Faculty Disclosures
Center for Health Research / Loma Linda University

Pramil N. Singh, Dr.PH

No relevant commercial interests.
Geographic Information Systems for Health Care Research, Practice, and Management

Pramil N. Singh, Dr.PH
Director and Associate Professor of Epidemiology
Center for Health Research
School of Public Health
Loma Linda University

Funding: Grants R03 TW007345-03, R01 TW05964-06 from Fogarty/NIH
Introduction to GIS
- What is a geographic information system?
- GIS Data Types
- GIS Functions and Analysis
- Where do I find GIS software and data?

GIS for Health
- Obesity Case Study
- Nurse Management Case Study

GIS@LLU

Questions
GIS Data: Data Layers

With GIS software, you can digitally represent geographic objects with a variety of shapes and layer those shapes on top of one another to create maps and perform analysis.

- Polygons
GIS Data: Data Layers

With GIS software, you can digitally represent geographic objects with a variety of shapes and layer those shapes on top of one another to create maps and perform analysis.

- Polygons
- Lines
With GIS software, you can digitally represent geographic objects with a variety of shapes and layer those shapes on top of one another to create maps and perform analysis.

- Polygons
- Lines
- Points
GIS Data: Data Layers

With GIS software, you can digitally represent geographic objects with a variety of shapes and layer those shapes on top of one another to create maps and perform analysis.

- Polygons
- Lines
- Points
- Raster images (pixels)
GIS Data Types: Spatial

Spatial or coordinate data represent features that have a known location on the earth.

- **Vector**: Points, lines, and polygons
- **Raster**: Row and column matrix
GIS Data Types: Vector

Polygon and Points

Lines
GIS Data Types: Raster

A model of the world as a surface that is divided into a regular grid of cells, arranged into rows and columns.

- All cells (or pixels) must be the same size.
- All cells have a value.

GIS Data Types: Raster

Rasters include images, elevation models, and scanned maps.
Data Attribute Table

- Spatial data have a backend database called an attribute table.
- It can be used for querying and analysis.
- All attributes can be mapped.
Each state is represented with a different color.
GIS Data Attribute Table

Each state is color coded based on its population.
GIS Data Types: Tabular

- Table (CSV, Excel) or database (Access, Oracle, PostgreSQL)
- Can be transformed into spatial data and mapped:
  - Join with spatial data files by a common attribute (state name, unique ID, etc.)
  - Map as points using coordinates such as longitude and latitude gathered from a GPS device
  - Geocode: associate address fields with a street network
GIS Functions: View Imagery

City of Cambridge Aerial Photograph, April 2010
GIS Functions: Create 3D models
GIS Functions: Create Maps
GIS Functions:
Create Maps
GIS Functions: Create Buffers

Calculate what is
- Inside
- Outside
- Within a certain distance

Buffers in ½-mile increments around Fenway Park
GIS Functions: Clip Features

All the water bodies in the US have been clipped using the Massachusetts state boundary.

Now only those water bodies within Massachusetts are visible.
GIS Functions: Spatial Analysis of Air Pollution and Mortality in ACS Study

1) Exploratory Overlay plot

2) Local Indicators of spatial association (LISA) to identify “hot spots”

3) G statistic identifies hotspot near the Great Lakes region and mortality rates already adjusted for confounders in a Cox model.
GIS Software and Data

1) County, State, and Federal Agencies
GIS Software and Data

2) Academia
GIS Software and Data

2) Industry – Esri (Pioneer of ArcInfo)

Pioneering ArcGIS, the world's most powerful mapping and analytics software

https://www.esri.com/en-us/home
Create your own Data: Map Coordinates or Addresses

Geocode Addresses:
• 77 Massachusetts Ave. Cambridge, MA 02139

Add XY data:
• 71.093458 W
• 42.359097 N
Create your own Data: Georeference maps and images
Collect Your Own Data

Global positioning system (GPS) devices are available for checkout from the Rotch Library circulation desk.

ESRI ArcGIS: ArcMap

• Provides the most tools for processing data, analysis, and creating maps
• Comprehensive support through our academic license
ArcToolbox
ESRI ArcGIS: ArcCatalog

- Manage files and folders
- Create new shapefiles and geodatabases
- Preview files
- View metadata in format of choice
- Create metadata so your data can be understood and shared with others
- Save metadata files as XML, TXT, HTML, or SGML
Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists
Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists

NIH Funded REGARDS Study: Reasons and Geographic and Racial Differences in Stroke.

Study risk factors in the “Stroke Belt”.
Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists

NIH Funded REGARDS Study: Reasons and Geographic and Racial Differences in Stroke.

Study risk factors in the “Stroke Belt”.
GIS for HEALTH

Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists

Where Are The Blue Zones®?
Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists

The Loma Linda Blue Zone

- The Adventist church was formed in the 1840s
- A culture focused on health with emphasis on lifestyle
- Adventists generally have a much lower risk of chronic diseases compared to the average American and enjoy a long, healthy life.
GIS for HEALTH

Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists

Lessons from Loma Linda

1. Find a sanctuary in time to decompress
2. Keep a healthy weight
3. Eat nuts!
4. Get regular exercise
5. Nurture tight social networks
6. Volunteer! Help others
7. Eat a light dinner.
GIS for HEALTH

Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists

Place/Context Matters to Health

• Medical geographers say:
  – “We all have our own ‘geographies’ as well as our biographies...Our ‘health’ and our ‘geographies’ are inextricably linked...Where you live affects your risk of disease or ill-health.”*

• Evidenced through the important work by *The Dartmouth Atlas of Health Care in the United States* Project (www.dartmouthatlas.org):
  – “…in health care, geography is destiny. The amount of care consumed by Americans is highly dependent on where they live—on the capacity of the health care system where they live, and on the practice styles of local physicians.”

Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists

NIH funded Study of 96,000 Seventh-day Adventists to examine Lifestyle and Cancer Risk
Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists
GIS for HEALTH

Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists

[Diagram showing correlation of county-level obesity prevalence rates and spatial cross-correlation scatter plots of obesity prevalence rates.]
GIS for HEALTH

Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists

Key Results

• Statistical Analysis
  – After multiple adjustments: the odds ratio of obesity was higher in rural Adventists versus urban.
  – In more obesogenic (i.e., high obesity prevalence) counties Adventists are more likely to be obese than in counties with lower obesity prevalence.
GIS for HEALTH

Case Study #1: National Obesity Distribution in All Adults and Seventh-day Adventists

Clean communities which promote and enable healthy behaviors

- A unique cross section of key leadership in policy, industry, and academia.
- Experts in the field of health promotion, preventative medicine, environmental health, community planning and design, and policy as the platform for discussion around the built environment and health.
- Key outcomes: ways to improve existing initiatives and the future of building healthy communities.

http://www.llu.edu/public-health/hcbd/2012/index.page
Case Study #2: The Healthy Model for Nursing Workforce Management and Planning

1) Stanford University Medical Center, located in Palo Alto, California, on the Stanford University campus, comprises three main components: the Stanford School of Medicine, Stanford Hospital and Clinics, and Lucile Packard Children's Hospital.
The nursing staff occupies the largest clinical workforce category, with approximately 2,700 registered nurses.
3) Long-range workforce planning for maintaining an adequate nursing staff is therefore an essential administrative challenge.
4) Almost every external clinical professional at any hospital, especially nurses, must be state licensed and registered, making their geographic location easy to map.
Case Study #2: The Healthy Model for Nursing Workforce Management and Planning

5) HR mapped analyzed and mapped these workforce data, to provide insight on nursing supply and demand, as well as information commute patterns and distances traveled to work.
Case Study #2: The Healthy Model for Nursing Workforce Management and Planning

The entire San Francisco Bay Area external registered nurse population with hospital points buffered at two, four, and six miles up and down the San Francisco Peninsula, showing the ease with which nurses can establish their careers by leapfrogging from one hospital to another.
Case Study #2: The Healthy Model for Nursing Workforce Management and Planning

Research Questions Tested

• If the nursing population living within a six-mile radius of our hospitals is projected to retire in 10 years, but the average home price in the area has become far too expensive for just about any clinical professional, how will we be able to attract new entrants to our workforce to this location?

• What if we experience an earthquake in the middle of the night, and the majority of our nurses live on the other side of a major bridge affected by the quake?

• Many hospitals around the rest of the country are or will be experiencing a nurse shortage. Do we or will we have a shortage in our metro area?

Spatial Conclusion

“While recruiters have had hunches for decades about what may or may not be attractive recruitment features for nurses—such as pay, shift, and location—GIS analysis has, once and for all, laid the location controversy to rest. The nurse comfort zone for Stanford University Medical Center is about a 12-mile radius. Looked at another way, this is also a retention factor. When close proximity to the hospitals is coupled with nurses surpassing the milestone of three to five years of service, they are more likely to stay on board until they retire.”
GIS for HEALTH

Case Study #2: The Healthy Model for Nursing Workforce Management and Planning

Outcomes for Stanford Hospital System after Implementing Policies based on GIS Analyses:

GIS helped free up $22.5 million in replacement/retraining costs over 2 years.

GIS helps anticipate and mitigate potential interruptions to continuity of care.
1) EPA Funded AHSMOG study examining cancer outcomes in a national cohort of non-smoking Adventists (1992-2008).
2) Fogarty/NIH: Building GIS Capacity into Tobacco Control Research Programs of East Asia (2017-2012)

- 5 year research program
- 33 personnel in Cambodia, Lao, Mongolia Trained in GIS

Health Geoinformatics — Certificate

<table>
<thead>
<tr>
<th>Overview</th>
<th>Program requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required</td>
<td></td>
</tr>
<tr>
<td>HGIS 524</td>
<td>GIS Software Applications and Methods 3</td>
</tr>
<tr>
<td>HGIS 535</td>
<td>Integration of Geospatial Data in GIS 3</td>
</tr>
<tr>
<td>HGIS 536</td>
<td>Spatial Analytic Techniques and GIS 3</td>
</tr>
<tr>
<td>HGIS 547</td>
<td>GIS for Public Health Practice 3</td>
</tr>
</tbody>
</table>
2) Fogarty/NIH: Building GIS Capacity into Tobacco Control Research Programs of East Asia (2017-2012)
3) Patient Wellness Apps

GIS Helps Loma Linda University Health Focus on What Matters

Credible, Up-to-Date Data Gives Health System the Know-How to Enhance Community Health Initiatives
Questions?