

Use of Geographical Information Systems (GIS) in Health Care

For: Center for Global Development

Presenter: Naoru Koizumi, PhD, Assistant Professor
School of Public Policy, George Mason University

Agenda

- GIS overview
- Examples of GIS applications in Health and Other Sectors
- Amit Patel, PhD Candidate
 - A success application of GIS to a health project in India
 - UN Population Fund (UNPF) funded project
- Not too much GIS applications so far in development projects
 - Any potential collaborations?

What is Geographical Information Systems (GIS)?

- GIS is a information system that captures, stores, manages, presents, and analyzes data that is linked to location.
 - **Capturing geographical data**
 - GPS (lon/lat), Remote sensing (satellite images)
 - **Storing and managing geographical data**
 - Databases (e.g., .dbf / .mdb formatted)
 - **Presenting and analyzing geographical data**
 - Mapping software and its extensions
- **First GIS:** Canadian GIS by Roger Tomlinson (British) of the Department of Energy, Mines, and Resources.
- **ArcView by ESRI** is currently the leading GIS software

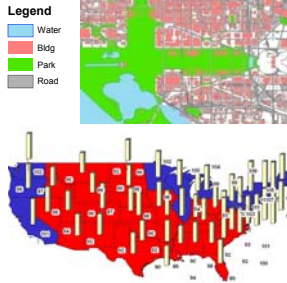
What can GIS do?

- **Can create a fancy map ("spatial data visualization")**
 - by overlaying multiple features
 - by mapping lon/lat (x/y) or addresses ("geocoding")
 - by showing a trend over time and create a movie ("Tracking Analyst" extension)
 - by showing 3D view with rotation ("3D Analyst" extension)
- **Can be used to do advanced spatial statistical analysis (w. potential collaboration with academia)**
- **Can be used to develop policies involving spatial issues (infectious disease, location decisions, transportation, etc.)**

Spatial Data Visualization Overlaying Multiple Features

demo

- **Thematic Map:** A map with multiple features
 - **Choropleth Map:** A map with different features (e.g., pop density, pollution level, etc.) that are colored or patterned in proportion to their sizes.
 - Use of US census file



Spatial Data Visualization Mapping Lon/Lat, Address Data

demo

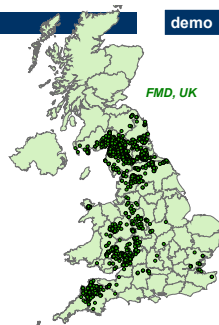
- **Display X/Y Data...**
- **“Geocoding” Embassies on Mass Ave. in DC)**
 - Downloading Tiger files from census/ESRI websites and create “Address Locator”
 - Use of SAS and other GIS software



Spatial Data Visualization Tracking Analyst

demo

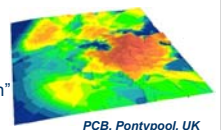
- **Creating a movie with trend data**
 - **Point** data for a time period
 - Spread of diseases (e.g., flu, small pox, FMD)
 - Spread of service users (e.g., peapods, pesticide)
 - **Polygon** data for a time period
 - Change in supply/demand per region, state, etc. (e.g., energy, tobacco sales)



Spatial Data Visualization 3D Analyst

demo

- **Creating a 3D map based on elevation/height data**
 - Map in the ArcScene (or ArcGlobe) platform
 - “Extruding” based on...
 - Building height
 - Land elevation (flooding)
 - Any numerical attribute (pollution)
 - Surface creation
 - Smoothing by “spatial interpolation”

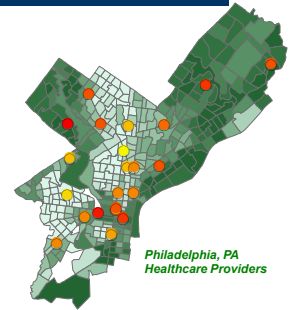


Spatial Data Visualization in Business

- Visualization is a great advantage from GIS to make reporting intuitive
 - A picture is worth 1000 words...(ex. Republican vs. Democrat states)
- Overlays can sometimes reveal several hidden answers
 - Philadelphia mental health outpatient services
 - Hurricane Katrina

Healthcare Provider Quality: OMH, Philadelphia, PA

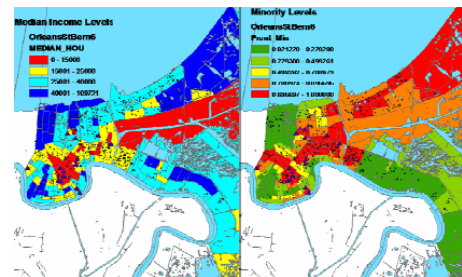
- Outpatient services for mental health patients in Philadelphia, PA
- Does the service quality correlate to the neighborhood demographics?
 - Income?
 - Race composition?



Hurricane Katrina (Cat 5) Aug-05

- Did minority suffer more?
 - "We must ... come to terms with the ugly truth that skin color, age and economics played a deadly role in who survived and who did not." (Howard Dean, chairman of the Democratic Party)
 - "To Me, It Just Seems like Black People are Marked." (Wil Haygood of The Wash Post)
 - "So poor, so black" (Wolf Blitzer of CNN)
 - "5,000 African Americans perishing." (Jesse Jackson)

Did Media Exaggerate???



Evolving Features in ArcGIS

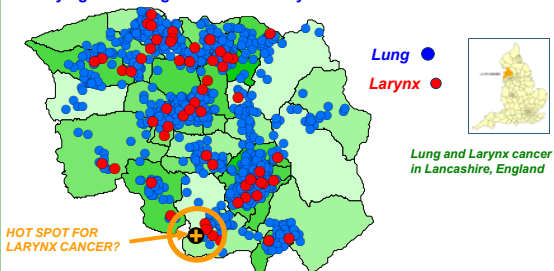
- More Spatial Modeling and Analysis in ArcGIS
 - Area data analysis, spatial regressions
 - Space – time analysis (STAR model)
 - Simulations
- Integration to google map / remote sensing image analysis
- Data sharing and formatting (“Open GIS”)

Spatial Statistical Analysis with GIS

- Point data analysis
 - Clustering / “hot-spot” analysis
 - K-function analysis
- Continuous (surface) data analysis
 - Spatial interpolation
 - Kriging
- Network analysis
 - Correlating traffic volume and air quality, etc.
 - Plume model
- Simulation with area or point data
 - Forecasting / prediction based on space-time data
 - STAR model

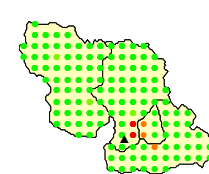
Analysis of Point Data

Identifying Clustering: K-function Analysis



Analysis of Point Data

Identifying Clustering: K-function Analysis



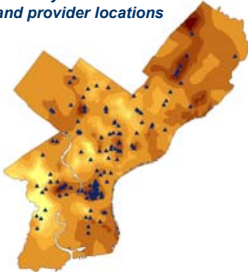
Where do we see unusual clustering of Larynx cancer events?



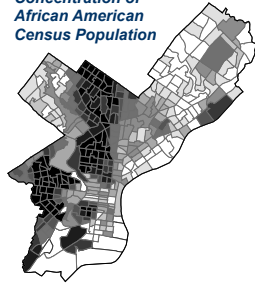
Smoothing (Spatial Analyst Tool => Spatial Interpolation using the p-values

Analysis of Point Data: Outpatient Service Use

Intensity of Service Use
and provider locations



Concentration of
African American
Census Population



Analysis of Network Data

Hot Spot Analysis of Pneumonia Cases

- Block level analysis
- Analysis controlling for:
 - Race, Age, HIV
- Potential hot spot in certain areas in Philadelphia

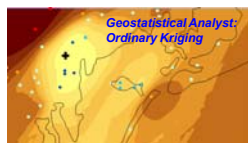
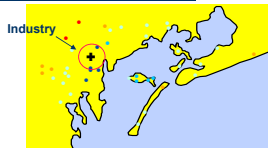


Philadelphia Area
Pneumonia Cases

Analysis of Continuous Data

Venice Study by Gambolati and Volpi (1979): Kriging

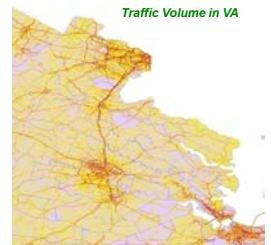
- **Data:** 40 borehole measurements of the water table level (relative to sea level) around Venice area in 1973.
- **Hypothesis:** There was a suspicion that overuse of groundwater by industry is causing water table to go down (and sinking Venice)



Analysis of Network Data

Shenandoah Air Pollution Project: Plume model

- **Data**
 - Traffic volume data
 - Sample air quality data
 - Health data: respiratory, cardio vascular
- **Policy Scenario Analysis**
 - Traffic restriction (tracks)
 - Promoting “green” cars
 - Idling



Simulation of Point Data

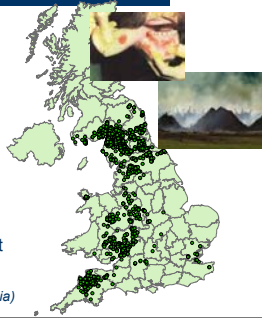
- **Foot-and-Mouth Disease Outbreak in England 2001**

- Space-time K-fn analysis
- Kernel function analysis

- **Control Mechanism**

- Custom control ("prevention")
- Vaccine
- Slaughtering
- Some regulation (traffic/import restriction, etc.)

(STAR analysis is still evolving in academia)

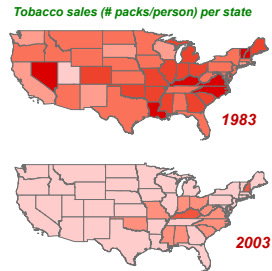


Simulation of Areal Data

demo

STAR Analysis of Tobacco Sales:

- Measuring the effectiveness of various tobacco policies using space-time regression
 - Proximity to "tobacco states".
 - Policies at neighboring states
- Simulating the impact of various tobacco policies based on the STAR model results.



Other GIS Projects

- STD Spread – Military base project (VDH, DoD)
- Gas station geocoding projects (Census Bureau, DOE, NGA)
- Antimicrobial resistance spread and agricultural use of antibiotics (USDA)
- Organ allocation project (NIH)

Thank you!

Q&A / Discussion?