Spatial Analysis on Environmental Justice in Los Angeles County

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Why Environmental Justice (EJ)

• Integrate the principles of Environmental Justice into SCAG’s transportation plan
  – Low-income and minority communities should have ample opportunity to participate in transportation decisions
  – They should receive an equitable distribution of benefits and not a disproportionate share of burdens
Legal Background of EJ

– **Title VI**
  - Avoid, minimize, or mitigate adverse effects, on sensitive population
  - Ensure the participation by all in the transportation decision-making process

– **SB 535 (Greenhouse Gas-Reduction Investments to Benefit Disadvantaged Communities)**
  - Requires Cal/EPA to identify disadvantaged communities
  - Requires that at least 10 percent of the available moneys must be directly allocated in disadvantaged communities
Research Goals

• Identification of areas with Environmental Justice (EJ) concerns in Los Angeles county
  – Focusing on air quality
  – Unit of Analysis = Census Tract

• Analysis on transportation and land use contributing factors to the EJ areas
## Identification of EJ Areas

- Quantifying and aggregating 4 aspects of EJ by Census Tract

<table>
<thead>
<tr>
<th>Variables</th>
<th>Source of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air quality</strong></td>
<td></td>
</tr>
<tr>
<td>Particulate Matter 2.5 (PM 2.5)</td>
<td>CalEnviroScreen (PM 2.5, DPM, &amp; Ozone)</td>
</tr>
<tr>
<td>Diesel Particulate Matter (DPM)</td>
<td>SCAG (PM 2.5, CO₁, CO₂, &amp; Nitrogen)</td>
</tr>
<tr>
<td>Ozone, CO₁, CO₂, Nitrogen</td>
<td></td>
</tr>
<tr>
<td><strong>Sensitive population</strong></td>
<td></td>
</tr>
<tr>
<td>Minority Population, Persons below Poverty</td>
<td>U.S. Census (2013 ACS 5-yr. Est.)</td>
</tr>
<tr>
<td>Senior Population, Child Population, Renters</td>
<td></td>
</tr>
<tr>
<td>Educational Attainment</td>
<td></td>
</tr>
<tr>
<td>Unemployed Population</td>
<td></td>
</tr>
<tr>
<td>Population without an Automobile</td>
<td></td>
</tr>
<tr>
<td><strong>Public health</strong></td>
<td></td>
</tr>
<tr>
<td>Low Birth Weight</td>
<td>CalEnviroScreen 2.0</td>
</tr>
<tr>
<td>Asthma-related Emergency Visits</td>
<td>California Department of Public Health (CDPH)</td>
</tr>
<tr>
<td>Women, Infant, and Children (WIC) Vendors</td>
<td></td>
</tr>
<tr>
<td><strong>Environmental nuisance</strong></td>
<td></td>
</tr>
<tr>
<td>Solid Waste Facilities, Superfund Sites</td>
<td></td>
</tr>
<tr>
<td>Clean-Up Sites</td>
<td></td>
</tr>
</tbody>
</table>
Air Quality Variables and Score

- PM 2.5 (EnviroScreen)
- Diesel PM
- Ozone
- PM 2.5 (SCAG)
- CO$_1$
- CO$_2$
- Nitrogen

Air Quality Score
Sensitive Population Variables and Score

- Minority
- Poverty
- Senior
- Child
- Renters
- Education
- Unemployment
- No Automobile

Sensitive Pop. Score
PH & EN Variables and Score

- WIC Vendors
- Asthma
- Low Birth Weight
- Solid Waste
- Clean-up
- Superfund

PH & EN Score
Identification of EJ Areas

• Identifying the areas with the concentration of high score by conducting spatial cluster analysis (Getis-Ord Gi*)
Identification of EJ Areas

- Air quality Score
- Sensitive population Score
- PH & EN Score

Cluster areas

Spatial Cluster Analysis

Overlaying

EJ areas

Air Quality
Sensitive Population
PH & EN

ESRI UC 2015
Map of EJ Areas

256 Census Tracts out of 2,343
Analysis of Contributing Factors

• Analysis of factors that potentially associate with EJ areas in these physical aspects
  – Transportation
  – Land Use

• Quantifying a variety of variables by Census Tract using GIS analysis

• Identifying the potential contributing factors by conducting statistical analysis
  – T-Test
  – Logistic Regression
Analysis of Transportation Factors

• Variables analyzed
  – Highway/Roadway
    • Roadway lane mile
    • Highway land mile
    • Automobile speed
  – Public Transit
    • TOD stations (Y/N)
    • Transit stations (Y/N)
    • Bus stop density
  – Active Transportation
    • Bicycle facility density
    • Bicycle collision density
    • Intersection density
  – Railroad
    • Freight rail distance

• Data sources
  – SCAG
  – NTAD
  – LA Metro
Highway/Roadway Factors

- Highway Lane Miles
- Roadway Lane Miles
- Automobile Speed

Linear Density Analysis

ESRI UC 2015
Public Transit Factors

- Within 0.5 Mile from Transit Stations
- Within 0.5 Mile from TOD Stations
- Bus Stops

Buffer Analysis

Point Density Analysis

ESRI UC 2015
Active Transportation Factors

- Intersection
- Bicycle Facility
- Bicycle Collision

Point Density Analysis
Linear Density Analysis
Point Density Analysis

ESRI UC 2015
Railway Factor

Weighted Distance From Freight

Weighted Distance Analysis
### T-Test and Logistic Regression Output

#### Logit

<table>
<thead>
<tr>
<th>Methods</th>
<th>Coef.</th>
<th>S.E.</th>
<th>Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-5.840</td>
<td>1.257</td>
<td>0.003</td>
</tr>
<tr>
<td>TOD (Y=1, N =0)</td>
<td>0.369</td>
<td>0.403</td>
<td>1.446</td>
</tr>
<tr>
<td>Transit (Y=1, N =0)</td>
<td>***-1.054</td>
<td>0.180</td>
<td>0.348</td>
</tr>
<tr>
<td>Freight Rail</td>
<td>***-0.001</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Bus Stop</td>
<td>***0.002</td>
<td>0.000</td>
<td>1.002</td>
</tr>
<tr>
<td>Bike Route</td>
<td>-0.056</td>
<td>0.045</td>
<td>0.946</td>
</tr>
<tr>
<td>Bike Crash</td>
<td>***3.908</td>
<td>0.718</td>
<td>49.822</td>
</tr>
<tr>
<td>Highway</td>
<td>-5.129</td>
<td>6.451</td>
<td>0.006</td>
</tr>
<tr>
<td>Roadway</td>
<td>-2.657</td>
<td>3.800</td>
<td>0.070</td>
</tr>
<tr>
<td>Speed Limit</td>
<td>***0.096</td>
<td>0.032</td>
<td>1.100</td>
</tr>
<tr>
<td>Intersection</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Cox & Snell $R^2$: 0.398

#### T-Test

<table>
<thead>
<tr>
<th>Methods</th>
<th>EJ Areas (Mean)</th>
<th>Non EJ Areas (Mean)</th>
<th>T-Stat.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TOD (Y=1, N =0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Transit (Y=1, N =0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Freight Rail</td>
<td>6584.473</td>
<td>11652.534</td>
<td>***-11.268</td>
</tr>
<tr>
<td>Bus Stop</td>
<td>812.763</td>
<td>246.736</td>
<td>***9.031</td>
</tr>
<tr>
<td>Bike Route</td>
<td>1.620</td>
<td>1.390</td>
<td>1.621</td>
</tr>
<tr>
<td>Bike Crash</td>
<td>0.218</td>
<td>0.081</td>
<td>***1.969</td>
</tr>
<tr>
<td>Highway</td>
<td>0.021</td>
<td>0.010</td>
<td>***1.968</td>
</tr>
<tr>
<td>Roadway</td>
<td>0.086</td>
<td>0.079</td>
<td>***1.967</td>
</tr>
<tr>
<td>Speed Limit</td>
<td>36.489</td>
<td>33.681</td>
<td>***1.968</td>
</tr>
<tr>
<td>Intersection</td>
<td>1.59</td>
<td>1.081</td>
<td>***1.968</td>
</tr>
</tbody>
</table>

* *, **, *** Correlations are significant at the 0.10, 0.05, and 0.01 levels, respectively (2-tailed)

The variable, Intersection, was excluded from the logit regression due to its' multicollinearity.
Summary of Findings

- Logistic regression shows notable differences between bus stops and distance to freight rail.
- TOD's have no relationship with EJ areas.
- Surprisingly, there is no correlation of the EJ areas with highway and roadway features.
Analysis of Land Use Factors

- Variables analyzed
  - Residential
    - Multi-family residential
    - Single family pervious surface
  - Non-residential
    - Industrial
    - Retail
    - Office
    - Open space

- Data sources
  - SCAG
  - LA County GIS Portal
Residential Factors

Multi-Family Residential

SF Pervious Surface

Building Density Analysis

Property Area – Building Footprint
Non-Residential Factors

Building Density Analysis

Property Density Analysis

Office

Retail

Industrial

Open Space
## T-test and Logistic Regression Outputs

### Variables

<table>
<thead>
<tr>
<th>Method</th>
<th>EJ Areas (Mean)</th>
<th>Non EJ Areas (Mean)</th>
<th>T-Stat.</th>
<th>Coef.</th>
<th>S.E.</th>
<th>Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.819</td>
<td>-0.121</td>
<td><strong>-1.090</strong></td>
<td>-0.819</td>
<td>0.121</td>
<td>0.441</td>
</tr>
<tr>
<td>Industrial</td>
<td>0.114</td>
<td>0.101</td>
<td>1.436</td>
<td><strong>-1.090</strong></td>
<td>0.545</td>
<td>0.336</td>
</tr>
<tr>
<td>Multi-Family</td>
<td>1.587</td>
<td>1.362</td>
<td><strong>-0.722</strong></td>
<td>0.328</td>
<td>0.486</td>
<td></td>
</tr>
<tr>
<td>Office</td>
<td>0.196</td>
<td>0.054</td>
<td><strong>-2.781</strong></td>
<td>0.297</td>
<td>0.185</td>
<td>1.340</td>
</tr>
<tr>
<td>Open Space</td>
<td>0.034</td>
<td>0.054</td>
<td><strong>-2.747</strong></td>
<td>-0.798</td>
<td>0.654</td>
<td>0.450</td>
</tr>
<tr>
<td>Pervious Surface</td>
<td>12.037</td>
<td>63.699</td>
<td><strong>-0.040</strong></td>
<td>0.003</td>
<td>0.961</td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td>0.107</td>
<td>0.042</td>
<td><strong>1.763</strong></td>
<td>0.491</td>
<td>5.828</td>
<td></td>
</tr>
</tbody>
</table>

### Cox & Snell R²

- 0.138

* , ** , *** Correlations are significant at the 0.10, 0.05, and 0.01 levels, respectively (2-tailed)
Summary of Findings

• The relationship between EJ factors and Land-use analysis is not as transparent as anticipated.
  – Industrial land-use is not found to be significant.
  – Pervious surface and retail show consistent results among statistical models.
Conclusion & Discussion

• The contribution of the transportation factors to the EJ areas is identified, while that of the land use remains unanswered.

• Public transit, particularly bus, serves the EJ areas appropriately, but it may cause public health and safety concerns.

• The unclear relationship between land use and EJ may caused by the spatial segregation between residential land use and non-residential land use.

• Future studies should properly address issues with the unit of analysis (Census Tract)