IHEEP 2018
Hosted by Nebraska DOT
IHEEP 2018 President – Jon Starr
Student Presentation
LAND SUITABILITY ANALYSIS FOR EMS POSTS ALONG STATE HIGHWAYS – A CASE STUDY OF CALIFORNIA

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OUTLINE

➢ Motivation
➢ Objective & Contribution
➢ Methodology
➢ Illustration
➢ Discussion of Results
➢ Conclusions & Recommendations
MOTIVATION

- The probability of death in road accidents is strongly correlated to EMS response time
  - A decrease in EMS response time increases in survival rate

- In traffic incident management - time matters
  - Every minute a lane is blocked, 4 extra minutes of delays are created.
  - Every minute in traffic congestion increases the risk of a rear-ended collision.
ASSUMPTION

- It is assumed that locating EMS services closer to possible fatality sites will facilitate the early treatment of serious injuries and will ultimately reduce fatalities.
Objective & Contribution

**Objective** - to demonstrate the viability of using Geospatial modeling to identify potential EMS locations for underserved areas.

**Contribution** - to provide the first step to assist local EMS agencies and planners to locate EMS underserved areas.

- Inline with **IHEEP goals** - it is an innovative way of supporting road safety management decision.
METHODOLOGY
GIS Multi-Criteria Analysis using the weighted linear combination method
Census Boundaries of Study Site

- Factor 1
- Factor 2
- Factor 3
- Factor 4
- Factor 5

Location Data

Create a Criteria Map for Each Factor

Combine Rasterized or Criteria Maps

Apply Weights

Scores (1, 2, 3, 4)

Decision Rule

Prepare Suitability Map with Classified Suitability Levels

Geospatial Modeling using ArcGIS ModelBuilder Environment
ILLUSTRATION OF METHODOLOGY
- California Case Study
PROBLEM STATEMENT

- The NHTSA in 2015 reported a national average EMS response times of
  - 13 minutes and 7 minutes for rural and urban areas, respectively.

- The California Strategic Highway Safety Plan (SHSP, 2015-2019) reports that
  - 37% of fatal collisions are ≥30 miles away from a trauma center in rural California and 8% in urban areas.
Problem Statement

Slide 12

To identify potential EMS locations in rural California to achieve a maximum EMS response time of 10 minutes, which is 3 minutes below the national average.
## GIS Data and Source

<table>
<thead>
<tr>
<th>FACTORS</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. TOPOGRAPHY AND LAND COVER (LAKES)</td>
<td>California Department of Fish and Wildlife <a href="https://www.wildlife.ca.gov/Data/GIS">https://www.wildlife.ca.gov/Data/GIS</a></td>
</tr>
<tr>
<td>5. NATIONAL PARKS &amp; RESERVES</td>
<td>California Protected Areas Database <a href="http://www.calands.org/data">http://www.calands.org/data</a></td>
</tr>
</tbody>
</table>
Model Development

1. Decision rule example for fatality locations

   • Assumptions
     - Average EMS speed = 70 mph
     - No delays

   • EMS arrival target = 10 mins

   • Implies that areas within a maximum distance of 6,160 ft. of a fatal crash site will be potential candidates for the location of EMS services.
## Model Development

<table>
<thead>
<tr>
<th>Decision Rules</th>
<th>Influence or weights (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close to fatality locations (within 6160 ft. radius)</td>
<td>30</td>
</tr>
<tr>
<td>Far from existing hospitals (≥ 6160 ft.)</td>
<td>30</td>
</tr>
<tr>
<td>Away from protected land areas (≥ 1000 ft.)</td>
<td>20</td>
</tr>
<tr>
<td>Close to rest stop areas (≤ 6160 ft.)</td>
<td>15</td>
</tr>
<tr>
<td>Away from lakes (≥ 1000 ft.)</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>
Weighted Linear Approach

1. The cells in each of the raster map are reclassified with scores from 1 to 4.

2. The score is used to rank raster cells with regards to the level of relevance. The value of 1 is the least suitable and 4 is the most suitable.
Weighted Linear Approach

\[(3 \times 0.3) + (4 \times 0.3) + (4 \times 0.4) = 3.7.\]
This is rounded up to ‘4’
1. Input layers

2. Create distance measure maps

3. Reclassify maps using scores

4. Combine maps using weightings
GIS MODEL RESULTS
SUITEABLE SITES BASED ON FATALITY
LOCATIONS

SUITEABLE SITES BASED ON HOSPITAL
LOCATIONS

NOT SUITABLE
SUITABLE
COUNTY

NOT SUITABLE
MODERATE
HIGH
VERY HIGH
COUNTY
Raster Maps

SUITABLE SITES BASED ON REST STOP LOCATIONS

- NOT SUITABLE
- SUITABLE
- COUNTY

SUITABLE SITES BASED ON PROTECTED LAND

- NOT SUITABLE
- SUITABLE
- COUNTY
Combined Map

Combined Map

- Out of 155,779 square miles of land area studied
  - 24% were classified as suitable,
  - 7% as moderately suitable, and
  - 69% as unsuitable for EMS locations.
Combined Map

- It was found that -
  1. The west side freeway corridor in California contains the largest size of suitable areas for rural EMS services.
  2. Scattered coastal and southern regions also show high suitability.
Northern region

Colusa County

Sutter County

Yolo County
Central

San Joaquin County

Stanislaus County

Merced County
Concluding Remarks
Concluding Remarks

- Geospatial modeling with GIS MCA using the weighted linear combination approach was demonstrated to have the potential to use in road safety management.

- The illustration of the approach is the first planning step for traffic incident management decision makers.
Recommendations

- Acquiring expert opinion can be used in future research to accurately predict the weightings of the factors.

- Future studies should consider additional factors such as earthquake susceptibility areas, fire prone locations, suitable soil, slopes, and access roads.
Recommendations

Second Step

- Detailing specific locations and optimization
  - A benefit-cost analysis is recommended in future studies to determine the suitability of specific sites within the identified counties
  - Spatial statistical analysis can be used to estimate the potential fatalities that could be reduced using this methodology.
Acknowledgement

- Co-authors -

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  - The content reflect the views of the authors and are not necessarily representative of the state of California or any local agencies

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- IHEEP President – Jon Starr & Team
  - Initial comments
THANK YOU