



**Transportation, Emergency, and Environmental GIS Services**

Team Members

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**T.E.E.G.S.**

A PROPOSAL TO:

Ana V. Gonzalez

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Austin Parks and Recreation

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1. **Introduction**

 **Summary**

The record drought of 2011 severely weakened the structural integrity of an unknown number of trees in and around the city of Austin. Structurally weekend trees pose a potential and unnecessary hazard to both emergency and municipal response services. The tree hazard can be managed by appropriately maintaining the city’s trees near roadways.

The Urban Forestry Program (UFP), as part of the City of Austin Parks and Recreation Department, is responsible for the upkeep and maintenance of approximately 300,000 trees along roadways and city owned property in the City of Austin. The UFP and the City of Austin Parks and Recreation Department wish to be proactive in the identification and subsequent removal of potential tree hazards from the city of Austin’s roadways. The identification and removal of potential tree hazards will help optimize the cities tree removal services and clear potential hazards for emergency service vehicles.

Our group (T.E.E.G.S.) can help the UFP accomplish the task of tree hazard risk mediation through our expertise in Geographic Information Systems (GIS). Our use of GIS will identify and rank the areas of greatest potential risk and highest priority routes for emergency services in order to optimize proactive preventative maintenance and reactive clearing.

 **Purpose**

The purpose of this project is to generate a comprehensive tree hazard inventory for the city of Austin Parks and Recreation department to facilitate the identification and removal of potential tree hazard locations along city roadways. A ranking system will be used to highlight areas with the greatest threat potential in order to prioritize preventative tree maintenance. The ranking system will take into account major roads used in emergency situations, areas of high tree density in relation to locations of hospitals, fire stations, shelters, and other emergency management services. T.E.E.G.S. will accomplish this by utilizing a GIS to analyze the existing tree shade index and identifying areas of high tree density which intersect or overlay with emergency service routes.

 **Scope**

Our study will include the City of Austin; including but not limited to the city limits. The study will take approximately 3 months to complete.



**II.Literature Review**

The analysis and study of emergency services through the use of geographic information systems (GIS) has become readily available to many emergency response personnel. It has become an area of focus in many cities today. A 2011 study from Leon County encompassing Tallahassee, Florida done by Mark Horner and Michael Widener used GIS to determine locations for emergency goods distribution centers in the event of a hurricane or other disastrous event. This is important to our study because after a storm, there will be failed network linkages throughout an area as a function of rising water, downed trees/limbs, and debris accumulation (Horner and Widener, 2011). In their study they chose to employ a model that optimizes the locations of relief distribution centers relative to populations as needed. This allowed [them] to concentrate on the issue of [road] network failure as it manifests itself to populations accessing goods (Horner and Widener, 2011). In the event of a hurricane or other disaster it is not known how many roadways will be subject to damage, deeming them impassible. This makes using a least cost path analysis non-functional for this study and others like it. Leon County divided into traffic analysis zones (TAZs), each containing a portion of the population. TAZs are represented in point format by computing their geometric centroids utilizing GIS. These were then connected to the road network using synthetic links; to reduce the risk that a TAZ centroid would be cut off each was connected using 30 synthetic links to ensure each TAZ has a functional route (Horner and Widener, 2011). The results of their study showed scenarios where people at certain TAZs are cut off from the rest of a network, and the links that are disabled do impact how relief service is provided (Horner and Widener, 2011). This is important to our analysis because our goal is to prevent citizens and emergency personnel from being completely blocked or trapped on road networks because of fallen trees/limbs.

A study done by Thomas J Cova illustrates an example of application of GIS in regional evacuation analysis: evacuation vulnerability mapping (Cova, 1999). It proposes one method for addressing this problem where people are assigned to the nearest intersection in the network using Theissen polygons. The links connecting this set of nodes to the rest of the network are considered the exit choice set for that particular evacuation (Cova, 1999). For our study this is important because we also suggested using Theissen polygons to help with our analysis. We can get a better idea of how to incorporate these into our study by further examining Cova’s breakdown of evacuation vulnerability mapping. Cova used census data and road networks to determine population per exit for each evacuation route. His deliverables included maps from example city Santa Barbara, CA showing evacuation vulnerability with streets in red with a relatively high ratio of residents to exiting lanes and streets in green showing a low ratio (Cova, 1999). This is the same concept we intend to use in our study for the City of Austin’s Urban Forestry Program, so it is important to understand how Cova conducted his analysis.



**Data**

|  |  |
| --- | --- |
| LAYER  | SOURCE |
| Road Network- Major Arterials- Core Transit Corridors- Neighborhood Streets | **City of Austin** |
| Facilities-Hospitals - EMS - Police Stations - Shelters- Fire Stations - Power Stations- Activity Centers - Schools (TEA) | **City of Austin****Texas Education Agency (TEA)** |
| Police Precincts | **City of Austin** |
| Tree Canopy Cover/Shade Index | **Urban Forestry Program** |
| Austin City Limits | **Capital Area Council of Governments (CAPCOG)** |
| Census Data | **Census Bureau**  |
|  |  |
|  |  |

**Methodology**

In order to assist the City of Austin Urban Forestry Department prioritize critical emergency response areas where proactive tree maintenance will support emergency response effectiveness our group will analyze emergency personnel response in order to develop a city wide weighting system to determine these proactive tree maintenance areas. First we will use our street network to identify the distance from emergency service (ES) locations to nearby road connections that lead away from their location. Second we will analyze point to point travel along our street network that will involve travel from an ES location, such as a fire or police station, to various points of interest, which will be described momentarily and finally to another ES location such as a hospital or health center. With these two factors of ES response addressed we will create a city wide weighting score that will determine which areas are most in need of proactive tree maintenance to aid emergency response.

 First, our group will perform a network buffer on our street network to determine the distance from an ES location to the connections leading away from it. After we locate the crucial road segments leading away from the ES location we will use the street tree shade index to assess which locations around an ES location would be prime candidates for proactive tree maintenance. By heavily weighting these road segments directly around ES locations, especially those with a high tree shade index, we will be able to ensure that ES personnel will have a clear route out of their station. While this step is clearly only one step of the response of ES personnel, it is very crucial to ensure that they are able to leave their station, otherwise they will not be able to reach areas in the city that require emergency response.

**III.Proposal**



**Methodology continued**

 Second, and perhaps most importantly, our group will analyze point to point travel first from various ES locations, like fire or police stations, to points of interest throughout the city and finally to other ES locations, like hospitals, health centers, or even jails should the situation call for it. In order to determine where these points of interest throughout the city will be located our group will create a Triangulated Irregular Network (TIN), similar to a Digital Elevation Model, or use Kernel Density in order to analyze population distribution. This population TIN or Kernel Density analysis will be based on population by census tract and will have smooth (low elevation) areas of low population, and high peak like areas of high population. We will establish approximately 25-50 of these population peaks to simulate emergency response to population areas. In addition to these population peaks we will use city facilities such as schools, neighborhood centers, and recreation centers as points to simulate ES response. The movement of ES personnel to points of interest and finally to ES locations will be done inside of their respective APD precincts to ensure emergency personnel are responding to situations nearby instead of across town.

After we have established the routes of ES personnel to various points of interest and then to other ES locations we will identify which road segments are used in higher frequency by ES personnel. Once this has been done we will weight road segments based on their frequency of use as well as the tree shade index for that given segment.

With these two factors of ES personnel response covered we will be able to analyze what road segments are traveled on most frequently by ES personnel either when leaving the direct area of their ES location, or when travelling throughout the city to points of interest and other ES locations. Additionally we will analyze which areas of these frequently traveled road segments are characterized by an especially high tree shade index and as such are ideal areas on road segments for proactive tree maintenance by the City of Austin UFD.

**Implications**

This project will rank blocks of the City of Austin based on how critical the routes are to city function, especially during an emergency situation, therefore identifying which routes need proactive preventative tree maintenance. The project will allow the City of Austin’s Urban Forestry Program to identify blocks which need preventative tree maintenance immediately and which are less critical and can be done when there is time. This may help the UFP create a tree maintenance schedule based on which areas need the most maintenance and are most critical for emergency service routes.

This project will be useful for responsive clearing following a major weather event or other natural disaster. The blocks will be ranked from most critical to least and clearing after the event can follow this ranking system to clear streets which are most needed by emergency services and so restore the city to order more quickly than would otherwise be possible.



**Budget**

**Data Collection** Total Hours (10 hours/week \* 5 weeks \* 2 consultants +

 7 hours/week\*5 weeks \* 1 consultant + 5 hours/week \*

 5 weeks \*1 consultant) 170

 Hourly Pay $30.00

 Total $5,100.00

**Data Analysis** Total Hours (10 hours/week \* 5 weeks \* 2 consultants +

 7 hours/week\*5 weeks \* 1 consultant + 5 hours/week \*

 5 weeks \*1 consultant) 170

 Hourly Pay $45.00

 Total $7,650.00

**System Management** *Project Manager*

 Total Hours 50

 Hourly Pay $80.00

 Pay $4,000.00

 *Assistant Manager*

 Total Hours 30

 Hourly Pay $60.00

 Pay $1,800.00

 Total Management $5,800.00

**Equipment Costs** Supplies ($150/workstation \* 4 workstations) $600.00

**(For 10 weeks)** Maintenance ($200/workstation \* 4 workstations) $800.00

 Depreciation ($100,000 [total value of equipment]/36

 [equip life in month] \* 2.5 [months equipment will be

 in exclusive use for project) $6,944.44

 Total Equipment Costs $8,344.44

**Data** Purchased Data, Software License for 10 weeks $5,000.00

 Total Data Costs $5,000.00

**Travel Expenses** 120 miles @ $0.40/mile $48.00

 Total $48.00

**TOTAL COSTS** **$31,942.44**

**Timetable**

Data Collection:

|  |
| --- |
| Weeks 1-4  |

Pre-Processing of Data

|  |
| --- |
| Weeks 4-5 |

Data Analysis

|  |
| --- |
| Weeks 6-8 |

Data Interpretation

|  |
| --- |
| Weeks 9-11 |

Important Dates:

*February 20th:*

Presentation of Project Proposal to Client

*March 25th:*

Progress Report and Presentation

*May 3rd:*

Final Project Presentations



|  |  |
| --- | --- |
| Week | February |
|  |  |  |  |  | 1 | 2 | 3 |
|  | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|  | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 1 | 18 | 19 | 20\* | 21 | 22 | 23 | 24 |
| 2 | 25 | 26 | 27 | 28 |  |  |  |

|  |  |
| --- | --- |
|  | March |
|  |  |  |  |  | 1 | 2 | 3 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 4 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 5 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 6 | 25\* | 26 | 27 | 28 | 29 | 30 | 31 |

|  |  |
| --- | --- |
|  | April |
| 7 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 9 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 10 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 11 | 29 | 30 |  |  |  |  |  |

|  |  |
| --- | --- |
|  | May |
| 11 |  |  | 1 | 2 | 3\* | 4 | 5 |
|  | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|  | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|  | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|  | 27 | 28 | 29 | 30 | 31 |  |  |



**Final Deliverables**

* Final Report
* Professional Poster
	+ Map of Tree Shade
	+ Map of Single APD Precinct for Network Buffer Example
* Website
* CD containing:
	+ Metadata
	+ Final Report
	+ Poster
	+ PowerPoint Presentation
* Table containing Block Ranking for Tree Maintenance
* Map of top 10% most important blocks for Proactive Tree Maintenance
* Map of High to Low Priority areas for the City of Austin
* Map of streets more highly utilized by emergency services

The final delivery for this project will be a table detailing city blocks and ranking them from most in need of immediate attention to least. This table will be accompanied by a map which shows the area’s most in need of attention. There will also be a general map showing the areas of the City of Austin ranked from highest need to lowest. A map of the streets we analyzed to be most important to emergency services will also be included.

**IV. Conclusion**

 Structurally weekend and damaged trees falling onto and around city roadways presents an unnecessary obstacle to the City of Austin’s emergency response services. T.E.E.G.S. possesses the Geographic Information Systems (GIS) experience and expertise necessary to help the City of Austin Parks and Recreation Department successfully manage and mitigate potential tree hazards in the future.



Team Member Tasks/Responsibilities

Lauren Bender : Data analyst: Project management: Implications

 : Introduction: References: Literature review

Aaron Gore : Data Analyst: Methodology: Project design

 : Conclusions: Project management

Amanda Magera : Budget Analyst: Literature Review: Introduction

 : Timetable: Final deliverables

Matthew Smith : Budget analyst: Project design: Introduction

 : Project management: Conclusion

**V. Participation**

**VI. References**

Horner, Mark, and Michael Widener. "The effects of transportation network failure on people’s accessibility to hurricane disaster relief goods: a modeling approach and application to a Florida case study." 59.3 (2011): 1619-1634. Web. 10 Feb. 2013.

Cova, T.J. (1999) GIS in emergency management. In: *Geographical Information
Systems: Principles, Techniques, Applications, and Management*, P.A. Longley,
M.F. Goodchild, D.J. Maguire, D.W. Rhind (eds.), John Wiley & Sons, New York,
845-858.

Philippines. Philippine Information Agency. *Confab highlights GIS use for disaster risk reduction*. 2012. Web. 10 Feb. 2013. <http://www.pia.gov.ph/news/index.php?article=1141353427298>.