Report Outline: Tree Cutting Priority Analysis

Course Name: Spatial Data Analysis
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Analysis Question

What are the priority zones for tree cutting based on multiple utility factors (tree mortality, population density, community features, and egress routes)?

Criteria

Our analysis criteria involve several factors, each evaluated independently and combined to form a comprehensive assessment of the cutting priority. Each factor is normalized and given external weights to provide balanced input into the final priority score. The criteria include:

1. **Tree Mortality:** Total mortality of trees across grid zones.
2. **Population Density:** Areas with higher population density, indicating higher risk in case of fire hazards due to trees.
3. **Community Features:** The proximity of important community infrastructure, like schools and fire stations.
4. **Egress Routes:** Streets and evacuation routes with a surrounding buffer

Data

Dataset	Desc	Source	Data model	Type of feature	Attributes
CuttingGrids	Polygon grid representing different geographic zones.	User	Vector	Discrete	OBJECTID, GRID, SHAPE_Leng, SHAPE_Area, geometry
Tree Mortality	Polygon representing tree mortality in different areas.	User	Vector	Discrete	OBJECTID, SHAPE_Leng, SHAPE_Area, Tot_mortal, geometry
PopulatedAreast	Polygon for population centers with population density.	User	Vector	Discrete	OBJECTID, PLACE_NAME, POP, pop_per_sq, geometry
Communityfeatures	Points representing community infrastructure.	User	Vector	Discrete	OBJECTID, NAME, weight, geometry
EgressRoutes	Line features representing street and evacuation routes.	User	Vector	Discrete	OBJECTID, weight, SHAPE_Leng, geometry

Methodology

The methodology followed in this analysis involved several critical steps to assess the priority zones for tree cutting based on multiple factors. The key steps are outlined below:

1. **Data Loading and Inspection**

    - Various shapefiles representing cutting grids, tree mortality, population density, community features, and egress routes were loaded .
    - Each shapefile was inspected for relevant fields to ensure the necessary data was present for further analysis.

2. **Data Normalization:**

    - Tree Mortality: The Tot_mortal attribute, representing total tree mortality, was normalized to a scale of 1-9. This rescaling allowed for easier comparison with other criteria.
    - Population Density: The pop_per_sq attribute was also normalized to a 1-9 scale, reflecting areas with higher population density that are more vulnerable in case of fire hazards.

2. **Spatial Operations:**

    - The Coordinate Reference System (CRS) of each dataset was aligned to ensure consistency in spatial analysis.
    - Spatial Joins: Spatial joins were performed to intersect datasets such as tree mortality and population density with the cutting grids, enabling the association of grid zones with these factors.
    - Buffers: A 100-meter buffer was created around community features and egress routes to account for the proximity effect of trees on critical infrastructure and evacuation paths

3. **Weight Assignment:**

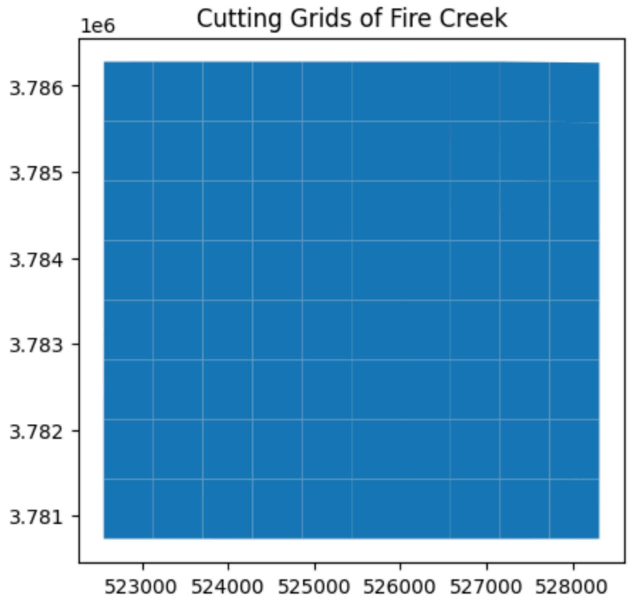
    - External weights were applied for each criterion based on its relative importance to fire risk and evacuation safety, such as:
        - Tree Mortality Weight: 0.4
        - Population Density Weight: 0.3
        - Community Feature Weight: 0.2
        - Egress Route Weight: 0.1
    - Missing values in grid zones (where no data was available) were filled with 0 to ensure completeness.

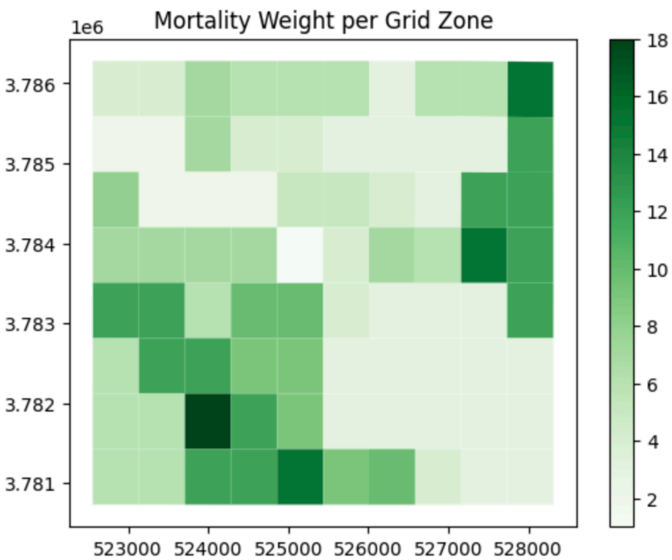
4. **Combining Criteria:**

    - The total priority score for tree cutting in each grid zone was derived by merging all the utility factors and applying external weights for each criterion.

5. **Visualization:**

    - The results were visualized using different color maps, each representing a specific criterion (e.g., tree mortality, population density).
    - A final composite map was created, showing the total priority score for each grid zone, where darker colors indicated higher priority areas for tree cutting.


Cutting Grids of Fire Creek
1e6
3.786
3.785
3.784
3.783
3.782
3.781
523000 524000 525000 526000 527000 528000


Mortality Weight per Grid Zone
1e6
3.786
3.785
3.784
3.783
3.782
3.781
523000 524000 525000 526000 527000 528000
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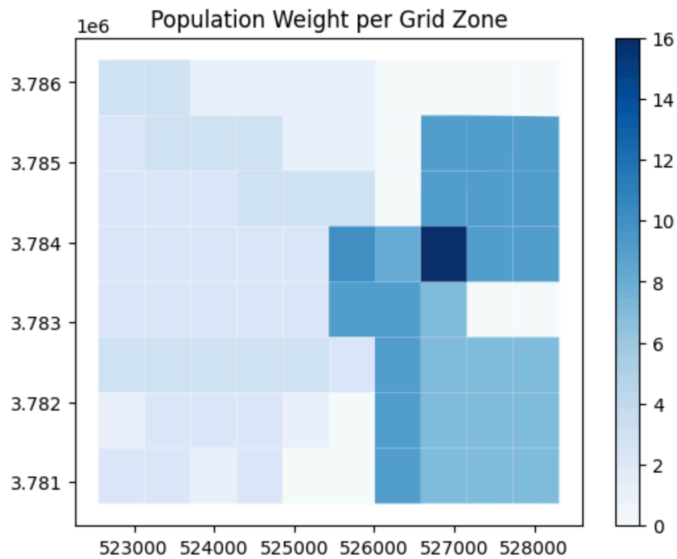
10
8
6
4
2


Population Weight per Grid Zone
1e6
3.786
3.785
3.784
3.783
3.782
3.781
523000 524000 525000 526000 527000 528000
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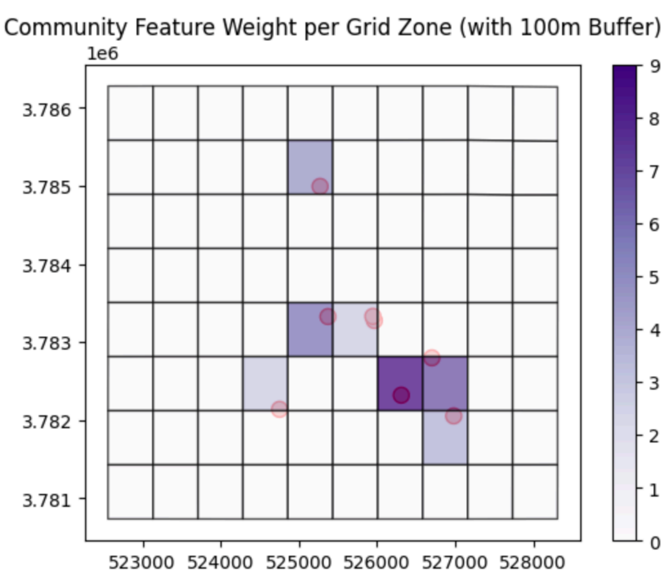
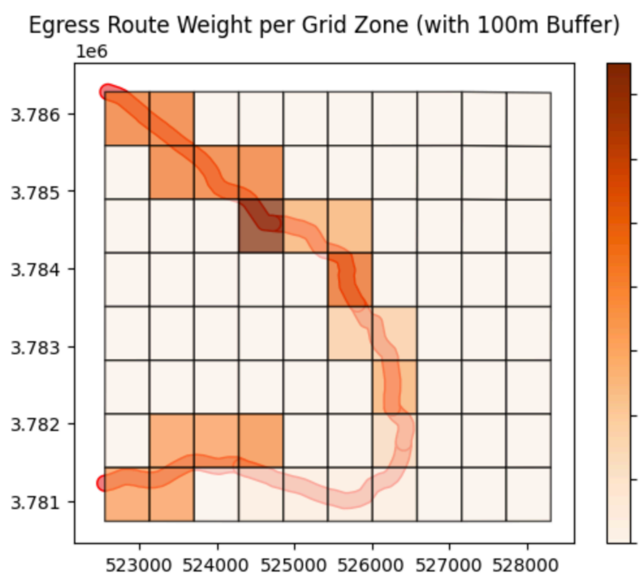
8
6
4
2
0


Community Feature Weight per Grid Zone (with 100m Buffer)
1e6
3.786
3.785
3.784
3.783
3.782
3.781
523000 524000 525000 526000 527000 528000
9
8
7
6
5
4
3
2
1
0


Egress Route Weight per Grid Zone (with 100m Buffer)
1e6
3.786
3.785
3.784
3.783
3.782
3.781
523000 524000 525000 526000 527000 528000
14
12
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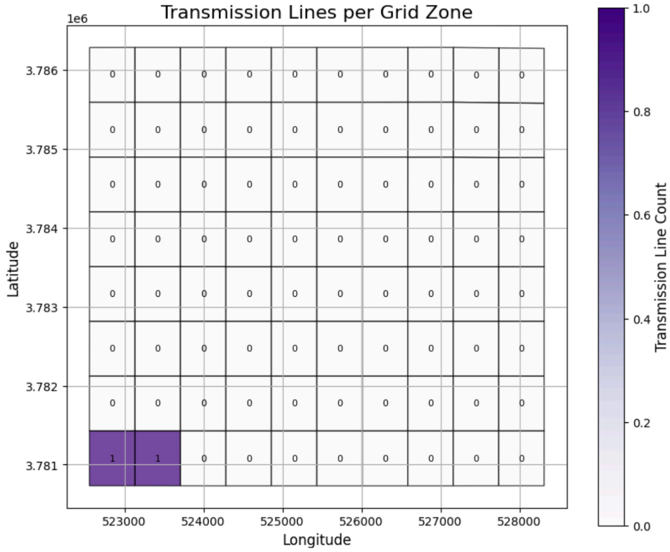
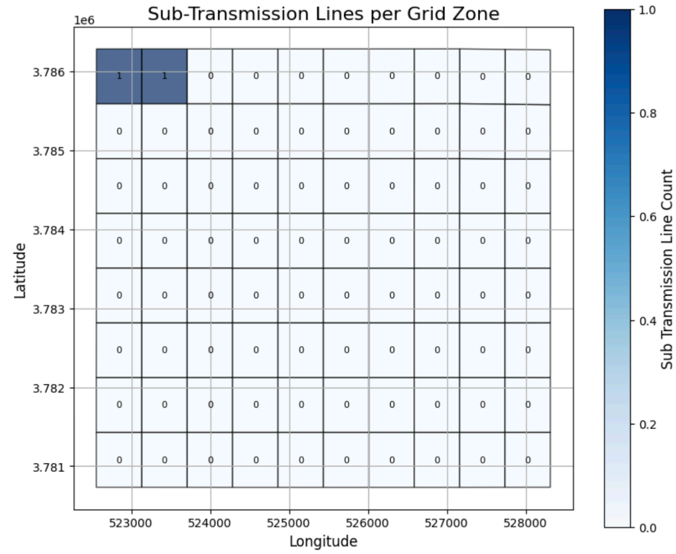
8
6
4
2
0



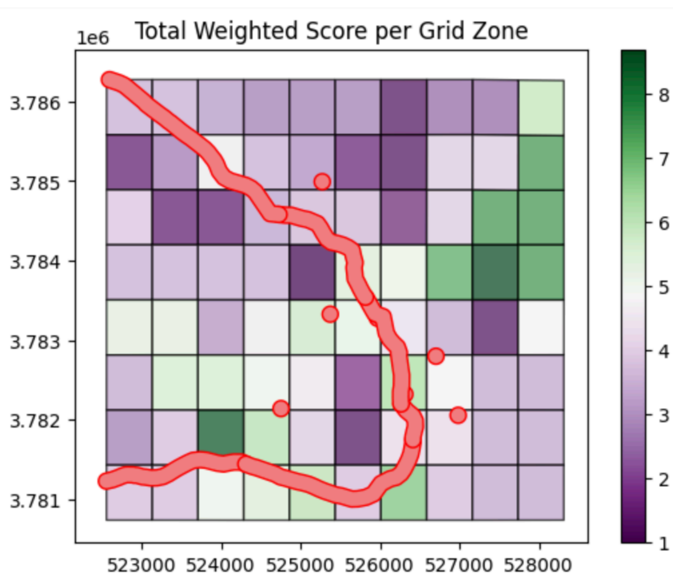


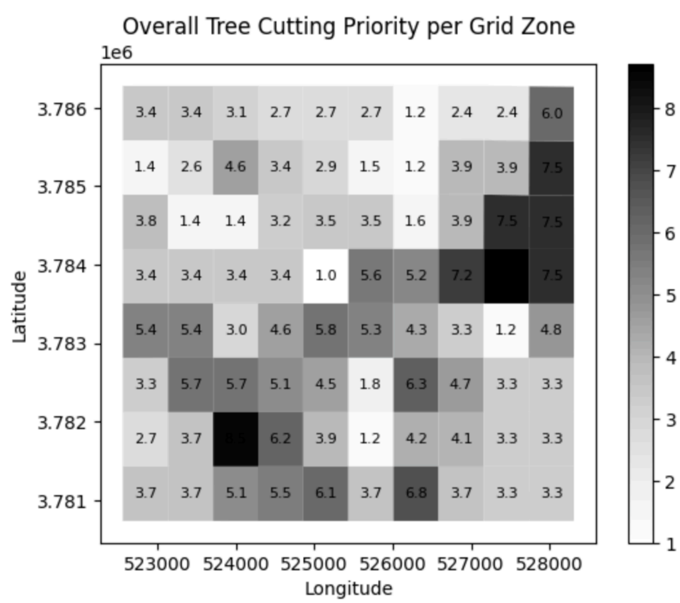
Results

The resulting analysis provided a comprehensive priority map for tree cutting operations. The grids with the highest priority are those where:

- **Tree mortality is high**, indicating a large number of dead or dying trees.
- **Population density is high**, showing areas at higher risk in case of wildfires.
- **Community infrastructure is present** and vulnerable to tree falls or fire spread.
- **Egress routes** are intersected, highlighting zones where evacuation routes could be blocked by fallen trees.

Grids are visualized with their final priority scores in a color-coded map where darker regions indicate higher priority.





How the process was done sequentially:

The analysis conducted on tree cutting priority involved multiple steps and factors to determine which zones should be prioritized for tree removal.

Initially, the data was loaded from several shapefiles, including those representing cutting grids, tree mortality, populated areas, community features, and egress routes. Each shapefile was inspected to check the available fields, ensuring that the necessary data for analysis was present. A crucial step in the process was aligning the Coordinate Reference System (CRS) across all datasets to allow for accurate spatial analysis, such as joins and buffer calculations.

Normalization of the data was performed for tree mortality and population density, scaling these attributes to a range of 1-9. This standardization was essential for comparing different criteria on a common scale. In addition, a 100-meter buffer was applied around both community features and egress routes to account for the proximity effect of trees on critical infrastructure and evacuation paths. The spatial join technique was then used to intersect the datasets, ensuring that each grid zone contained information on the factors being analyzed.

External weights were assigned to each criterion based on its importance to fire risk and evacuation safety. Tree mortality was given the highest weight (0.4), followed by population density (0.3), community features (0.2), and egress routes (0.1). These weights were applied to the normalized values, and missing data for certain grid zones (e.g., where no tree mortality or population data existed) was filled with a weight of 0 to maintain completeness. The final score for each grid zone was calculated by summing the weighted values, and this total priority score was rounded to one decimal place for clarity.

The results were visualized using color-coded maps, with each factor represented by a distinct color scheme (e.g., greens for tree mortality, blues for population density), and a final map showing the composite priority score for each grid zone. Darker regions on the map indicate zones with higher priority for tree cutting, where tree mortality is high, population density is significant, critical infrastructure is nearby, and evacuation routes are at risk of obstruction. This comprehensive approach provides actionable insights for resource allocation in tree-cutting efforts, helping to mitigate fire hazards and protect both populations and infrastructure. Future improvements could include integrating real-time data, such as weather patterns, or applying machine learning to further refine the prioritization model.

Conclusion

By integrating multiple factors such as tree mortality, population density, community infrastructure, and evacuation routes, we have created a robust priority system for tree cutting across different geographic zones. This model provides actionable insights into where resources should be concentrated to reduce fire hazards, protect populations, and safeguard critical infrastructure. Further refinements could involve integrating additional datasets or adjusting the external weights based on domain-specific feedback.

Check out the code on google colab [Notebook]