**Tree Canopy Vulnerability Index in Austin, Texas**



**Prepared for:**

**City of Austin Community Tree Preservation Division**



**Prepared by:**

Linsey, Morgan (Graphic Designer & Researcher)

Crock, Kevin (Editor & Researcher)

Chace, Abigail (GIS Specialist & Researcher)

Ramirez, Rodrigo (Tito) (Graphic Designer & Assistant Manager)

White, Zane (Project Manager)

**21 January 2020**

**Table of Contents**

1. Introduction …………………………………………… 1

1.1 Summary …………………………….………….. 1

1.2 Purpose …………………………………………. 1

1.3 Scope …………………………………………… 2

2. Literature Review …………………………………… 2

3 Data …………………………………………….. 4

3.2 Methodology ……………………………………. 6

3.3 Projected Budget ……………..……………….. 8

3.4 Timeline ……………………………..………….. 9

3.5 Final Deliverables ……………………………… 10

3.6 Conclusion ……………………………………… 10

3.7 Participation …………………………………….. 10

References ……………………………………… 11

**1. Introduction**

1.1 Summary

In recent years, there has been an influx of people that are moving to urban areas within Texas. The urban population of the world has increased from 34% in 1960 to 54% in 2014 and is showing signs of continuous growth with no end in sight (“Urban Population Growth.”). The city of Austin in the great state of Texas is one of the most rapidly growing big cities in the United States (Weissman). Because of this large migration of people moving to urban areas, resources such as tree canopies can become adversely affected within the city. Urban tree canopy (UTC) is essential to a city because it combats factors such as climate vulnerability and social vulnerability. UTC is also essential in determining updated land development codes for zoning parcels of land within the city. Having a better understanding of the UTC and the impact it has on the City of Austin will allow for better understanding of the impact of new land development codes in respect to certain constraints. The integration of a Geographic Information System (GIS) will allow for the City of Austin officials and leaders to visualize and determine best ways to effectively combat vulnerabilities as well as update land development codes.

1.2 Purpose

For this study, we will analyze the distribution of UTC as well as environmental constraints that could affect UTC. We will score the environmental constraints and data provided to us and identify the most relevant inputs. With this data, we will create a regression analysis model that can be used to determine what areas of high and low vulnerability. This will allow for a better understanding of what parts of the city will be most heavily affected by the proposed zoning and help identify specific variables that will have a greater impact.

1.3 Scope

The scope of this project will be within the Austin’s full purpose, limited purpose, and extra-territorial jurisdictions. The time period considered in this project will be from mid-January to early May. This will be approximately 14 weeks.

**2. Literature Review**

For this study, we looked at literature that would aid us in understanding the importance and benefits of urban tree canopies from a social and an environmental standpoint. *Beyond Fraction Coverage* gave us a macro level and introduction to potential benefits of UTC cover. Although the scope of our proposal is Austin, the article notes statistics from the United Nations on how much of the global population will be living in urban areas by 2030 and the potential hazards from such dense urban areas (Green p.45). In addition to this, it brought us understanding of many issues that come with such densely urban areas, such as more exposure to variables like air pollution and urban heat island effect (Green p.45). These environmental phenomena not only affect the people living in them, but also affect the city from a financial standpoint.

We then wanted to examine the environmental and financial benefits that UTC can provide by looking at a study titled *Evaluating the Impact of Government Land Use Policies on Tree Canopy Coverage.* To do this, we looked at specific land parcel policies impacts on previous rezoning projects. Evaluating the impact of government land policies on tree canopy cover showed us an array of benefits that UTC can provide. One of these benefits are from mitigating urban heat island effects, and how it can help increase the value of the properties within the city by decreasing air pollution as well as lower electricity consumption (Hill p.407). This can cut costs from an energy and a health standpoint, as UTC would be providing cleaner living to the people residing within the land parcels (Hill p.413). This article also talks about how cities can change rapidly, and how elected officials in a city’s governments need to have accurate and proper data to help them make decisions on future land zoning (Hill p.408). This is in line with our project as we want to provide the city of Austin a vulnerability index in which land policy makers can reference and help with future zoning. This source provided approximate numbers on how much a city could save due to UTC. As previously mentioned, from health issues and energy costs, trees can save a city millions of dollars, which makes preserving UTC from a land zoning perspective much more important (Hill p.413).

Now that we have a better understanding of the benefits of tree canopy cover, we decided to look at this from a perspective solely with the city of Austin in mind. We understand Austin is in a floodplain and subject to flooding from past events. We looked at *The Effect of Street Trees and Amenity Grass on Urban Surface Water Runoff in Manchester, UK* to give us perspective on how much UTC can help such an issue. The study found that trees can cut water runoff by more than half which could assist with urban flooding and soil erosion (Armson p.285). This source will help us because the proposed zoning of Austin is urging people to move closer to transportation corridors. These factors will be our variables within our vulnerability index.

Finally, we wanted to look at past projects and articles that could relate to the one we are proposing. *Determining Existing, Possible and Preferable Urban Tree Canopy for Austin, Texas* was key to tying all the previous articles and sources mentioned together into understanding how UTC can affect Austin. As well as the current state of Austin’s UTC and where we can expand UTC in a logical cost-efficient way. This study was interesting as it not only provided the benefits UTC can bring, but also the costs of UTC from a natural and financial standpoint, making smart tree planning that much more important (Halter pg.5). Furthermore, as we are proposing to make a vulnerability index of UTC within Austin’s jurisdiction, this study went through the process of creating its own index (Halter pg. 35). This index would be a great reference moving forward as we begin to create our own index and determine weights for the different variables that would impact the vulnerability of UTC.

**3. Proposal**

3.1 Data

The data for this research project will consist of Austin City Limits Boundary, Austin Tree Canopy, Environmental Constraints, Planning Cadastre, and Risk Indices supplied by the City of Austin. All data is projected in NAD 1983 Texas State Plain Central Coordinate system. These layers are made up of vector and raster datasets and will be used jointly to achieve our final maps. We will be running analysis on our data within ArcGIS Pro in order to best accomplish our research goal.

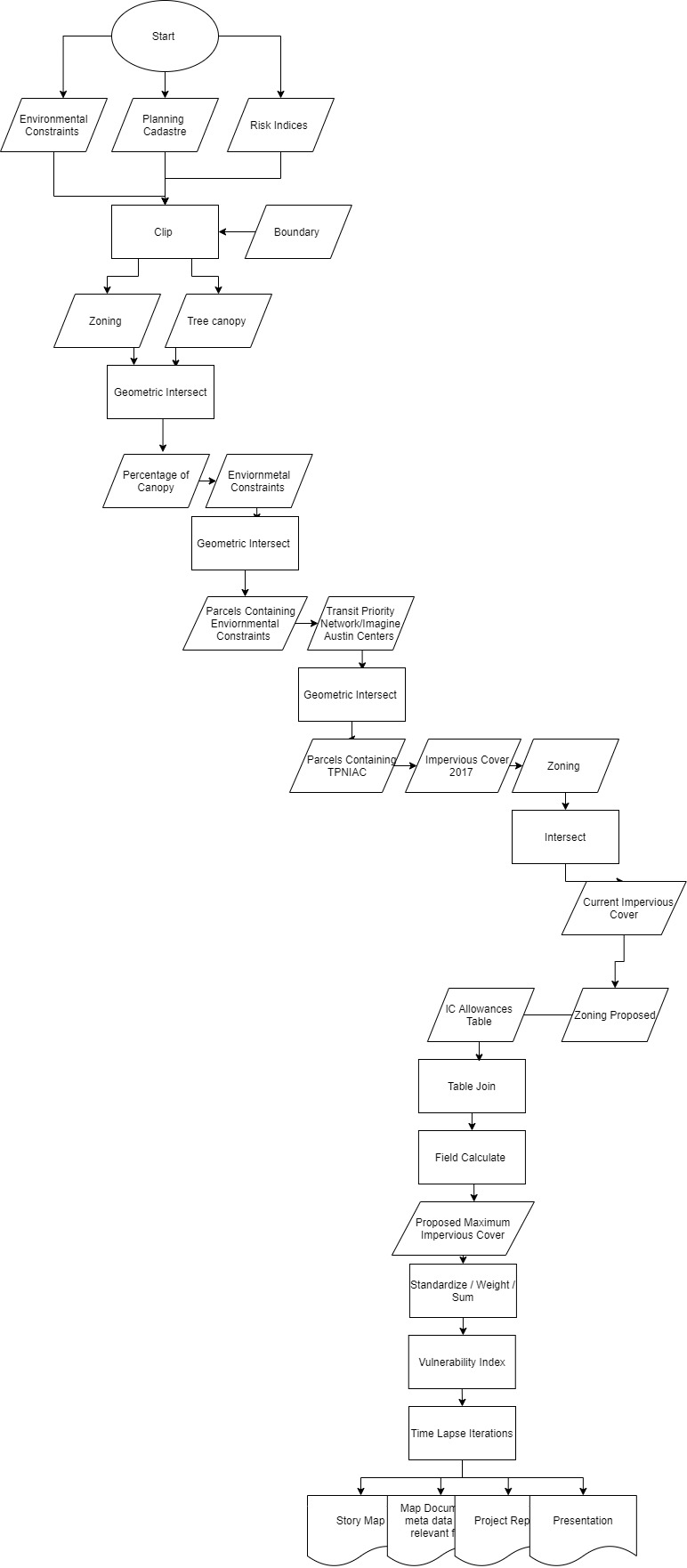
Table 1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Entity** | **Attributes** | **Spatial Objects** | **Status** | **Source** |
| Austin Tree Canopy Data | 1-3 | Cellular Raster | Available | City of Austin |
| Current Austin Zoning | Zoning, shape area | Polygon | Available | City of Austin |
| Proposed Austin Zoning | Zoning, shape area | Polygon | Available | City of Austin |
| Austin City Limits Boundary | Shape, shape area, shape length, city name | Polygon | Available | City of Austin |
| Rock Outcrop | Shape, BRG id, name, case number, average height, plan set data, feature status, latitude, longitude, field check request, feature comments, shape length | Polyline | Available | City of Austin |
| Creek Buffers | Shape, BRG ID, name, feature type, case number, plan set date, latitude, longitude, field check request, feature comments | Polygon | Available | City of Austin |
| Critical water quality zones | Shape, creek buffers id, drainage area ordinance, watershed regulation area, critical water quality zone, minimum buffer distance, maximum buffer distance, shape length, shape area | Polygon | Available | City of Austin |
| Edwards Aquifer Zone | Shape, EA zone buffer, zone, shape length, shape area | Polygon | Available | City of Austin |
| Floodplains | Shape, drainage id, source citation, shape length, shape area | Polygon | Available | City of Austin |
| Erosion hazard zone | Shape, erosion hazard id, buffer distance, shape length, shape area | Polygon | Available | City of Austin |
| Seeps and springs | Shape, BRG id, name, feature type, case number, other id number, plan set date, feature status, elevation, latitude, longitude, field check list request, feature comments | Point | Available | City of Austin |
| Wetlands | Shape, BRG id, name, feature type, case number, plan set date, feature status, latitude longitude, field check request, feature comments, shape length, shape area | Polygon | Available | City of Austin |
| Social Vulnerability Index | Shape, Geoid10, social vulnerability index, shape length, shape area | Polygon | Available | City of Austin |
| Community Wildfire Risk | Shape, percent wildland, wildfire risk class, wildfire risk score, shape length, shape area | Polygon | Available | City of Austin |
| Climate Vulnerability Index | Shape, Geoid10, climate vulnerability Index, shape length, shape area | Polygon | Available | City of Austin |
| Zoning Proposed | Shape, zoning id, proposed zoning, impervious cover increase proposed, parcel acres, shape length, shape area | Polygon | Available | City of Austin |
| Transit priority network and LA corridors centers | Shape area, shape length | Polygon | Available | City of Austin |
| Impervious Cover 2017 | Shape, impervious cover id, parent feature id, source, origin feature class, max height, elevation, base elevation, shape length, shape area | Polygon | Available | City of Austin |
| Steep Slopes | Shape, dissolve, shape length, shape area | Polygon | Available | City of Austin |

3.2 Methodology

To better comprehend tree canopy deterioration within the greater Austin area, we will create a weighted index matrix that will aid in the protection of Austin’s urban forest and access the relationship between tree canopy and urban development. By conducting this study, we aim to identify land parcels that run the risk of tree canopy decrease as the city undergoes a new land development code revision.

The process starts by clipping all individual data layers to the full purpose jurisdiction study area. Geometric intersection of the zoning parcels and tree canopy layers will be calculated to find the percentage of canopy in each parcel. Environmental limitation variables: creek buffers, critical water quality zones, Edwards aquifer zone, flood plains, erosion hazard zone, seeps and springs, wetlands, and slope will be individually intersected with the zoning parcels layer to find the percentage of parcel extent covered by the environmental limitation and attributes were formed. We will locate all intersecting parcels with the transit priority network imagine Austin centers and corridors layer and form attributes. In order to find present impervious cover, we will intersect the impervious cover (IC) 2017 layer with the zoning parcel layer and determine the amount of impervious cover for each parcel. From this, the lC allowances table will be joined to the proposed zoning layer using the “proposed zoning symbol” and “zoning proposed” fields. From here, we will then calculate the greatest impervious cover permitted. We will use the findings from the prior calculations when determining a score system for impervious cover. Transforming all variables to percentages allows us to standardize the data equally in order to apply weights. Our weight system is determined by a regression on the input variables and how they correlate to the tree canopy variable, a combined sum gives us a combined score for our tree canopy vulnerability index.

Figure 1.

3.3 Projected Budget

Data Collection and Processing

Total Hours- 5 hours/week \* 14 weeks \* 5 consultants = 350 Total hours

Hourly Pay $25.00

Total $8,750

Data Analysis

Total hours- 5 hours/week \* 10 weeks \* 5 consultants = 250 hours

Hourly Pay $40.00

Total $10,000

System Management

*Project Manager*

Total Hours 50 hours

Hourly Pay $75.00

Pay $3,750

*Assistant Project Manager*

Total Hours 50 hours

Hourly Pay $55.00

Pay $2,750

Potential Travel Costs

30 miles \* 5 members @ $0.40 cents per mile $60.00

Total Costs$25,310

3.4 Timeline

Table 2.

|  |  |
| --- | --- |
| Week of February 3rd | Initial project planning and first meeting with client |
| Week of February 10th | Literature review and research development |
| Week of February 17th | Presentation preparation |
| Week of February 24th | Proposal presentation in front of client |
| Week of March 2nd | GIS data processing |
| Week of March 9th | Study area and zoning parcels |
| Week of March 16th | Analyze attributes and environmental constraints |
| Week of March 23rd | Progress report and presentation  3rd client visit |
| Week of March 30th | Impervious cover analysis and identification |
| Week of April 6th | Tree canopy vulnerability index formation |
| Week of April 13th | Standardization of vulnerability index inputs |
| Week of April 20th | Final GIS outputs and results |
| Week of April 27th | Finalize and edit deliverables |
| Week of May 4th | Final presentation and client visit |

3.5 Final Deliverables

At the conclusion of this project, Canopy Cats Consulting will provide the following documents and files for the City of Austin Community Tree Preservation Division:

* Project Proposal
* Progress Report
* Detailed Final Report (2 copies)
* Professional Poster for display in the Geography
* Department
* CD (2 copies) containing: Map Poster, Final Report, PowerPoint Presentation Slides, Derived GIS feature classes with metadata, Readme file for CD instructions

3.6 Conclusion

Canopy Cats Consulting will provide the City of Austin Community Tree Preservation Division with a series of maps visualizing the change in the Urban Tree Canopy with past, present and proposed zoning. We will locate the areas most impacted by the new land codes. Our approach in the methodology should have no issues in allowing the Canopy Cats to utilize the data provide by the client to make a quality map. Our maps will clearly allow the Preservation Division to make quality recommendations for zoning changes in order to minimize any potential Tree Canopy loss for the City of Austin.

3.7 Participation

• Linsey, Morgan - Budget, Timeline

• Crock, Kevin - Introduction, Purpose, Scope, References

• White, Zane - Table, Deliverables, Conclusion, Participation

• Chace, Abigail - Data, Methodology

• Ramirez, Rodrigo (Tito) - Title, Literature review

References

Greene, Christopher S., and Peter J. Kedron. “Beyond Fractional Coverage: A Multilevel Approach to Analyzing the Impact of Urban Tree Canopy Structure on Surface Urban Heat Islands.” *Applied Geography*, Pergamon, 19 Apr. 2018, www.sciencedirect.com/science/article/pii/S0143622817301935.

Hill, Elizabeth, et al. “Evaluating the Impact of Government Land Use Policies on Tree Canopy Coverage.” *Land Use Policy*, Pergamon, 2 July 2009, www.sciencedirect.com/science/article/pii/S0264837709000647.

Armson, D., et al. “The Effect of Street Trees and Amenity Grass on Urban Surface Water Runoff in Manchester, UK.” *Urban Forestry & Urban Greening*, Urban & Fischer, 17 May 2013, www.sciencedirect.com/science/article/pii/S1618866713000460.

Halter, Alan Dale. “Determining Existing, Possible, and Preferable Urban Tree Canopy for Austin, Texas.” *TexasScholarWorks*, University of Texas at Austin, 1 May 2013, hdl.handle.net/2152/22682.

Weissmann, Jordan. “Austin, Texas, Is Blowing Away Every Other Big City in Population Growth.” *Slate Magazine*, Slate, 21 May 2015, slate.com/business/2015/05/population-growth-in-u-s-cities-austin-is-blowing-away-the-competition.html.

“Urban Population Growth.” *World Health Organization*, World Health Organization, 16 Mar. 2015, www.who.int/gho/urban\_health/situation\_trends/urban\_population\_growth\_text/en/.