

Research Proposal: Ideal Locations for Evacuation Centers in Los Angeles City

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Introduction

Each year, California has at least two earthquakes of magnitude larger than 5.5, which is enough to cause moderate damage to structures (California Department of Conservation). Additionally, over 245,000 acres of land were burned down due to wildfires in 2022 alone (California Department of Forestry and Fire Protection). Since Los Angeles city alone makes up 10.1% of all of California's population (U.S. Census Bureau), it would be in our great interest to build evacuation centers to be prepared for the worst.

Los Angeles has already made efforts to prepare its residents to be ready for these kinds of natural disasters. The city itself has already written guides such as “City of Los Angeles: Emergency Operations Plan” (Emergency.lacity.org), and the University of California Institute of Transportation Studies conducted a study on the evacuation capacity of Los Angeles roadways and bridges (University of California Institute of Transportation Studies). To expand on these efforts and find suitable locations to build evacuation centers, we need to consider external factors such as average temperature and rainfall, surrounding fire hazards, and proximity to emergency services. That way, we can build these sites in locations that have low risk of fires, floods, disease, and uncontrolled crime and focus more attention on maximizing the quality of the facilities themselves and planning routes for residents to reach them as quickly as possible.

Objective

The objective of this proposal is to find out which areas in Los Angeles city will best serve as evacuation centers in times of natural disasters and which areas are the most vulnerable.

Research Design and Data Collection Method

Data Sources

- Temperature and precipitation data will be obtained from 2021 data from NOAA's NCEI website, fire hazard zone data will be obtained from the Los Angeles Public Directory, and emergency service data will be obtained from USGS

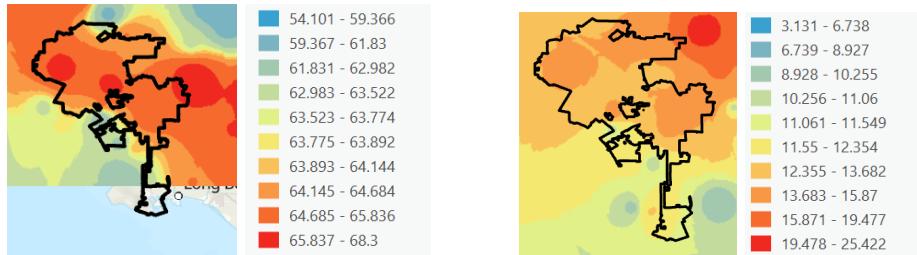
Data Collection (methodology)

- We will use aggregate scores on the collected data on a scale of 0-10 points where a score of 0 points indicates the least preferable extent of a characteristic and a score of 10 points indicates the most preferable extent of a characteristic. The factors, their used methods, and aggregate scores are as follows
 - Average annual rainfall
 - Method: spatial interpolation (inverse distance weighting) on data of average annual temperatures of Los Angeles city (NCEI)
 - Weightings (lower rainfall will be awarded with larger weights)
 - 0 - 4 inches: 10 points
 - 4 - 8 inches: 8 points
 - 8 - 12 inches: 6 points

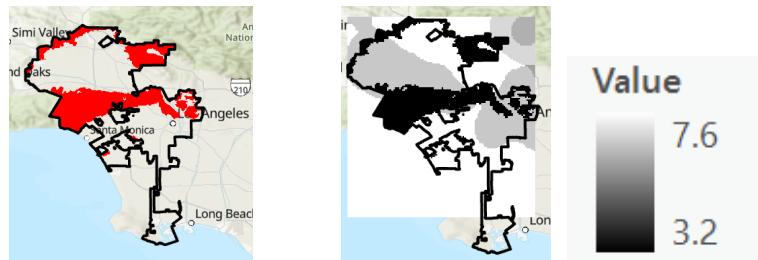
- 12 - 16 inches: 4 points
 - 16 - 20 inches: 2 points
 - 20+ inches: 0 points
- Average annual temperature
 - Method: spatial interpolation (inverse distance weighting) on data of annual precipitation of Los Angeles city (NCEI)
 - Weightings (lower average temperature will be awarded with larger weights)
 - 50 - 55 °F: 10 points
 - 55 - 60 °F: 8 points
 - 60 - 65 °F: 6 points
 - 65 - 70 °F: 4 points
 - 70 - 75 °F: 2 points
 - 75+ °F: 0 points
- Fire Hazard Zones
 - Method: obtain data from the remote data server "Layer: Fire Hazard Severity Zones (ID: 2)" (Los Angeles County Public Directory)
 - Weightings (lower fire risk will be awarded with larger weights)
 - None: 10 points
 - Moderate: 6 points
 - High: 4 points
 - Very High: 2 points

- After all the calculations are completed, we will then use weightings for each of the three above factors in a final raster calculation to prioritize them differently. These weightings have to add up to one, and higher weightings indicate a higher priority of the factor
 - Fire hazard zones will have the largest weighting of 0.4 since California is notorious for its wildfires due to its hot climate, dry vegetation, and little rainfall.
 - Average temperature will have the second highest weighting of 0.35 since we don't want the evacuation sites to be unbearably hot for its residents and hotter weather contributes to more frequent wildfires.
 - Rainfall will have the lowest weighting of 0.25 since although problematic in excess, it is the easiest risk to manage out of the three since it does not rain often in California.
- After the final raster calculation, land at an aggregate score of 7 points or above will be rated as sufficient for evacuation centers to be built on. The resulting land will then be filtered by whether it is simultaneously within 10 miles to a fire, police, and ambulance service. Such services will be located by the remote data server “structures (MapServer)” (Structures (Mapserver))

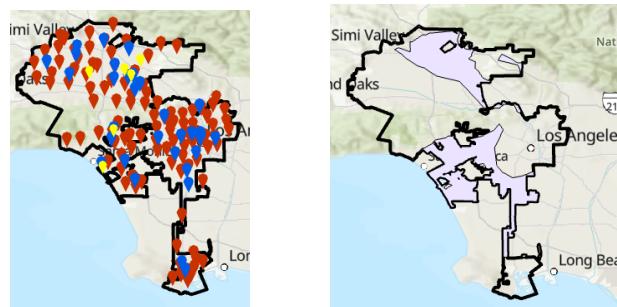
Summary of Preliminary Results



Figures 1 and 2: Results of Spatial Interpolation of Los Angeles City's Average Annual Temperatures (Left, Fahrenheit) and Precipitation (Right, Inches)



Figures 3 and 4: Fire Hazard Zones in Los Angeles County (Left, Red = Very High Risk), and Results of Final Raster Calculation (Right)



Figures 5 and 6: Emergency Services in Los Angeles City (Left, Red = Fire Stations, Blue = Police Stations, Yellow = Hospital Services) and Final Calculated Suitable Land (Right, Green = Suitable Land)

- Average annual temperature data ranged from 54.101°F to 68.3 °F (Figure 1), average annual precipitation data ranged from 3.131 inches to 25.422 inches (Figure 2), and there were only “Very High” risk fire zones (Figure 3). As a result, the final raster calculation of the three factors had values ranging from 3.2 to 7.6 (Figure 4). Even when considering proximity to emergency services, the calculated suitable land did not change
- The calculated area of suitable land in Los Angeles county is 0.036672 units, and the total area of populated land in Los Angeles county is 0.121012 units. This means that when only considering the four given factors, approximately 30.3% of Los Angeles city is suitable for evacuation centers to be built on them. In terms of the suitable land itself, it is split by Los Angeles city’s “Very High” risk fire hazard zone and is clustered in the northeast and mid southwest sections of Los Angeles city (Figure 6).

Discussion on Future Study

If a closer study is wished to be conducted on the proposal, other more nuanced factors like wind speeds and proximity to coastlines could be considered for future site suitability studies. The city's population density and demographics could also be considered in a future analysis when allocating people in certain areas and creating evacuation routes to these evacuation sites and. People such as minors who are unaccompanied by adults and those with disabilities need extra accommodations and less travel time to these evacuation sites (fema.gov). If more factors were to be considered, the weightings of the factors in the final raster calculation will have to be adjusted so that they still all add up to 1 and are properly prioritized.

The data gathering strategies used here could also be applied to many other future research and commercial topics on the rest of the world. For instance, spatial interpolation could be used to estimate densities of dry vegetation and help determine the rate that a wildfire can spread in a national park.

References

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Suitable Land for Evacuation Centers in Los Angeles City

