A Profile of Crime in Long Beach Using ArcGIS Spatial Statistics Tools

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Goals of Presentation

• Share my application of ArcGIS tools for crime analysis
  - Working with crime data
  - Crime counts and rates
  - Hotspot analysis
  - Regression analysis
  - Distance between crime-arrestee and crime-victim
Long Beach
Long Beach Demographics (2015)

- **Population**: 471,210
- **Diversity Index**: 87.8
- **Per Capita Income**: $25,807
  - 86% of California per capita income
- **Didn’t Finish High School**: 9.0%
  - 110% of California’s rate
- **Bachelor’s Degree**: 18.6%
  - Same as California
- **Renter Occupied Housing Units**: 56%
  - 132% of California’s rate

**Data source**: Esri Business Analyst
Crime Data

- Long Beach Police Department
  - 2010-2014

- Included:
  - Crime type
  - Crime location by address
  - Arrestee/Citee by address
  - Victim by address
Crime Data: Geocoding

• Tip #1:

  • Use ArcGIS Desktop to geocode first.
  • Then use ArcGIS Online for the rest.
    - Save credits that way.
Crime Data: Geocoding

- Tip #2

- With crimes, and addresses of people...
  - Remove/recode points from police station and police substations.
  - Remove/recode points that geocode to zip code centroid.
Hotspot Analysis

• Consider Scale.
  - Block, neighborhood, city, or regional patterns?

  - 1. Determine your units of analysis
    - Fishnet grid, census block groups, census tracts...

  - 2. Determine your Distance Band
    - Larger band = broader patterns
    - Smaller band = local patterns
Hotspot Analysis: Effect of Distance Threshold

- Robbery Rate
  - 3000’ distance threshold vs. 12,000’ distance threshold
  - Both are statistically valid
Hotspot Analysis: Counts vs. Rates

• Crime counts
  - Useful for patrol officers and commanders.
  - Where are the crimes and where do I need more officers?

• Crime rates
  - Useful for researchers and policymakers.
  - Control for population size/housing units.
  - Where are a higher proportion of people involved in crimes?
Hotspot Analysis: Counts

- Interested in local scale.
- Create Fishnet tool.
  - 500’ grid
  - Based on location of all crimes.
    - Represents location of all possible crimes (excludes rivers and other non-populated places)
Hotspot Analysis: Process

- Use Model Builder
  - Select crime type for each year
  - Spatial Join with fishnet
  - Hotspot Analysis *(CONTIGUITY_EDGES_CORNERS)*
  - Directional Distribution
Hotspot Analysis: Residential Burglaries (Count)

- Shows localized hotspots
- Where patrols are most needed.
- Higher density areas
  - Downtown
  - Belmont Shores
  - North LB
Directional Distribution of Hotspot Analysis (Residential Burglary)

- Directional Distribution tool.

- Visualize changing spatial patterns.

- Ran hotspots for each year 2010 to 2014

- 1 Standard Deviation (68%) of weighted values (Gi_Bin)

- Very consistent pattern
  - Except 2011
Directional Distribution of Hotspot Analysis (Street Assault/Battery and Street Robbery)

- Assault/Battery (left) – shifting focus on downtown
- Robbery (right) – increasing focus on downtown.
Hotspot Analysis by Police Patrol District

• Within each patrol district, where should officers spend more time?

• Hotspot analysis compares mean of search window to mean of study area.

• Different mean in each patrol district.
Hotspot Analysis by Police Patrol District

- Robbery (left) and Burglary (right)
- Narrows hotspots around downtown
- Expands hotspots around east LB
Hotspot Analysis: Rates

- Based on US Census Block Groups
- American Community Survey data (5 yr.)
  - Comes at block group level
- Most rates based on population.
- Burglary rates based on housing units.
- Wanted “neighborhood” scale.
  - 3000 foot distance threshold
  - Based on larger block groups in east
Hotspot Analysis: Residential Burglaries (Rate)

- Downtown and Belmont Shores hotspots disappear.

- Lower income North LB is hotspot.

- Higher income Eastern LB is cold spot.
Residential Burglaries: North LB Hot Spot
Residential Burglaries: East LB Cold Spot
Hotspot Analysis: Assault/Battery and Robbery (Rate)

- Assault/Battery (left), Robbery (right)
- Clearly around downtown.
Assault/Battery and Robbery: Downtown

- Commercial and pedestrian activity.
- Pine St.
- Anaheim St. and PCH.
Regression Analysis

- Test Social Disorganization Theory
  - Shaw and Mckay (1940s-60s)
    - Crime is place specific.
    - Lack of social controls to guide personal behavior due to neighborhood instability.
    - Measured arrest rate vs. poverty, ethnic heterogeneity, and population turnover.
Regression Analysis

- **My dependent variable**
  - Arrest/Citation Rate

- **My independent variables (from ACS 5 yr. Block Groups)**
  - Percent less than high school
  - Percent unemployment
  - Diversity Index
  - Percent poverty
  - Year of residence
  - Percent households with over 1 person per room
  - Percent vacant housing units
  - Percent renters
  - Percent speaking English only
  - Per capita income
  - Percent of single mothers
  - Distance from crime hotspots
  - Percent using public transit
Regression Analysis

- Exploratory Regression tool.
  - Great Esri documentation.
    - Interpreting Exploratory Regression Results
    - What they don't tell you about regression analysis

- Could not get passing models.
  - Failing Jarque-Bera test.
  - Looked at histograms.
  - Log transformed variables if they were skewed (not normally distributed)
  - Removed 11% of block groups with zero people arrested.
Regression Analysis

- **Exploratory Regression**
  - After working with data—multiple passing models
  - Selected model based on
    - Simplicity (fewer variables are better)
    - Match with theory (didn’t select distance-to-crime-hotspot)
    - R2 (higher) and AICc (lower)
Regression Analysis

- **Ordinary Least Squares Regression tool**

  - **Dependent variable**
    - Log Arrest/Citation

  - **Independent variables (with coefficients)**
    - Percent Renter (+0.681307)
    - Percent English Only (-0.714586)
    - Log Percent Poverty (+0.152645)
    - Log Per Capita Income (-0.370633)

  - **Adjusted R2 of 0.55**
Regression Analysis: Interpretation

- Arrest/Citation rates increase as block groups have
  - Higher rates of poverty
  - Larger percentage of rental housing
  - Lower rates of English speaking
  - Lower per capita incomes

- Supports Social Disorganization theory.
  - Shaw and Mckay
    - Poverty
    - Ethnic heterogeneity
    - Population turnover.
Regression Analysis: Interpretation

- Adjusted R2 of 0.55

- Still missing about 50% of explanatory power.

- Missing variables that can influence arrest rates?
  - Gang membership rate
  - Racial profiling
  - Police deployment patterns
  - Other?
Regression Analysis: Policy Implications

• Reduce Social Disorganization
  - Population turnover (stability with knowing neighbors).
    - First time homeowner assistance.
  - Ethnic heterogeneity (lack of integration/communication with neighbors/authorities)
    - Expand ESL for adults/children
    - More multilingual public services.

• Economic condition
  - Upgrade skills/job training
  - Employment programs
Distance: Arrestee to Crime and Victim to Crime

- Test Crime Pattern Theory
  - Crimes occur in activity space of individuals.
  - Overlap of perpetrators and victims in spatial context.
    - Within neighborhoods
    - Commercial areas
    - Entertainment areas
    - Downtown
    - Etc.
  - Criminals work in places they are familiar with.
Distance: Arrestee to Crime and Victim to Crime

- Add XY fields to geocoded points for peoples’ addresses.

- Add XY fields to geocoded points for crimes.

- JOIN people and crime layers based on a crime ID field.

- XY to Line tool
  - Get length field
Distance: Arrestee to Crime

- **Assault/Battery:**
  - 33% same address
  - 43% within 500’

- **Robbery**
  - 23% within 1500’
  - 37% within 3000’
  - 52% within 1 mile
Distance: Arrestee to Crime

- **Burglary**
  - 35% within 3000 feet
  - 47% within 1 mile
Distance: Victim to Crime

- **Assault/Battery**
  - 37% same address
  - 50% within 500’
  - Similar to arrestees

- **Robbery**
  - 43% within 1500’
  - 58% within 3000’
  - 69% within 1 mile
  - Closer than arrestees
Distance: Arrestee to Crime and Victim to Crime

• Classic distance decay patterns
  - People move more within places close to home.

• Supports Crime Patterns Theory
  - Overlapping activity spaces in local areas
    - Neighborhood streets
    - Neighborhood shopping areas
    - Neighborhood entertainment

• Policy Implications
  - Crime prevention education
  - More community watch (less social disorganization)
Conclusion

- Take care with geocoding.
- Think about your scale of analysis with hotspots.
- Use theory to guide regression analysis.
- **Exploratory Regression tool to find valid models.**
  - Careful with non-normal distributions!
- **Run OLS Regression with final model.**
- **Use XY to Line tool to see spatial relationships between arrestees/victims/crime location**

- **Special thanks to**
  - [Rethinking Greater Long Beach](http://www.rethinkinggreaterlongbeach.com)