

Treme,
New Orleans

Urban Canopy Analysis

In part of a study of the relationship
between community practice & system
resilience



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Introduction

In a special issue on “Resilience” in the *Environmental Education Research* journal, the authors of **Stewardship, learning, and memory in disaster resilience** argue civically-minded efforts to restore local ecology (i.e. including urban community forestry, community gardening, and other forms of stewardship) are self-organizing, re-emergent manifestations of how social learning is instrumentalized to foster social-ecological (SES) resilience.¹ SES resilience, the authors propose, is the potential of a system to remain in a particular configuration and maintain feedbacks and functions following disturbance-driven change.² In the aftermath of hurricane Katrina, volunteer groups referred to as “communities of practice,” demonstrated SES resilience throughout New Orleans. These communities of practice conducted community tree plantings as a means to cope with devastating losses as well as a means to rebuild their communities to a state better than before the storm. These efforts served as examples of voluntary collective action and were leveraged into collaborative and adaptive management practices that compelled a greater level of resilience – a community configuration of feedbacks and functions following a major perturbation.³ Just like natural systems in the environment, groups of people who share a common practice and learn to improve and expand that practice are self-organizing and re-emergent. Provoked by hurricane Katrina, people in Treme, New Orleans came together to repair and revitalize themselves and their surroundings. Three groups who catalyzed these efforts include *Hike for Ka-tree-na*, *Parkway Partners* and *Regreen NOLA*.⁴

Treme is a neighbourhood of roughly 140 square blocks in downtown New Orleans. As of the 2000 census, there were 8,853 people, 3,429 households, and 2,064 families residing in the neighborhood.⁵ Treme abuts the north side of the French quarter, away from the Mississippi River. Broad Street marks the northern border with Rampart Street to the south, Saint Louis Street west and Esplanade Avenue on the east. Claiborne Avenue is the main thoroughfare

through the neighborhood. Historically a wide “neutral ground” lined with old and stately live oak trees characterized Claiborne Avenue. Tidball describes the chain of events:

The public green space is said to have been used as a community gathering place for the area's mostly African-American residents. The construction of an elevated highway through Treme in the late 1960s is thought to be one of the most controversial developments in New Orleans' history. Following the construction, parking lots along the freeway replaced grassy areas. The concrete supports for the highway replaced oak trees. Construction of the overpass contributed to the overall decline of Treme in the 60's and 70's. In 2002, as part of the "Restore the Oaks" art installation, artists painted outer freeway columns to memorialize the live oak trees that once stood on both sides of Claiborne Avenue.⁶

Without hesitation, in the wake of hurricane Katrina Treme residents began planting. Techniques to ensure successful tree plantings permeated among residents. For example, the NGO Parkway Partners trained citizen “Tree Troopers” to aid in the replanting and tree care efforts. Similar to what occurred in the Living Memorials Project, opportunities for cross-site learning were created, as when trained Tree Troopers were called upon to go to other neighborhoods to train additional tree planters.⁷

In **Stewardship, learning, and memory in disaster resilience**, the authors pose comprehensive arguments linking the impact of green space on social productivity and overall community well-being. At the end of their analysis, one question remained unanswered: what is the precise relation between the efforts of tree-planting groups and their total impact to the tree canopy in Treme? More specifically, what is the net effect of all tree-planting initiatives in regards to biomass and the urban canopy?

Purpose of the Research

The purpose of this research is twofold: first to compare Treme's tree canopy in the aftermath of hurricane Katrina. Orthoimagery from March 2006 served as the basis of the damaged canopy analysis. Orthoimagery from February 2009 served as the most recent (and available) imagery to convey Treme's current tree canopy status following tree planting efforts

of communities of practice. The three-year comparison could potentially convey the impact the tree planters on the overall urban canopy. It would also provide insight for organizing and compelling future tree planting efforts in the region.

Second, to determine how much of Treme's total surface area consists of tree canopy. Tree canopy in relation to other impervious surfaces illuminates the overall character of the neighborhood, while also providing ratios to compare canopy-to-impervious surfaces in other neighborhoods throughout New Orleans.

Client

Keith Tidball, the Associate Director of the Initiative for Civic Ecology in the Natural Resources department at Cornell University, recently published **Stewardship, learning, and memory in disaster resilience**. The work of Tidball and his colleagues in compelled this analysis. Tidball has been involved throughout the project, providing direction as the availability and applicability of data has changed. It is my hope this analysis will serve future systems resilience work. More importantly, may it prove useful for the people of Treme who, in the wake of one of the most deeply felt disasters in US history, did what their hearts compelled them to do: plant trees and soil new roots.

Methodology

Urban canopies are the sum of leaves, branches, and stems of trees that cover the ground when viewed from above in and around dense human settlements. Trees concentrations in urban areas provide many direct and indirect benefits, most notably cooling neighborhoods and reducing costs associated with storm water management.⁸ To give context to the associated benefits provided by trees in urban areas, especially following a major disaster, the amount of tree canopy must be estimated.

Initially, a composite suitability analysis was thought to be the best means to determine what was or was not tree canopy in the Treme neighborhood. Logic being if pixels in an image could be given a weight, the model builder tool in ArcMap would derive a composite suitability analysis where pixels of similar color and texture were categorized in tree canopy and other impervious surfaces. The result being canopy, roads and buildings would fall into distinct categories. This, however, proved to yield varied results when data was held constant, not to mention the results were inaccurate – areas designated as trees also included rooftops, roads and other green shrubbery.

The alternative involved creating new shapefiles plots from high-definition raster data that visually distinguish urban tree canopy from other urban areas. Though subjective, this technique (outlined in detail: see appendix A) proved the most accurate and practical given scope of the project.

Alternative Techniques

One method to estimate baseline canopy is called remote sensing. Implemented by various localities in the state of Virginia, it involves using a masked geographical boundary of a designated area. Much like how this analysis was conducted, GIS specialists manually classify a multi-spectral (ERDAS) image. The result is an image consisting of different classes which typically include tree canopy, other vegetation, impervious surfaces, and water. More complex tree canopy analyses exist, most of which use complex algorithms to differentiate surface area among high resolution multispectral satellite imagery. These effective methods for calculating urban tree canopies implemented by the USFS Forest Service are arguably more objective; by using models to distinguish tree canopy, they eliminate human error in the selection process. What one person may perceive as the canopy of a tree may in fact be the shadow cast by the

canopy. Such mistakes are ‘avoided’ using algorithms, but are complex and utilize software alternatives to ESRI GIS.

Data Sources

The search for data proved to be the greatest obstacle in the analysis. Orthoimagery online was limited. The two key criteria guiding the search were image resolution and the date images were taken. Abscissa and ordinate resolution (image quality) varied between 3 - .3 meters per pixel. Depending on the time of year, total area of tree canopy would either increase (during summer months) or decrease (winter months). Taking these two factors into account, two ortho-images along with residual data from the US Geological Survey (USGS) seamless server provided a basis for the tree canopy comparison and the surface area analysis.⁹

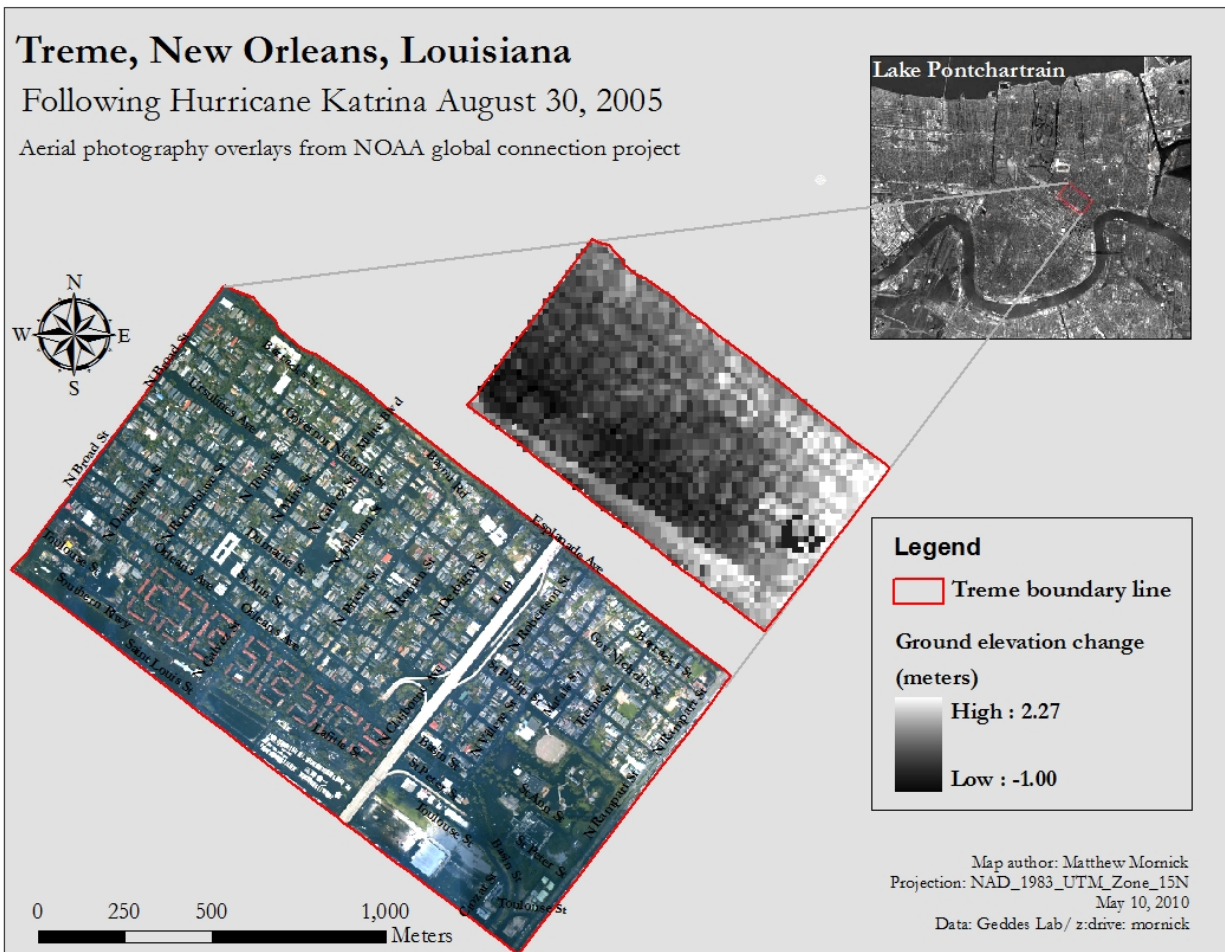
Road information was taken from the Census. The City of New Orleans Planning Department also provided one crucial shapefile consisting of all building footprints of the downtown financial district. Luckily, roughly two-thirds of the total buildings in Treme were included in the shapefile (the remaining one-third was plotted by hand for both 2006 and 2009).

Nine aerial photographs taken on August 30, 2005 by the National Oceanic and Atmospheric Administration reveal the immediate aftermath following the storm. These nine images were assembled to portray a baseline map of Treme when the neighborhood was inundated with water. National elevation data during that time was also incorporated to portray the variation in ground elevation within Treme.

August 30, 2005 Analysis

This initial map portrays the aftermath immediate following hurricane Katrina in Treme, New Orleans. It references Treme’s location in Greater New Orleans, as well as portrays the ground level elevation change in the neighborhood. Referring to the legend, the ground elevation change within Treme varies roughly three meters. This sheds some insight on low-

lying areas most vulnerable to water damage. Comparing maps from 2006 to 2009 in both the following analyses, housing projects (red roofed buildings) along Saint Louis Avenue in the southwest portion of Treme were removed, most likely due to the extensive water damage.



Urban Canopy Analysis

The urban canopy analysis involved a two-map comparison of images from March 2006 and February 2009. The maps portray the urban canopy in Treme neighborhood in downtown New Orleans. The map is divided into nine corridors running perpendicular to Esplanade Avenue and Saint Louis Street. Reason being, nine corridors allow comparison on a street by street basis. Volunteer tree planting organizations can see the impact of their efforts within a specific

corridor. Furthermore, the map may guide future tree planting efforts and grant opportunities in corridors with a low percentage of urban canopy in relation to the total (corridor) area.

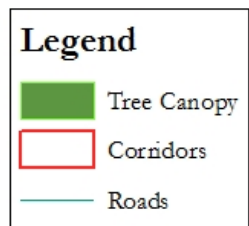
Damaged Tree Canopy Analysis: Treme, New Orleans, Louisiana

March, 2006



Orthoimagery provided by U.S.G.S Seamless server, March 2006

Corridors	Total area	Total canopy area	Percent of total area
	(square meters)		
1 N. Broad St.	196,500.00	14,060.79	7.16%
2 N. Rochelblave St.	254,600.00	31,507.44	12.38%
3 N. Miro St.	221,100.00	22,777.29	10.30%
4 N. Johnson St.	216,400.00	17,401.27	8.04%
5 N. Roman St.	211,100.00	22,585.61	10.70%
6 N. Claiborne Avenue	241,200.00	17,753.87	7.36%
7 N. Villere St.	191,500.00	14,091.90	7.36%
8 Treme St.	182,500.00	18,059.89	9.90%
9 N. Rampart St.	145,100.00	24,308.22	16.75%
Treme total area	1,860,000.00	182,546.27	9.81%



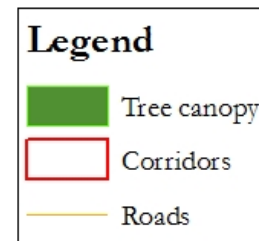
Matthew Mornick: Map author
 May 10, 2010
 NAD_1983_UTM_Zone_15N: Projection
 Geddes Lab/ z:drive: mornick: Data

Damaged Tree Canopy Analysis: Treme, New Orleans, Louisiana

February 2009



Corridors	Total area	Total canopy area	Percent of total
	(square meters)		
1 N. Broad St.	196,500.00	16,437.59	8.37%
2 N. Rocheblave	254,600.00	34,588.72	13.59%
3 N. Miro St.	221,100.00	24,875.33	11.25%
4 N. Johnson St.	216,400.00	21,596.74	9.98%
5 N. Roman St.	211,100.00	22,276.00	10.55%
6 N. Claiborne A	241,200.00	19,223.82	7.97%
7 N. Villere St.	191,500.00	16,193.04	8.46%
8 Treme St.	182,500.00	20,094.97	11.01%
9 N. Rampart St.	145,100.00	25,757.23	17.75%
Treme total area	1,860,000.00	201,043.44	10.81%



Matthew Mornick: Map author
May 10, 2010

NAD_1983_UTM_Zone_15N: Projection
Geddes Lab/ z:drive: mornick: Data

Surface Area Analysis

Cities are typically built outwards and upwards with brick, concrete, and asphalt. The ambient air temperature in urban areas depends, to a large extent, on its surface characteristics.¹⁰ In general, building materials capture and store heat making urban ambient air temperatures are higher than non-urban areas. Large numbers of people, the increased quantity of impervious surface, the lesser extent of tree canopy, and the emission of heat from homes, buildings, and automobiles further enhances this effect.¹¹

This surface area analysis determined the type and total surface area within the Treme neighborhood. Along with the tree canopy information derived in the tree canopy analysis, two other primary surfaces had to be accounted: road surfaces and building rooftops. A fourth category was included to account for parking lots, sidewalks, grassy areas and other multifarious surfaces. The first step in the analysis was to identify all road surfaces as well as building rooftops. Together, these ratios helped define the nature of the Treme neighborhood. It would also reveal surface ratios that could be used to extrapolate “heat island” measurements. These measurements describe the air temperature above different surfaces within a city. Because the rooftop and road surfaces were calculated by hand, the analysis only permits a complete area comparison instead of corridor by corridor.

Treme, New Orleans, Louisiana March 2006

Surface Area Analysis



Orthomosaic provided by USGS Seamless server, March 2006

Legend	
	Treme neighborhood
	Building surfaces
	Tree canopy
	Road surfaces
	Roads

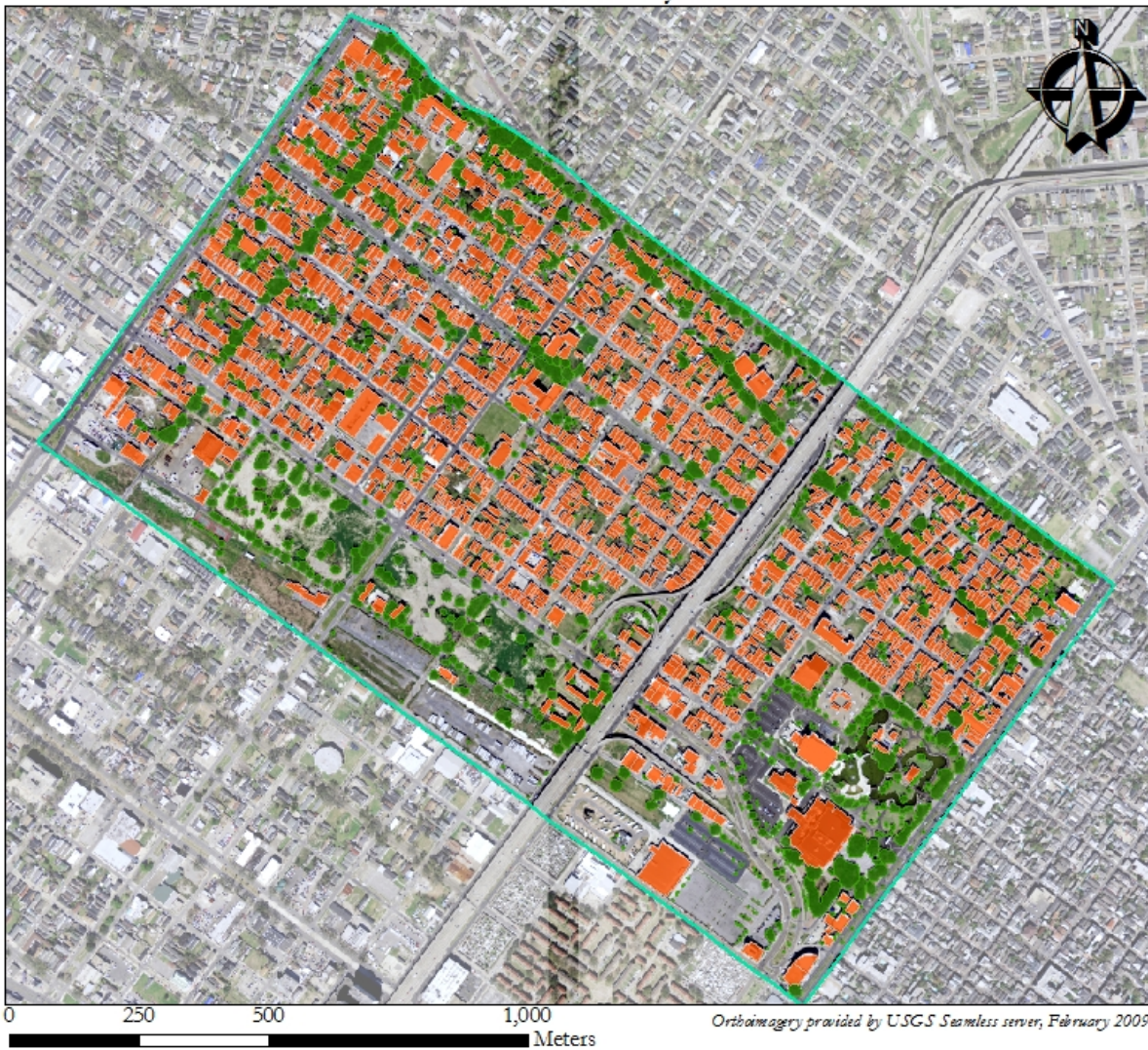
Surface	Total Area	Percent of total
	square meters	
Tree canopy	182,546.27	9.81%
Roads	432,800.00	23.27%
Buildings	420,534.21	22.61%
Other	824,140.79	44.31%
Treme total	1,860,021.27	1.00


** other includes parking lots, sidewalks, grassy areas, neutral ground, trailers, and trailer campgrounds.*

Matthew Mornick - Projection: NAD_1983_UTM_Zone_15N
 Date: May 10, 2010 - Data: Geddes Lab/ z:dive: mornick

Treme, New Orleans, Louisiana February 2009

Surface Area Analysis



Legend	
	Treme neighborhood
	Building surfaces
	Tree canopy
	Road surfaces
	Roads

Surface	Total Area	Percent of total
	square meters	
Tree canopy	201,043.40	10.81%
Roads	421,400.00	22.66%
Buildings	405,347.80	21.79%
Other	832,230.07	44.74%
Treme total	1,860,021.27	1.00
<i>* other includes parking lots, sidewalks, grassy areas, neutral ground, trailers, and trailer campgrounds.</i>		

Map author: Matthew Mornick - Projection: NAD_1983_UTM_Zone_15N - May 10, 2010 - Data: Geddes Lab/ z:drive: mornick

Conclusion

From March 2006 to February 2009, the tree canopy in Treme showed a 1% increase. Of the nine corridors, all except the N. Roman street corridor showed marginal increases in tree canopy cover. This in no way speaks to the efforts of the tree canopy initiative, but rather a result of less than ideal data to analyze. The 2006 analysis is based off of springtime imagery. Tree coverage was in bloom and evident to the viewer's eye. The 2009 analysis, however, involved imagery taken at the tail-end of winter just before spring. Roughly 80% of the tree cover at this time was clearly discernable. To depict the remainder of the canopy involved following shadows of branches and tree trunks to determine whether a tree in fact existed, let alone would eventually bloom a canopy. It is also worth noting when trees are planted it takes years before saplings develop canopies that are discernable in aerial photographs. Though all trees were accounted for in this analysis within the Treme boundary line, comparing data from similar seasons over a longer period of time would result in a more accurate depiction of the Treme's true tree canopy transformation.

Potential Future Work

This analysis is the beginning of potential research in Treme. Combining the efforts of this analysis with work done on the ground among tree planting groups is crucial. For example, as tree planting groups conduct training sessions and plant trees, they could also collect highly useful tree data without a substantial increase in effort. Compiling the location (address or GPS coordinates), tree type along with water and nutrient requirements would provide much more detailed information for future studies.

As previously mentioned, a more accurate analysis would result if a current canopy status map utilized imagery taken in either March 2010 or 2011 rather than from February 2009. More time in between the two maps would allow saplings to set canopies. Other areas of analysis could compare per capita income or home property value among various areas in New Orleans to

the relative percent of tree canopy. Doing so conveys the benefits of trees in economic terms. Given the surface area analysis, it would also be interesting to measure air temperatures over the four different surface types at various times of day at various points throughout the year to determine the heat island effect. A comparison among levels of energy consumption at the warmest parts of the year in different corridors in Treme could shed light on how the number of trees (shade) influences energy consumption (cooling implements).

Policy Implications

According to American Forests’ *Urban Canopy Analysis of New Orleans’ metropolitan area (2002)*, local communities should aim for a 40% overall tree canopy; 50% tree canopy in suburban residential; 25% tree canopy in urban residential; 15% tree canopy in the central business district.¹² Besides providing environmental benefits (detailed below), Tidball and his colleagues made a strong case regarding the wellbeing of a community: revitalizing local ecology through tree planting creates the space for people to heal after a catastrophic loss, develops strong local bonds and becomes a proponent of SES resilience.

New Orleans Metropolitan Area Tree Cover Benefits			
	Current Tree Cover (24%)	Modeled at 30% canopy	Modeled at 40% canopy
Air Pollutants Removed Annually (lbs.)	2,854,237	3,537,126	4,716,169
Air Pollutants Removed Annually (\$)	\$7,103,173	\$8,802,639	\$11,736,852
Stormwater Mitigated (total cubic feet)	370,500,836	409,553,346	431,250,928
Stormwater Mitigated (total \$)	\$741,001,672	\$819,106,692	\$862,501,856
Carbon Stored (total tons)	1,291,700	1,600,700	2,134,300
Carbon Sequestered Annually (tons)	10,000	12,400	16,600

Table taken from the American Forests 2002 study. 13

Roughly 10% of Treme’s total surface area is occupied by tree cover. If the American Forests organization calls for a minimum of 25% tree canopy in urban residential areas, Treme is at a grave deficit. From the findings in this analysis along with the work of Tidball and his colleagues, Treme and similar areas throughout New Orleans are top candidates to pursue and receive support to launch a large-scale tree planting initiative.

Baseline Map

1. Open photoshop:
 - a. Open the nine NOAA images and drag each image as a separate layer into a new (large) canvas.
 - i. Align each layer so the nine images create a coherent layout of the downtown New Orleans.
 - ii. Once aligned, select new mask for layer 1
 1. Select the paint brush tool, and adjust brush size to 35 and opacity to 25%.
 2. Using the brush tool, lightly erase the edges of the layer. This creates a smooth blend between layers.
 - iii. Repeat for each layer as needed.
 - b. Once the nine images blend together, adjust the levels, curves and color saturation so the contrast and colors in each layer are similar.
 - c. Under layers, select flatten layers.
 - d. Crop image.
 - e. Resize the image to under 5mb. Save baseline image as a jpeg.
2. Open ArcMap:
 - a. Import newly created baseline image. Import the roads shapefile downloaded from the Census.
 - b. Under the georeferencing toolbar, select fit to display. Set the “layer:” as the baseline image.

- i. Georeference the baseline image with the road shapefile. Three points were selected to make for a precise alignment of the two shapefiles.
The intersections:
 1. Saint Louis Avenue & N. Broad Street
 2. Saint Louis Avenue & N. Rampart Street
 3. N. Rampart Street & Esplanade Avenue
 - ii. Save georeferenced points.
 - c. Import treme_calculatedarea shapefile.
3. Clipped the baseline image to work off solely the area in the Treme designated polygon.
 - a. Under data management tools, selected clip:
 - i. Input raster is the baseline photo.
 - ii. Output extent is the Treme calculated area shapefile.
 1. Selected “use input features for clipping geometry” to ensure the clipped area aligned with the Treme boundary.
 4. Delete original baseline photo.
 5. Create a new layer set
 - a. Import the USGS national elevation data (NED) for August, 2005.
 - b. Import the Treme_calculatedareas shapefile.
 - c. Align the two separate layers within the map to depict their point of original from a referenced map.

Urban Canopy Analysis

1. Open ArcMap.
2. Imported Orthophoto (32471594.tiff) from USGS that includes Treme.
3. Imported roads shapefile (census data).

4. Projected roads shapefile in NAD_1983_UTM_Zone_15N to correspond with the Orthophoto projection.
5. Select the roads only within the Treme designated area.
 - a. Treme border (N. Broad St, Saint Louis Avenue, Esplanade Avenue, N. Rampart St).
 - b. Select all streets within the designated area.
 - c. Under the shapefile, go to Data, export new shapefile of only the roads in Treme.
6. In ArcCatalog:
 - a. Go to data folder, create a new polygon shapefile titled “treme_border.”
7. Import new shapefile in ArcMap.
 - a. Under the edit menu, start an editing session.
 - b. Use *trace tool* to trace the outer border of Treme along the streets (N. Broad St, Saint Louis Avenue, Esplanade Avenue, N. Rampart St). Note: There is significant tree canopy along Treme’s perimeter, particularly along Esplanade Avenue with numerous trees along the neutral ground. To account for these and other trees along the perimeter, used the ‘modify feature’ tool to ensure the outer sidewalks of the four streets served as the perimeter. Trees on the opposite side of the perimeter streets were not included.
 - c. Save edits, classified new polygon as the ‘treme_area.’
8. Calculated area tool:
 - a. Use ‘calculate area tool’ to calculate the total area of only the newly edited Treme polygon shapefile. Once the area is calculated, this number serves as the total area (square meters) to compare tree canopy and other impervious surfaces.
9. Data Management tools, clip function:

- a. Clip the original orthophoto to work off solely the area in the Treme designated polygon.
 - b. Under data management tools, selected clip:
 - i. Input raster is original orthophoto.
 - ii. Output extent is the Treme calculated area shapefile.
 1. Select “use input features for clipping geometry” to ensure the clipped area aligned with the Treme boundary.
10. On the original orthophoto, set transparency to 33% to distinguish area of interest (Treme) and elsewhere.
11. In ArcCatalog:
- a. In my data folder, create a new polygon shapefile titled “canopy_miro” (the tree canopy +/- one street alongside miro street)
12. In ArcMap, imported new canopy_miro shapefile.

Note: Divided canopy into nine corridors running northeast to southwest, parallel to N. Broad St. and N. Rampart St. Canopy shape file corresponds to the street +/- 1 street to the northeast/southwest.

13. Started editing session
- a. Set 1 street +/- northwest and southeast of Miro St. between Saint Louis and Esplanade as the first corridor for the canopy analysis.
 - b. With polygon tool, began outlining trees.
 - i. *Criteria for canopy outline:*

1. Subjective analysis based on visual information to make canopy selection:

- a. Do not include shadow.
 - b. Greenery relative to neighboring roofs (above or below as a distinction).
 - c. Make 'best guess' as to what is a tree versus bush or shrub.
 - d. Shadow extent (length relative to height) used as a basis of distinction. The greater the shadow, the more likely the object in question was a tree.
- ii. For unclear areas between what is/is not a tree, assumed a path to project a 'reasonable canopy.' For obscure areas, the client's consultation was required.
 - iii. Clusters of trees may have been included into one polygon. One polygon does not necessarily signify one tree.
 - iv. Trees whose canopy overlaps two corridors were accounted in the corridor where the majority of polygon was located.
- c. Saved edits, close editor.

14. In the Data attribute table for each canopy corridor shapefile:

- a. Under options, selected 'Add Fields'
 - i. Create 'sq_meter' column: depicts total area for each polygon within the specified corridor in square meters.
- b. Selected calculate geometry
 - i. Under property, selected area
 - ii. Under units, selected default (square meters).
- c. Each polygon was granted a specific square meter calculation.

15. Creating the corridors shapefile

- a. In ArcCatalog, go to data file, new, polygon shapefile entitled *corridor_areas.shp*.
 - b. Import new shapefile into ArcMap.
 - i. Start editing session:
 1. Using the select tool, select each corridor by along the Treme border shapefile as well as the respective street boundary.
 2. Using the trace tool, outlined the precise corridor area, making sure to account for the entire area within each corridor so all corridors account for the total area within the Treme boundary.
 3. Once completed the boundary, in the *corridor_areas* shapefile, open the Data attribute table.
 4. Under options, clicked on 'add field'
 - a. Created new text field named *Corridor*.
 - b. Created a second field named *sq_meter*.
 - c. Renamed corridor based on the central street.
 - d. Calculated area (square meters) for the corridor.
 - ii. Saved edits. Repeated above process until all nine corridors were complete.
16. Calculated the total area of each corridor as well as each respective tree canopy cover in excel (by importing each tree canopy corridor .dbf file).
17. Tree canopy analysis: March 2006 and February 2009 maps

Surface Area Analysis

Road Surface

1. Open ArcCatalog
 - a. Create a new polygon shapefile called “roads_handarea”
2. Imported *roads_handarea* into ArcMap.
 - a. Open editor, start editing session
 - b. Select target as roads_handarea
 - c. Task is set as create new feature
 - d. By hand, outlin all road surfaces within the Treme neighborhood boundary.
 - e. Click save edits, stop editing.
3. Under data management tools, select dissolve.
 - a. Input features: roads_handarea
 - b. Output feature class: select original data folder
 - c. Under dissolve fields: selected sq_meter
 - i. Statistic type : SUM
 - d. Once dissolve is complete, remov the original roads_handarea shapefile
4. With new roads_handareadissolve shapefile, open data attribute table.
5. Under options, select add fields:
 - a. Add Fields
 - i. Create ‘sq_meter’ column: depicts total area for each polygon within the specified corridor (square meters).
 - b. Select calculate geometry.
 - c. Under property, select area.
 - i. Ensure coordinate system for the data source is set to PCS: NAD 1983 UTM Zone 15N.
 - d. Under units, select square meters.

- e. The entire road system within Treme included a total square meter area calculation.
6. Buildings
 - a. Set projection
 - b. In the Arctoolbox, under data management tools, projections and transformations, feature, select project:
 - i. Input dataset – buildings shapefile.
 - ii. Output dataset – original data folder.
 - iii. Output coordinate system: NAD_1983_UTM_Zone_15N.
 - c. Save new projected buildings shapefile.
 7. Buildings only in Treme
 - a. In the ArcToolbox, under data management tools, select clip feature.
 - i. Input is original orthophoto.
 - ii. Output extent is the Treme calculated area shapefile.
 - i. Select “use input features for clipping geometry.”
 - b. New clipped shapefile replaced previous shapefile of buildings. Only buildings within Treme remain.
 8. Working with this impartial data, open the editor and select ‘start editing session.’
 - a. Select target as buildings_treme_project.
 - b. Task set to create new feature.
 - c. By hand, outlined all unidentified building surfaces within Treme boundary.
 - d. Click save edits, stop editing.
 9. At many points throughout the map, tree canopy covers both roads and buildings. To ensure no layer overlaps the other, use the erase tool to calculate the net street surface, net building surface and total tree canopy area (in square meters).

- a. Merge all tree canopy shapefiles
 - i. In ArcToolbox, select Merge under Data Management tools. Select the nine tree canopy shapefiles, merge them into one shapefile called canopy_treme.
- b. Ensure no area duplication in calculation
 - i. In ArcToolbox, under Analysis tools/ Overlay/ select Erase.
 1. For input features, selected roads_handarea_dissolve.
 2. For erase features, selected canopy_treme.
 - ii. Repeat same step for buildings, using both the new roads shapefile and the canopy_treme file to ensure no overlap in the calculation.

10. Calculating total areas:

- a. Export canopy_treme, buildings_treme_project and roads_handarea .dbf files into excel. Also export the treme_area .dbf total area shapefile.
- b. Using the total area calculations for each shapefile, take the difference of the tree canopy, street and buildings total areas from the total area in Treme to derive the total area for all *other* areas – the fourth surface designation – in the analysis.
- c. Import excel spreadsheet into ArcMap .mxd file.

11. Repeat analysis for 2009 data. Complete: surface area analysis: March 2006 and February 2009.

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- ¹ Tidball, Keith, Marianne Krasny, Erika Svendsen, Lindsay Campbell, and Kenneth Helphand. *Stewardship, learning, and memory in disaster resilience*. Department of Natural Resources, Cornell University, Ithaca, NY, USA; ^b Northern Research Station, US Forest Service, New York, NY, USA; ^c Department of Landscape Architecture, University of Oregon, Eugene, OR, USA. April 2009. Abstract.
- ² Tidball, Keith, Marianne Krasny, Erika Svendsen, Lindsay Campbell, and Kenneth Helphand. *Stewardship, learning, and memory in disaster resilience*. 3.
- ³ Tidball, Keith, Marianne Krasny, Erika Svendsen, Lindsay Campbell, and Kenneth Helphand. *Stewardship, learning, and memory in disaster resilience*. Abstract.
- ⁴ Tidball, Keith. "Treme Tree Planting Data." Email to jalbrecht@parkwaypartnersnola.org. 7th May, 2010.
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