Dynamic Site Suitability for Emergency Services in Hyderabad

1.) Team Members

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2.) Background of the problem

Hyderabad's explosive growth and notorious traffic congestion create a critical public safety challenge. Standard GIS site selection models, which often use simple "as the crow flies" distance or static speed limits, are dangerously misleading. A hospital that appears "central" may be completely ineffective if its service area is crippled by peak-hour traffic. Therefore, a modern, data-driven approach is required to identify optimal locations for new emergency facilities.

3.) Problem statement

Hospital Analysis: Will identify "healthcare deserts" by finding high-population areas with *long ambulance/private vehicle travel times* to existing hospitals. The analysis would be driven by a realistic “Peak-Hour Traffic” model.

4.) Objectives

1. To model a realistic **"Peak-Hour Traffic" road network** for Hyderabad by assigning scenario-based travel speeds (e.g., primary_road = 15 km/h).

2. To perform a **Hospital Suitability Analysis** by: Calculating the Peak_Travel_Time from every 1km grid cell to the nearest *hospital*. Using **K-Means Clustering (ML)** on Total_Population and Peak_Travel_Time to identify "Healthcare Desert" hotspots. Combining these hotspots with suitability factors (e.g., land availability) in a Weighted Overlay.

5.) Research questions

Using a peak-traffic model, where are the "healthcare deserts" (high-population, high-travel-time) in Hyderabad? How easily and in time can someone be allotted medical services?

6.) Possible datasets to be used

Vector Data (from OpenStreetMap): Hyderabad Road Network, Existing Hospital Locations, Existing Fire Station Locations, Land Use (polygons), Water Bodies, Parks, Industrial Zones. **Raster Data (from WorldPop):** 100m Gridded Population Data for India (2020). **Vector Data (from external):** Hyderabad Administrative/Ward Boundary.

7.) Possible methods to be adopted

Traffic Modeling (GIS): Create a "Peak-Hour" road network in QGIS by defining realistic, low-speed rules for each road class (e.g., residential = 10 km/h). **Feature Engineering (GIS):** Create a 1km grid. For each cell, use **Network Analysis** to calculate Peak_Travel_Time_to_Hospital. Use **Zonal Statistics** to calculate Total_Population and a). **Machine Learning (K-Means Clustering):** Cluster cells based on Total_Population and Peak_Travel_Time_to_Hospital. **Multi-Criteria Decision Analysis (MCDA):** For each analysis, use **Weighted Overlay (Raster Calculator)** to combine the ML-derived "hotspot" map, suitability factors (e.g., road proximity), and constraint layers (lakes, parks).

8.) Expected results

A **"Peak-Hour Healthcare Desert" Map** (from K-Means A) identifying the most vulnerable populations. A final **Hospital Suitability Map** recommending the top 5% of locations, optimized for population access.

9.) Keywords

Site Suitability Analysis, GIS, K-Means Clustering, Machine Learning, Network Analysis, Traffic Modeling, Access Time, Weighted Overlay, Hyderabad, Healthcare, Fire Response.

Research Papers Referred: 1) **Erden, T., & Coşkun, M. Z. (2010). "Multi-criteria site selection for fire services: the interaction with analytic hierarchy process and geographic information systems."** ***Natural Hazards and Earth System Sciences*****.**

2) Vahidnia, M. H., Alesheikh, A. A., & Alimohammadi, A. (2009). "Hospital site selection using fuzzy AHP and its derivatives." ***Journal of Environmental Management*****.** •