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Urban Tree Shade Analysis for Austin Parks and Recreation: Urban Forestry Program

Prepared By:

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INTRODUCTION

Summary

The use of shade for sun protection can affect many aspects of life, especially within an urban environment. By recognizing shade patterns and developing a shade index, not only will we be able to determine the location of areas that need tree implementation, but also illustrate the relationship between current urban shading and the frequency of road maintenance intervals, crime rates, available moisture levels in soil, in addition to other possible implications. The City of Austin Parks & Recreation department, which oversees the Urban Forestry Program (UFP), is interested in the tree shade distribution and its related impacts in the City of Austin. Sustainable Solutions of Central Texas (SSOCT) is ideally suited to help the City of Austin reach this goal through our team of geographic experts skilled in the use of Geographic Information Systems (GIS). We will use GIS to help the City of Austin identify areas of shade distribution as it relates to sidewalks and streets for future planning based on supply and demand.

Purpose

The objective of this project is to create a block-by-block tree shade index for the streets and sidewalks of the City of Austin. SSOCT will do this by examining and analyzing the existing tree canopy within the city limits, and restricting the canopy to just the streets and sidewalks that it overlays. The tree canopy is very important to the urban environment of the city. It provides cleaner air, improves esthetic qualities, and above all keeps us shaded from the sun. Once the shade index has be established, we can use it to determine which streets and sidewalks of the city are lacking tree cover, therefore identifying areas where trees should be implemented in the future. SSOCT will also use the shade index to examine the less shaded streets and sidewalks to

establish a relationship between them, and the street pavement conditions of these thoroughfares as well. The results of this study will provide the UFP with a tree shade index of the streets and sidewalks that can be used for further evaluation and analysis.

Scope

The study region for this project includes the entire City of Austin, including the extra territorial jurisdiction (ETJ). The completion of this project will take approximately 3 months (September 8, 2011 to December 13, 2011).

LITTERATURE REVIEW

The examination and analysis of urban tree canopies through the use of GIS has recently become a focus of many growing cities. A 2010 study conducted by the Texas Tree Foundation in Dallas used GIS to develop a model based on 12 criteria, which was used to create a tree planting "roadmap". Of the data used in the Dallas study (parcel information, urban heat islands, land use type, existing, tree cover, watershed priority, riparian values, soil permeability, overhead power lines, public health and income data, transportation, storm water runoff, and proximity and orientation to buildings), most is relevant to our stage two analysis. Not only are trees aesthetically pleasing, but they offer value in the form of kilowatt per hour savings, CO2 intake benefits, and also by the gallons of storm-water mitigated by tree canopies (Texas Tree Foundation 2010). According to data collected by the Texas Forest Service, a single Post Oak tree can save roughly $17 in energy, $5 in CO2, $60 in storm water savings, and $79 in aesthetic and other value leading to an annual savings of $162 (Texas Tree Foundation 2010). By utilizing GIS, the team was able to accurately portray the data for public use and preserve the database for

further analysis. This is a large goal as well in our analysis. In November 2002, the City of San Antonio preformed a study on their urban environmental quality and recognized the many benefits that an urban tree canopy can provide. The city looked at the three important geographic locations: the Extra Territorial Jurisdiction (ETJ), the City of San Antonio (COSA), and the Edwards Aquifer Recharge and Transition Zone (EARZ). The Urban Ecosystem Analysis analyzed the ecology of land cover in 2001 and 2006. Their findings showed that between 1985 and 2001, the City of San Antonio had lost 39% of its heavy tree canopy cover, with its most dramatic tree canopy loss occurring in the EARZ at a decline of 6.0% (American Forests 2009). The COSA, as well as the ETJ, saw a 3.4% and 1.2% decrease of tree canopy, respectively (American Forests 2009). Being able to provide concrete numerical data can change the minds of many and is a necessity in implementing a generally accepted plan. Planting trees in an urban environment has been proven beneficial to preserving and lengthening the life of the surrounding street asphalt within a tree's shade cover. In an online report by the US Forestry Service, the effects of street tree shade and its relation to concrete pavement performance were put to the test. The study took place in Modesto, California where city officials say streets with adequate shade are repaved usually every 10 years; and streets with extreme shading may take 25 years for repaving (McPherson and Muchnick 2005). The economic analysis in the study illustrated that planting Crape Myrtles (smaller trees) and Hackberrys (larger trees) along a stretch of road 35 ft. wide can reduce pavement costs of up to $2,900 over a thirty year period (McPherson and Muchnick 2005). The study was able to show the officials in Modesto that repaving streets every 10 or 25 years was not necessary, and planting specific types of trees instead will provide enough shade to extend the life of the street asphalt. This study examined the benefit trees have on street pavement conditions and directly relates to our project.

PROPOSAL

Data

Table 1-Data Layers and their sources.

Layer	Source
Parks	COA*
Streets	CAPCOG*
Sidewalks	COA*
Tree Canopy (Lidar)	COA*
Watersheds	COA*
Planning Neighborhoods	COA*
200ft. Grid	COA*

*Abbreviations: Capitol Area Council of Governments (CAPCOG), City of Austin (COA)

In creating a shade indices map of the City of Austin's (COA) streets and sidewalks, multiple data layers must be obtained and utilized. The layers we will be using include the COA city limit boundary, COA street polygons, COA sidewalk polygons, the COA tree canopy, COA watersheds, a 200ft grid layer, and COA neighborhoods. Further analysis using the newly created shade indices data might call for additional data layers. The additional data might include but are not limited to, COA street maintenance, COA home sale prices, COA soils/available soil moisture data, and COA crime rates. All data will be obtained through the City of Austin Parks and Recreation Department as well as various online sources as needed. All data sources are

defined in Table 1. Arc GIS 10 and Microsoft Excel will be the primary software used in our City of Austin shade analysis.

Methodology

The underlying techniques required to complete this project include the preparation, analysis, and final processing of the allocated data layers. We will be using ESRI® (Environmental Systems Research Institute) ArcGIS 10™ software to aid us in the process and procedures that will give us our final deliverables and end results. The first task that SSOCT will conduct will be the preparation of the six data layers provided by the UFP. These layers include the streets, sidewalks, tree canopy, watersheds, neighborhoods, and APD districts within the COA. To make things a bit simpler, we will join the streets and sidewalks layer to create one whole polygon file that encompasses both vector files; this now gives us five layers instead of the original six. Prior to the join we will produce a 2ft buffer around the sidewalks layer, which will enable us to combine them into one polygon layer. After that is completed, we will be clipping the canopy layer, along with the newly formed streets and sidewalks layer into more manageable portions that will fall within different sections of the watersheds and neighborhoods layers. This will give us four unique layers that will display: the canopy divided by the watersheds, the canopy divided by the neighborhoods, the streets and sidewalks divided by the watersheds, and the streets and sidewalks divided by the neighborhoods. Once those layers are in place, we will join the two layers previously clipped by the watersheds as well as join the two layers clipped by the neighborhoods. We will end up with two resulting layers. One will display a watershed layer that incorporates both the canopy and the streets and sidewalks layers, which will be constricted to the boundaries of the different watersheds. The other layer will include the same structure, only it will be a neighborhood layer constricting its contents to the different neighborhood boundaries.

After the two layers are established, we will manipulate them once more. We will clip the canopy by the streets and sidewalks for both the watershed and neighborhood layers. The subsequent layers will display the canopy cover of the streets and sidewalks only, in both the neighborhood and watershed layers.

Once we have the final layers in place, we will create a shade index that represents the amount of shade the canopy cover provides to the streets and sidewalks within the different neighborhoods and watersheds. The shade index will be divided into four or five different categories that will be color coordinated on the maps and displayed block by block. The index will display the distribution, density, and impact of trees along the streets and sidewalks of the COA. We will apply the shade index to the final neighborhoods and watersheds layers discussed earlier, as well as a 200ft grid layer that will help the UFP decide what street blocks need some level of shade, which ones may need further shade, and which blocks are sufficiently shaded by canopy cover. When this analysis is completed, SSOCT will be able to take the tree shade results and relate them to other municipal GIS data with the end goal of establishing a connection between the lack of trees and/or shade with things like: street pavement conditions, home sale prices, air quality, the urban heat island effect, and the crime rate.

Implications

This project will meet the COA's need for a shade index, analysis, and map of the COA as well as the ETJ. The data and visual representation provided by SSOCT will play a major role in future tree planting projects taking place within the COA and the ETJ. Visual representation of the data sorted by neighborhoods and watersheds will provide the COA with valuable information that can be referred to during important decision making processes. Analysis of how

tree shade might affect home prices, the need for road maintenance, air quality, the urban heat island effect, and crime rates are future implications for this study if time permits.

Budget

Sustainable Solutions of Central Texas – Project Budget				
Personnel	**Hours**	**Total Hours**	**Hourly Rate**	**Total**
Data Collection (1)	30.00	30.00	$30	$900.00
Data Analysis (1)	50.00	50.00	$45	$2,250.00
Project Manager	80.00	80.00	$80	$6,400.00
Assistant Manager	80.00	80.00	$60	$4,800.00
Total Personnel Cost				$14,350.00
Equipment	**Description**	**Cost**		**Total**
Supplies	3 workstations	$200.00		$600.00
Maintenance	3 workstations	$100.00		$300.00
Depreciation*				$277.00
Total Equipment Costs				$1,177.00
Data				**Total**
Purchased			-	$0.00
Software License			-	$0.00
Total Data Cost			-	$0.00
Total Expenses				
				$15,527.00

*Depreciation is based on value of all equipment ($4,000) over the life of the equipment (36 months) for time used (2.5 months).

Timetable

Table 2-Proposed Timetable

Activity	Initiation date	Completion date
Form teams	29 August	29 August
Data Collection	31 August	21 September
Data Pre-processing	12 September	10 October
Clipping layers into manageable forms	21 September	12 October
Analysis of tree shade indices	5 October	17 October
Data interpretation	28 September	21 November
Create website	14 November	5 December
Prepare final deliverables	5 December	12 December

Final Deliverables

Final deliverables will include:

- Detailed final report (2 copies)
- Professional poster for display in the Geography Department
- Website
- CD (2 copies) containing
    - All data
    - Metadata
    - Proposal, Progress, and Final reports
    - Poster
    - Power Point presentation
    - Instructions on how to use CD (readme file)

CONCLUSION

This proposal has described the techniques that will be used to determine the tree shade index for the streets and sidewalks in the City of Austin. Included in our study is an extensive literature review that provides similar analysis among other cities in the state. The raw data comes from several governmental sources to ensure a standard of accuracy and precision for the study. Also

included in the report are potential uses for the final product outside its original intent. A budget, timeline, and deliverables list completes the proposal. We look forward to this project and working with the Urban Forestry Program and Board to provide solutions between economic and environmental relationships and help preserve the future of tree planting in the Austin area.

PARTICIPATION

Team Member	Contribution of Each Team Member to the Proposal
Brooks Andrews Project Manager and Web Analyst	Formatted document for final delivery Compiled all sections Examined relevant literature and wrote 1/3 of literature review Wrote Methodology Wrote Purpose section Wrote Scope section
Lori Beabout GIS and Web Analyst	Examined relevant literature and wrote 1/3 of literature review Wrote Intro section Wrote Summary Wrote Conclusion section Wrote Timetable section
Chaz Armijo Assistant Project Manager and GIS Analyst	Designed logo Examined relevant literature and wrote 1/3 of literature review Wrote Data section Wrote Budget section Wrote Implications section Wrote Final Deliverables section

REFRENCES

American Forests. May 2009. *Urban Ecosystems Analysis: San Antonio, Texas*. Washington: American Forests.

McPherson, G.; Muchnick, J. 2005. Effects of Street Tree Shade on Asphalt Concrete Pavement Performance. *Journal of Arboriculture* 31(6): 303-310.

Texas Tree Foundation. 2010. *The Dallas GIS Roadmap Model for Urban Tree Planning & Planting: The Potential Urban Forest of Dallas, Texas.* Dallas, Texas