Introduction to spatial analysis

Stacy E. Woods, MPH

JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

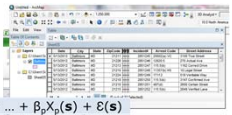
Outline

- What is spatial analysis?
  - Spatial data, GIS, spatial statistics
- What are some concerns with spatial analysis?
- How can spatial analysis inform education, outreach, and policy?

An overview of how spatial analysis harnesses location information to improve analysis and communicate results

What is spatial analysis?

- Investigation of data tagged with **location**
- 3 components:
  - Spatial data
  - GIS
  - Spatial statistics



$$Y(\mathbf{s}) = \beta_0 + \beta_1 X_1(\mathbf{s}) + \ldots + \beta_p X_p(\mathbf{s}) + \varepsilon(\mathbf{s})$$

$\mathbf{s}$: Location
$Y(\mathbf{s})$: Outcome at location s
$X_p(\mathbf{s})$: Covariate at location s
$\varepsilon(\mathbf{s}) \sim N(\mathbf{0}, \boldsymbol{\Sigma})$, spatially correlated

Curriero (2013)

Spatial data

Data tagged with a location

Why collect spatial data?

- ➢ To study spatial variation in risk
- ➢ Location can serve as an information gateway / proxy for unmeasured factors
  - Environmental
  - Social
  - Demographic
- ➢ Proximity to risk factors

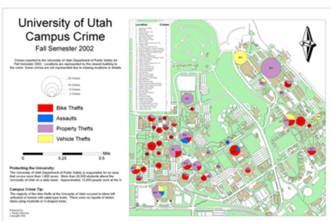
Incident#	Date	Arrest Code	Street Address	City	State	ZipCode
2851245	5/13/2012	20002(a) VC	3100 True Street	Baltimore	MD	21211
2851246	5/13/2012	12020.5	270 Actual Ave	Baltimore	MD	21226
2851247	5/13/2012	115.5(b)	1162 Correct Drive	Baltimore	MD	21213
2851248	5/13/2012	11357(b) HS	18 Legal Street	Baltimore	MD	21210
2851249	5/13/2012	[illegible]	519 Veritable Way	Baltimore	MD	21224
2851250	5/13/2012	115.5(b)	3147 Confirmed Ave	Baltimore	MD	21218
2851251	5/13/2012	487(a)	2600 Certain Street	Baltimore	MD	21210
2851252	5/13/2012	115.5(b)	2649 Verified Lane	Baltimore	MD	21215

Curriero (2013)

Types of spatial data

Point pattern data: Locations are the data

Where do events occur?



Hancock (2002)

Types of spatial data

Geostatistical data: Data is tagged with location

Where have we measured?

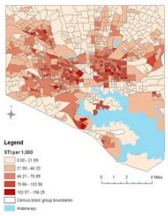
Monitored Ozone 2007

Berman (2012)

Types of spatial data

Spatial area level data: Data is aggregated to an area unit

How many events occur in a given area?



Jennings et al (2013)

How to aggregate data?

Any way you can!

By legislative district

By City Council district

By census tract

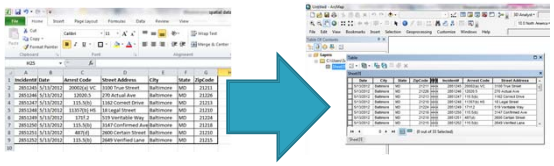
ESRI (2013)

Storing / viewing spatial data: GIS

- Input into Geographic Information Systems (GIS)
  - Database for spatial data
  - Examples: ArcGIS (ESRI), MapInfo (Pitney Bowes), IGiS (ScanPoint Geomatics Ltd.)
- Allows user to combine multiple layers of information into a single product which is usually a visual map

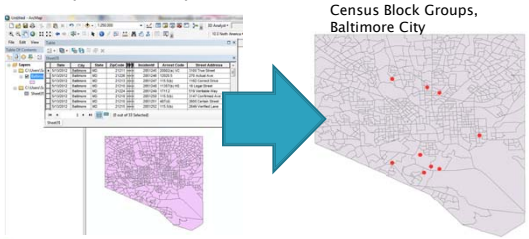
Why use GIS?

To store, organize data



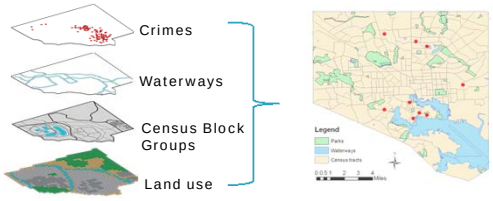
Why use GIS?

To produce maps



Why use GIS?

To generate/refine hypotheses by adding additional spatial data

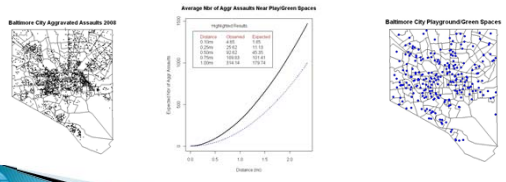


Did crimes occur close to parks in Baltimore?

Curriero (2013)

Analyzing spatial data: Spatial statistics

- Going “beyond the map” to investigate and evaluate spatial data
- Example: To investigate large scale trends



Curriero (2013)

Analyzing spatial data: Spatial statistics

- Going “beyond the map” to investigate and evaluate spatial data
- Examples: To evaluate “hotspots”

Significant cluster of Lyme disease cases in Howard County area, Maryland 2008 - 2010

(Relative risk = 1.95, p<0.001)

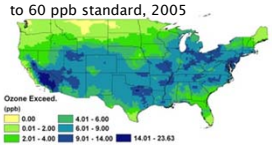
Woods (2011)

Analyzing spatial data: Spatial statistics

- Going “beyond the map” to investigate and evaluate spatial data
- Example: To predict risk at unsampled locations

Monitored ozone

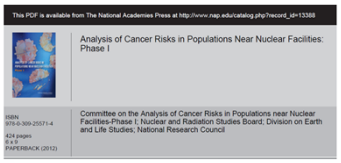
Predicted ozone exceedance relative to 60 ppb standard, 2005



Berman (2012)

Analyzing spatial data: Spatial statistics

- Going "beyond the map" to investigate and evaluate spatial data
- Example: To evaluate sources of interest



Curriero (2013)

Spatial statistics resources

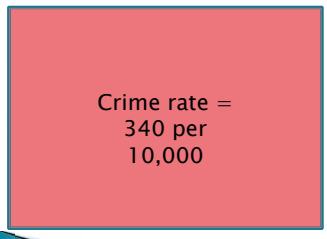
- Textbooks
  - Waller, L. A. and Gotway, C. A. 2004. Applied spatial statistics for public health data. – Wiley.
  - Schabenberge, O. and Gotway, C. A. 2005. Statistical Methods for Spatial Data Analysis. – Chapman & Hall
- Statistical programs
  - R
  - SAS
  - STATA

Proceed with caution!

- Confidentiality

Proceed with caution!

- Modifiable area unit



City Population

City crime incidents

Proceed with caution!

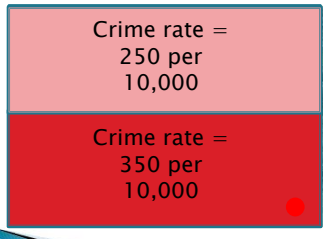
- Modifiable area unit

Population by census tract

Crime by census tract

Proceed with caution!

- Modifiable area unit



Population by school district

Crime by school district

Proceed with caution!

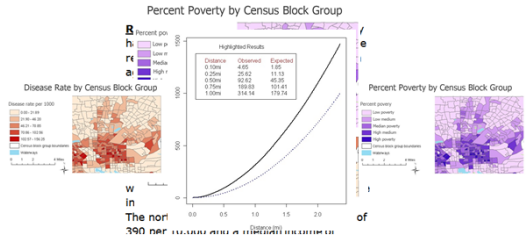
- Modifiable area unit

THE AGGREGATION SCHEME MATTERS!

Maps illustrate the story,

But you tell the story

How can spatial analysis inform education, outreach, and policy?



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- Hancock, JR (2002). University of Utah Campus Crime. Image via http://www.gisanalyst.org/projects_maps.htm (Accessed 5/23/2013)
- Curriero, FC (2013). Spatial Analysis and GIS I and II. Classes taught at the Johns Hopkins Bloomberg School of Public Health.
- Woods, SE (2011). Spatial analysis of Lyme disease incidence in Howard County, Maryland. Poster presented at American Public Health Association Annual Meeting and Exposition, November 1, 2011.
- Jennings, JJ; Woods, SE; Curriero, FC. The spatial and temporal impact of neighborhood drug markets on rates of sexually transmitted infections in an urban setting. *Health and Place*. Publication pending.
- ESRI (2013). ArcGIS Census Demographics: Baltimore. Interactive Map accessed 5/24/2013 via http://www.baltimorecity.gov/Government/AgenciesDepartments/Planning/2010Census.aspx

Thank you!

Stacy E. Woods
Department of Environmental Health Sciences
Johns Hopkins Bloomberg School of Public Health
swoods@jhsph.edu

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