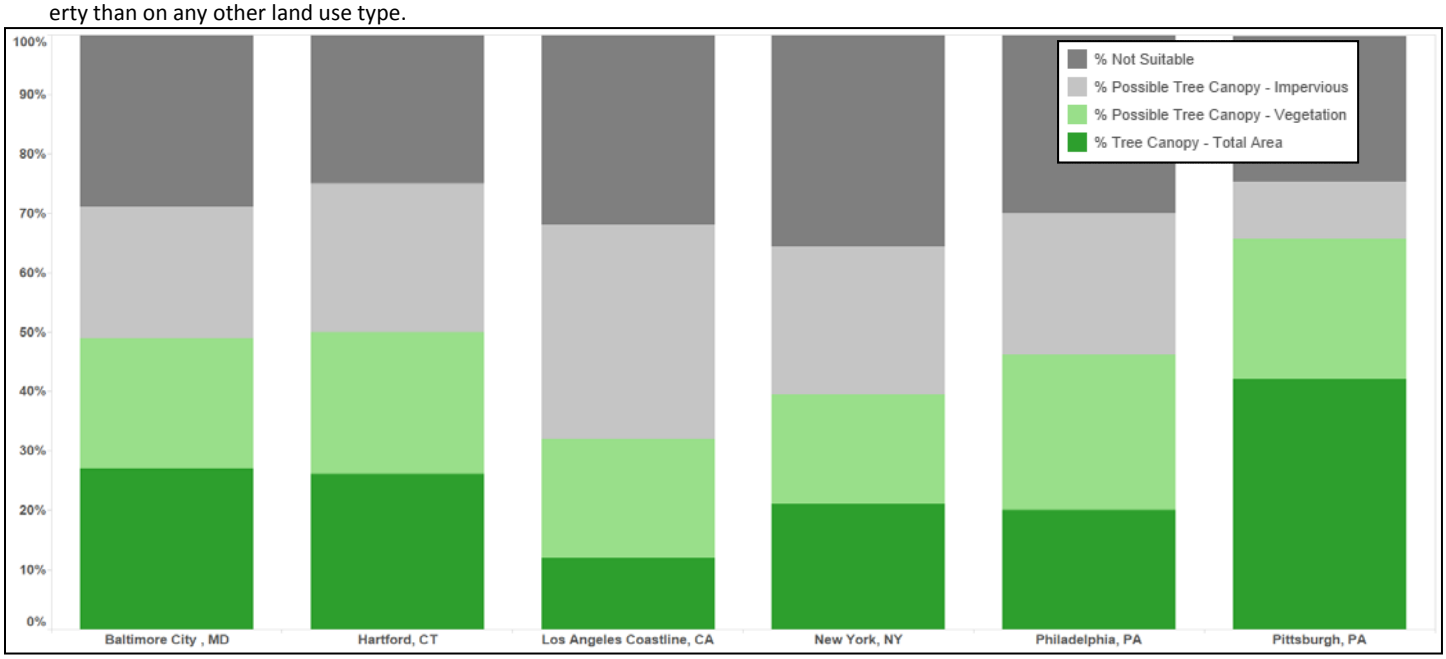


Figure 21: Comparison of Existing and Possible Tree Canopy with other communities similar in size that have completed Tree Canopy Assessments.

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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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