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. 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 TC is an important step in urban forest planning. A TC 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.

How Much Tree Canopy Does Cook County Have?

An analysis of Cook County based on land cover data derived from high-resolution aerial imagery and LIDAR (Figure 1) found that 174,461 acres of the study area were covered by tree canopy (termed Existing TC). This represents 29% of all land in the study area (Figure 2). An additional 47% (280,547 acres) of the county’s land area could theoretically be modified to accommodate tree canopy (termed Possible TC). Within the Possible TC category, 32% (192,677 acres) of total land area was classified as Vegetated Possible TC and another 15% as Impervious Possible TC (87,871 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.

Project Partners

This project applied the USDA Forest Service’s Tree Canopy Assessment protocols to Cook County, IL. The analysis was conducted using imagery and LIDAR data that was acquired in 2010. 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, American Forests, Cook County, The Field Museum, Morten Arboretum, Chicago Region Trees Initiative and the Chicago Metropolitan Agency for Planning.

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).

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

Figure 2: Tree Canopy metrics for Cook County, IL on percent of land area covered by each TC type.
A previous estimate of tree canopy for Cook County, derived from the 2011 National Land Cover Database (NLCD 2011), was 14%, notably lower than the 28% obtained in this study (based on the total study area, 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 imagery (Figure 3b) and LiDAR acquired in 2010, in combination with advanced automated processing techniques, land cover for Cook County was mapped with such detail that individual trees were detected (Figure 3c). This method can therefore be used to manage the forest on a much smaller scale.

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

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 Cook 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.
Increasing vegetation and reducing impervious surfaces will help reduce stormwater runoff and the urban heat island effect. 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. The total area for each land use class was summarized, and was then correlated with the percentage of vegetated cover (trees, grass, and shrubs) in each land use category (Figure 5). This analysis provides an understanding of how “green” each land use class is. The largest single land use category is Residential followed by Right of Way. Not surprisingly, Agriculture is the most green land use class, with 98% of its land area covered by vegetation. At the low end, Commercial and Industrial land uses have 26% of their land 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).
Tree Canopy metrics were computed for each parcel’s land use in the study area. Residential is the dominant land use in Cook County and thus, this land use has the most Existing and Possible Tree Canopy by total area (Figure 6). On average, 31% of Residential land is covered by tree canopy (Figure 6). Conservation and Natural Areas has the highest percentage of tree canopy at 68%, and Agriculture has the greatest percentage of its land available for establishing new tree canopy with 87% 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 “all lands” approach is required for maintaining and increasing tree canopy, with governments, residents, non-profits, and the private sector all playing a role.
Trees reduce ground-surface temperatures, through direct shading and increased retention of soil moisture. In areas with low canopy cover, surface temperatures can be substantially higher than adjacent forested areas. Impervious surfaces, further increase surface temperatures because they absorb and hold thermal radiation from the sun. Analysis of recent thermal data (Landsat, September 23, 2014) illustrated this effect in Cook County (Figure 8). 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, the Des Plains River corridor of tree canopy descending from the northern border of Cook County, provides for substantially lower temperatures.

Figure 8: Surface temperature, degrees Fahrenheit on September 23, 2014 (left) in comparison with Existing Tree Canopy (right).

Figure 9: Surface temperature in relation to percent tree canopy. Each circle represents a 4000ft grid cell. A 2000ft x 2000ft 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 September 23, 2014.
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 Cook County (Figure 10). Flint Creek-Fox River Watershed has the highest percentage of Existing Tree Canopy (46%). This watershed, located in northwestern Cook County, has large patches of forest and has comparatively little urban development. Hickory Creek Watershed has the highest percentage of Possible Tree Canopy (70%) and the second lowest Existing Tree Canopy percentage (18%) behind Calumet River - Frontal Lake Michigan.

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 in Cook County and summarized by land use.
Environmental analyses are also possible at finer scales, including an assessment of Existing and Possible Tree Canopy in floodplains. Trees are important in floodplains as they reduce flooding. Additionally, floodplains tend to contain higher amounts of habitat for wildlife. The 100 Year Floodplain has 47% Existing Tree Canopy, much higher than the county average of 29% (Figure 12). There is more room to plant trees within the floodplain, with Possible Tree Canopy at 39%. Possible and existing canopy cover vary greatly across land use types within floodplains. Figure 13). Agricultural land uses contain the highest amount of Possible Tree Canopy within the flood plain (86%), followed by Transportation and Utilities at 75%.

Figure 12: Tree Canopy Metrics summarized by 100 foot riparian buffer (left) and map of 100 Year Floodplain.

Figure 13: Tree Canopy Metrics broken down by land use for floodplains in Cook 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.
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 Chicago (Figure 14). Metro Cities is the largest of the Urbanization categories, and it contains 34% Existing TC (Figure 15). Small Towns and Principal Urban Centers have low Existing TC percentages of 15% and 19%, respectively. Opportunities exist to plant trees in Small Towns, with a Possible TC percentage of 68%. As the Urbanization classification changes from urban to rural Existing TC percentage decreases, reflecting the prairie and agrarian landscape. Metro Cities and Suburban areas have a considerably higher Existing TC (34% and 33%) than Small Towns and Rural areas (15% and 22). The Metro Cities in Cook County contain long-established residential areas with robust patches of urban tree canopy while Small Towns and Rural areas contain agricultural fields, prairie land, and Industrial parks that have little tree canopy (Figure 16). More information: http://downloads.esri.com/esri_content_doc/dbl/us/tapestry_segmentation_poster.pdf

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.
Efforts to increase TC 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 TC (Figure 18). High Society encompasses the largest area (61,226 acres) and has the second highest canopy cover (41%), whereas American Quilt, while small has plenty of potential to increase canopy cover (42%). Patterns within LifeMode groups can be further explored by breaking them down by land use. Residential land uses have the most area of Possible TC Vegetation, making the residents of Cook County essential to successfully increasing canopy (Figure 19). More information: http://downloads.esri.com/esri_content_doc/dbl/us/tapestry_segmentation_poster.pdf

![Figure 17: LifeMode groups displayed by Census Block Group.](image1)

![Figure 18: Tree Canopy Metrics percentages by LifeMode group.](image2)

![Figure 19: Percentages of Possible Tree Canopy Vegetation for each Lifestyle group in Cook County and summarized by land use.](image3)
Conclusions

- Tree canopy in Cook County is a vital asset that reduces stormwater 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.

- Cook County could consider setting tree canopy goals, not only for increasing the overall tree canopy but to focus on increasing tree canopy in urban areas that have low Existing Tree Canopy and high Possible Tree Canopy.

- Tree canopy is correlated with lower surface temperatures. Increasing canopy cover in Cook County will help reduce summer temperatures, thereby reducing energy use, saving businesses money and improving human health.

- Cook County’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 land than 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 provide opportunities for additional tree canopy.

- In the Urbanization gradient, Principle Urban Centers and Urban Outskirts could be the focus for re-greening. Both categories contain large proportions of Residential land located on Possible Tree Canopy Vegetation, while also having low percentages of Existing Tree Canopy.

- Strategies to increase canopy cover can be focused on watersheds, floodplains or urban centers. By looking at current and possible tree cover in these areas, managers can create plans to, for example, reduce runoff or manage stormwater. Individual strategies can be tailored to suit the needs of the projects.

- When planning tree planting projects, the LifeMode groups could better inform the process. 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.

- Some land uses will not necessarily be appropriate for planting trees, including the airport along with vegetated lands that are occupied by cemeteries, 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.

Figure 20: 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/