Using Spatial Analysis to Influence Decision Making for Reaching Limited Resource Audiences

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Presented by:
Noel M. Estwick & Nelson T. Daniels
Outline

• Introduction & Background
• Objectives
• Study Area
• Method
• Results and Discussion
• Conclusion
• Recommendations
Introduction & Background

- The Texas Gulf Coast Region is prone to hurricanes and other disasters
  - Hurricanes Katrina and Rita (2005), hurricane Ike (2008)
- In addition to becoming more diverse, the Houston region received an influx of residents post hurricane Katrina
- Houston Texas population is expected to be 75% minority by 2050 (Tameez, 2014)
- For decades it has been accepted that limited resource audiences are poor, most likely receive public assistance, have single or teenage parents as head or household (Couchman, Williams & Cadwalader, 1994)
- South Dakota State University Extension describes limited resource audiences as those with pregnant women, families with young children under 18 years old, pregnant and parenting teens and school age children between 5 and 19 years old (Wilson-Sweebe, 2014)
Past PVAMU Disaster Education Programs

A series of Disaster Education Programs were held on the PVAMU Campus. These programs focused on university employees and individuals in the local area surrounding the university. These programs included:

• Hurricane Preparedness with the meteorologist from KBTX-TV as guest speaker
• Emergency Preparation Kit Development
• Animal Safety in Emergency Situations – Livestock and Companion animals
• Food Safety following a disaster
• Communications during and after a disaster
• Developing an emergency evacuation plan
Disaster Preparedness activities conducted by the County Extension Staff in Waller and Harris County include meeting with officials in the county to catalog the following in case of an emergency:

- Fire Departments – Urban Areas
- Volunteer Fire Departments – Rural Areas
- Location of Hospitals and other medical facilities
- Location of various Emergency Medical Services (EMS)
- County and City Law Enforcement Centers
- Potential areas use as Disaster Relief Centers
- Agency and Organizations such as Red Cross to assist in case of an emergency
- Areas that can be used as animal shelters
- Resources to assist with livestock rescue, retention and maintenance
Objectives

• Better understand where PVAMU clientele are located in the study area
• Define the limited resource audience PVAMU serves within the context of disaster preparedness
• Identify clusters where high percentages of the various population groups exist in the study area
Four Phases of Emergency Management

Mitigation → Preparedness → Response → Recovery

Source: Godschalk, 1991
Study Area

Harris County
- 2013 population estimate- 4,336,853
- % population change from April 1, 2010 to July 1, 2013, 6%
- Black or African American alone population in 2013, 19.5%
- Hispanics or Latino in 2013, 41.6%

Waller County
- 2013 population estimate- 45,123
- % population change from April 1, 2010 to July 1, 2013, 4.6%
- Black or African American alone population in 2013, 25.8%
- Hispanics or Latino in 2013, 29.5%

Source: U.S. census
Null hypothesis

- There is complete spatial randomness of the values
Method

• The geographic approach was adopted
  – Pose a question, model and compute, explore and interpret results, decide, share results
• The software utilized was esri ArcGIS 10.1
• Spatial autocorrelation (Moran’s I)
  – Measure whether similar values are clustered or dispersed

\[ I = \frac{n}{S_0} \sum_{i=1}^{n} \sum_{j=1}^{n} w_{i,j} z_i z_j \]  (1)

\[ S_0 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{i,j} \]  (2)

Where \( z_j \) is the deviation of an attribute for feature \( i \), \( w_{ij} \) is the spatial weight feature \( i \) and \( j \), and \( n \) is the total number of features, and \( S_0 \) is the aggregate of all spatial weights.

The \( z_I \) score for the statistic is computed as

\[ z_I = \frac{I - E[I]}{\sqrt{V[I]}} \]  (3)

Where

\[ E[I] = -1/(n - 1) \]  (4)

\[ V[I] = E[I^2] - E[I]^2 \]  (5)

Source: esri, 2012a
G-statistic

- **G-statistic (Getis-Ord Gi*)**
  - Indicates whether hot spots or cold spots are in the study area

\[ G_i^* = \frac{\sum_{j=1}^{n} w_{i,j} x_j - \bar{X} \sum_{j=1}^{n} w_{i,j}}{S \sqrt{n \sum_{j=1}^{n} w_{i,j}^2 - \left( \sum_{j=1}^{n} w_{i,j} \right)^2}} \]  

\[ \bar{X} = \frac{\sum_{j=1}^{n} x_j}{n} \]  

\[ S = \sqrt{\frac{1}{n} \sum_{j=1}^{n} x_j^2 - (\bar{X})^2} \]  

Where \( x_j \) is the attribute values for feature \( j \), \( w_{ij} \) is the spatial weight between feature \( i \) and \( j \), and \( n \) is the total number of features.

Source: esri, 2012b
Data & Variables

• U.S. Census 2010 data at the census tract level was analyzed

• The variables selected were:
  – % of all families below the poverty line with children under 18 years of age
  – % of population enrolled in public school, kindergarten to 12th grade
  – % female householder, below poverty line, no husband present with children under 18 years old
  – % educational attainment 9th to 12th grade with no diploma
  – % of families with children under 18 years of age
Limitations

• In some cases no data was available for some census tracts
• The distance band selected can impact the Moran’s I results
• Features near the edge of the study area will normally have fewer neighbors
Results & Discussion

• The Moran’s I results reveal that the features exhibit clustering
• The hot spot analysis (Getis-Ord Gi*) results show statistically significant clusters of families below the poverty line
• The statistically significant clusters indicate potential disaster education areas
% of all Families Below Poverty Line
Global Moran’s I

Graph of Poverty z scores

Determining the Distance Band
Global Moran’s I Report

Spatial Autocorrelation Report

Moran’s Index: 0.437769
z-score: 26.224891
p-value: 0.000000

Given the z-score of 26.22, there is a less than 1% likelihood that this clustered pattern could be the result of random change.

Global Moran’s I Summary

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Moran’s Index</td>
<td>0.437769</td>
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<tr>
<td>Expected Index</td>
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<tr>
<td>Variance</td>
<td>0.0000280</td>
</tr>
<tr>
<td>z-score</td>
<td>26.224891</td>
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<tr>
<td>p-value</td>
<td>0.000000</td>
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</table>

Dataset Information

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<th>Input Feature Class</th>
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<td>Conceptualization</td>
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<tr>
<td>Selection Set</td>
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</tr>
</tbody>
</table>
Hotspot Analysis for All Families Below Poverty Line
Exploring the Gi* Results
## Statistical Hot Spots Listed by ISD

<table>
<thead>
<tr>
<th>Variable</th>
<th>Target Independent School District (ISD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of all families below poverty line with children under 18 years of age</td>
<td>Alief, Houston, Pasadena, North Forest, Aldine, Spring</td>
</tr>
<tr>
<td>% population enrolled in public school, kindergarten to 12th grade</td>
<td>Pasadena, Aldine</td>
</tr>
<tr>
<td>% Female householder, below poverty line, no husband present with children under 18 years old</td>
<td>Alief, Pasadena, Galena Park, Houston, Spring Branch, Aldine, North Forest</td>
</tr>
<tr>
<td>% Educational attainment 9th to 12th grade with no diploma</td>
<td>Houston, Pasadena, Deer Park, Galena Park, Channelview, Sheldon, North Forest, Humble, Aldine, Spring, Klein, Cypress</td>
</tr>
<tr>
<td>% of families with children under 18 years old</td>
<td>Tomball, Cypress Fairbanks, Klein, Spring, Aldine, Katy, Waller, Humble, North Forest, Sheldon, Galena Park, Channel View, Deer Park, Pasadena, Royal</td>
</tr>
</tbody>
</table>
Median Income

Legend
VC03
- 0.00 - 14,773.00
- 14,773.01 - 28,581.00
- 28,581.01 - 37,817.00
- 37,817.01 - 47,886.00
- 47,886.01 - 60,586.00
- 60,586.01 - 75,269.00
- 75,269.01 - 95,389.00
- 95,389.01 - 121,250.00
- 121,250.01 - 158,750.00
- 158,750.01 - 214,861.00
Conclusion

• Will help us provide targeted community based disaster education programs that meet the needs of PVAMU Extension clientele

• Assist with the location of disaster resources (in both the preparation and response phases) and improve decision making
Recommendations

• Extension should collaborate with schools within the respective ISDs to develop disaster programs

• Develop disaster preparedness programs specific to the clientele identified in this study

• Extend the study into the strike force counties
  – 96 counties in Texas are designated as strike force counties
Mobile Disaster Education
References


Contact Information

• Noel M. Estwick, Ph.D,
  email: nmestwick@pvamu.edu

• Nelson T. Daniels, Ph.D,
  email: ndaniels@ag.tamu.edu
Questions/Comments?