City of Pittsburgh Tree Planting Site Analysis

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**Introduction**

The City of Pittsburgh Planning Department (“Planning,” “The Department,” or “The Planning Department”) has asked for a geospatial analysis to help determine appropriate sites for new tree planting in the city. In response to the RFP, I have in this project created and run a suitability model to determine five possible regions for new tree planting. This model used the following criteria as inputs at the census tract level, in line with the City’s stated equity, environmental, and vulnerability goals:

**Equity:** percentage of Black residents, percentage of residents within 125 percent of the Federal Poverty Line (FPL)

**Environment:** land surface temperature, average daily traffic count

**Vulnerability:** percentage of residents over 65, percentage of children under 5, percentage of children with asthma, percentage of population who are smokers

In addition to these inputs, the models used Trees Per Capita as an estimate of tree canopy coverage in each census tract. This variable was the primary criteria for determining preferred regions for tree planting.

The results of this suitability analysis are recommendation for areas where Planning can conduct further street-level studies to determine exact planting sites. The suitability model was run several times with different weights on the criteria, as explained in the Methodology section of this report. This gives the Planning Department additional flexibility in choosing sites in alignment with the City’s primary goals.

**Methodology**

Before inputting criteria into the suitability model, I collected all necessary data and cleaned the datasets to eliminate unnecessary variables, filter for rows appropriate to the analysis, create calculated fields necessary to the analysis, and join appropriate tables. Data sources can be found in Appendix I.

Once the data were cleaned and imported into ArcGIS Pro as feature classes, I performed several geoprocessing tasks to further derive the necessary variables for analysis and prepare the layers for the suitability model. A log of these tasks can be found in Appendix II.

Once the feature classes were derived into raster data layers, I began the Suitability Model process. First, I added each layer as a criterion to the model and transformed the data using ArcGIS Pro’s built-in transformation process. This process converts each layer’s data to exist on a shared scale and allows the user to control how values are assigned a preference value in the model. For example, I used a transformation process on the smoking rate data to indicate that very large data values were the most preferred when selected tree planting sites. A log of all transformation processes can be found in Appendix III.

Once the data were transformed, I ran the suitability and location processes. To give the Department multiple options for determining tree planting sites, I ran the model several times using different criteria weights based on the City’s three key goals: equity, environment, and vulnerability.

**Model 1:** Trees Per Capita weighted at 2, with all other criteria assigned a weight of 1

**Model 2 (“Equity Model”):** Trees Per Capita weighted at 2, equity criteria weighted at 1.5, with all other criteria assigned a weight of 1

**Model 3 (“Environment Model”):** Trees Per Capita weighted at 2, environment criteria weighted at 1.5, with all other criteria assigned a weight of 1

**Model 4 (“Vulnerability Model”):** Trees Per Capita weighted at 2, vulnerability criteria weighted at 1.5, with all other criteria assigned a weight of 1

Each of the models produced 5 regions suitable for further exploration by the Planning department.

**Results and Analysis**

*Map

Description automatically generatedModel 1 – Trees Per Capita Weighted*

*Figure 1: Model 1 – Trees Per Capita weighted twice as much as all other criteria.*

Model 1 produced five suitable regions that were well equally distributed around the city (Figure 1). Considering the variable weights, this model as expected primarily considered trees per capita when measuring preference (Figure 2).

Map

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*Figure 2: Trees Per Capita choropleth map.*

However, as seen from the region zoom-ins in Figure 1, the most suitable regions factor

in other variables as well, such as neighborhoods that have been historically neglected by the city, such as the Hazelwood/Glen Hazel area and parts of the Hill District. It also produced high suitability scores for areas with higher land surface temperature (Shadyside) and areas with high amounts of poverty (Carrick/Knoxville).

*Model 2 – Equity Criteria Weighted*

Model 2 produces similar results to Model 1, with a few key differences. First, Region 1 includes more of the northwest parts of the city, such as Sheraden and Fairywood. Region 3 extends further into Oakland away from the Lawrenceville area. Region 4 shifts north and towards the river to include the Mt. Washington and Duquesne Heights neighborhoods. These shifts account for the increased weights on high-poverty areas and areas with high percentages of Black residents, populations which have been historically neglected by major cities.

Map

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*Figure 3: Model 2 – Weighted Equity Criteria.*

However, Model 2 still does not recommend regions that fully prioritize poverty and race as criteria (Figures 4 and 5). For example, the neighborhoods of Homewood and parts of the North Shore are not identified as suitable regions. This demonstrates the effects of multiple criteria as inputs to the model.

Map

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*Figure 5: Race Makeup choropleth map.*

*Figure 4: Poverty Makeup choropleth map.*

*Model 3 – Environment Criteria Weighted*

Map

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*Figure 6: Model 3 – Weighted Environment Criteria.*

Model 3 shifts Region 5 to central Pittsburgh to account for the heavier weights on environmental factors, such as traffic and land surface temperatures. We can also see from Figure 2 that these areas have less concentrated tree coverage, which likely contributes to the higher LSTs. If interested in focusing on these factors, the City should consider exploring new planting sites in areas such as the Hill District, Oakland, East Liberty, and parts of Point Breeze.

*Model 4 – Vulnerability Criteria Weighted*

*Figure 7: Model 4 – Weighted Vulnerability Criteria.*

Map

Description automatically generatedThe regions identified in Model 4 look nearly identical to Model 1, despite weighting criteria associated with vulnerable populations (e.g. elderly, children, children with asthma, smokers). This could show that these factors are highly correlated with the trees per capita metric, or that they do not display strong spatial correlation.

**Recommendations and Next Steps**

The Planning Department has several options for next steps given these models. There are some regions each of these models have in common that I recommend the Planning Department seriously consider for new tree planting sites:

1. The Upper Hill/North Oakland
2. Glen Hazel/Hazelwood/South Squirrel Hill/Greenfield
3. The northwest side (Elliot, Crafton Heights, Sheraden)

Other neighborhoods for consideration depend on whether the City has primary and secondary goals for tree canopy cover. For example, if the City wants to focus on mitigating environmental factors such as traffic pollution and land surface temperatures, they should focus tree planting efforts in central Pittsburgh: the Hill District, Oakland, Lower Lawrenceville, East Liberty, Bloomfield, and Highland Park.

Once the City has decided on general neighborhoods to focus on, the Planning Department should conduct further street-level studies to select exact sites, and study tree types to select species that maximize shade coverage at full maturity.

Appendix I: Data Sources

The Western Pennsylvania Regional Data Center

Pittsburgh Trees (XY data), Daily Traffic counts (.csv), Smoking Rates (shapefile), Childhood Asthma Healthcare Utilization 2017 (.csv.), Pittsburgh Neighborhoods (shapefile), Pittsburgh census tracts 2016 (.csv)

Census.gov

2020 American Community Survey 5-year estimates for poverty and demographic characteristics (.csv)

Mendeley Data

US Urban Heat Island Database (.csv)

Appendix II: Geoprocessing Log

|  |  |
| --- | --- |
| **Input Layer** | **Geoprocessing Tasks** |
| Trees | Used “Summarize Within” tool to aggregate number of trees to the census tract level and create “Count of Trees” variable  Divided “Count” by Total Population for each census tract to create Trees Per Capita variable |
| Traffic | Used “Summarize Within” tool to take average of all traffic count data points in each census tract to get the overall average daily traffic count for each tract. |

Appendix III: Data Transformation Process Log

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| --- | --- | --- | --- |
| **Layer** | **Criterion** | **Transformation Function** | **Other parameters (if applicable)** |
| ChildrenTracts | PctPop\_Under5 | Large (large values are preferred) | Midpoint: 0.05 (mean of distribution)  Point spread: 5 (default) |
| AsthmaTracts | Pct of Children (<18) Using Asthma Services | Large (large values preferred) | Midpoint: 0.08 (mean of distribution)  Point spread: 5 (default) |
| ElderlyTracts | PctPop\_Elderly | Large (large values preferred) | Midpoint: 0.17 (mean of distribution)  Point Spread: 5 (default) |
| LST | LST\_urb\_CT\_all | Large | Midpoint: 22.67 (mean of distribution)  Point spread: 5 (default) |
| PGHTractTraffic | Mean average\_daily\_car\_traffic | Large | Midpoint: 3494 (mean)  Point spread: 5 |
| PovertyTracts | PctPop\_125FPL | Large | Midpoint: 0.23  Point Spread: 2.5 (wanted to include more values of the distribution as highly preferred because of metric) |
| RaceTracts | PctPop\_Black | Large | Midpoint: 0.22  Point Spread: 5 |
| PGHTrees\_SummarizeWithin | Trees Per Capita | MSSmall (not a lot of variation at the bottom of the distribution) |  |
| SmokingRateTracts | smokeratepre | MS Large (variation heavily concentrated at top of distribution above 0–want to isolate especially high values) |  |