Using Geographic Information Systems for Health Research: Mapping and Analyzing Health Data

Health Disparities and Social Justice Conference
8 August 2017

Prof. Euan Hague (Department of Geography)
Cassie Follett (GIS Coordinator)
Nandhini Gulasingam (Senior Analyst, IT solutions, SSRC)

Department of Geography
DePaul University

With additional maps/assistance from Dr. Judith Singleton, and DePaul students Eric Phillips, Sophie Mimica, and others
Geographic Information Systems (GIS)

• Used to map and analyze any geo-coded data (i.e. data with an address, census tract, zip code, community area, etc.)

• Layers of data enable comparisons (e.g. put a map of homicides on top of one showing unemployment)

• Identify hotspots, clusters, anomalies, differences

• Knowing where can help to understand why and to target intervention

https://www.youtube.com/watch?v=XxW_e9o0lA8&index=1&list=PLaoDa0bl_LMd-IRgNAaAa8gfujQjbqV

• Software: ESRI/ArcGIS, MapBox, Carto,*Boundless, *QGIS, *MapZen
  (*=open source)
Mapping Chicago’s Health

Average Life Expectancy

Legend:
- Red: 67 - 72 years
- Orange: 72 - 75 years
- Yellow: 75 - 78 years
- Light Green: 78 - 81 years
- Dark Green: 81 - 84 years

Map of Chicago's neighborhoods with varying life expectancy ranges.
Maps by DePaul Students

**Teenage Birth Rates And Socioeconomic Hardship In Chicago, 2009**
Map Created By Sydney Thai, 2013

Legend
- Teenage Births: Births Per 1,000 Females Aged 15-19
  - 1.3 - 39.1
  - 39.2 - 116.9
- Socioeconomic Hardship Index
  - 1.0 - 19.0
  - 19.1 - 39.0
  - 39.1 - 58.0
  - 58.1 - 78.0
  - 78.1 - 98.0

Socioeconomic Hardship Index incorporates six socioeconomic indicators:
- % housing crowded, % households below poverty,
- % aged 16+ unemployed, % 25+ w/o high school diploma,
- % under 18 or over 64, and per capita income.

*scores increase in hardship from 1 to 100.

**Note:** The 2009 national average for teenage birth rates was 39.1
**Note:** 0% denotes non-Chicago area

Source: City of Chicago, Chicago Department of Public Health Epidemiology & Public Health Informatics Program

**Multi-Faith Veteran Support Initiative**
Veteran Population by Census Tract

Legend
- Austin
- Community Areas
- Normalized Veteran Population
  - 0% - 1.98% (171)
  - 1.99% - 3.73% (219)
  - 3.74% - 5.77% (208)
  - 5.78% - 8.44% (144)
  - 8.45% - 14.46% (56)

Authors: Lauren Ribant, Lauren Rooney, & Katie Romack
DePaul University | GEO 442
Source: U.S. Census Bureau, 2014 ACS 5-Year Estimates, TIGER/Line Shapefiles, Chicago Data Portal
Number of Bicycle Crashes by Zipcode in Chicago

Legend

CommToCrashes Count

0 - 1
2 - 3
4 - 5
6 - 7
8 - 9
10 - 11
12 - 13
14 - 16
19 - 20
21 - 22
23 - 24
25 - 27
28 - 33
34 - 47
48 - 61

CBF_BikeCrash

Green Spaces and Public Health
The Percentage Amount of Green Space by Community, Estimates of Overweight or Obesity Prevalence among Chicago Public Schools Students by Community Area of Residence*

Percentage of Green Space by Community

0.4% - 3.1%
3.2% - 6.4%
6.5% - 11.4%
11.5% - 20.4%
20.5% - 37.2%

Percentage of Overweight or Obesity Prevalence by Community
(Kindergarten, 6 and 9 Grades Students)

• 21.4% - 32.3%
• 32.4% - 38.7%
• 38.8% - 43.3%
• 43.4% - 45.8%
• 45.9% - 52.3%
The Average Rate: 43.3%

Chicago Community Areas

1 Rogers Park
2 West Ridge
3 Uptown
4 Lincoln Square
5 North Center
6 Lake View
7 Lincoln Park
8 Near West Side
9 Near North Side
10 North Center
11 Jefferson Park
12 Forest Glen
13 North Park
14 Albany Park
15 Porage Park
16 Irving Park
17 Humboldt Park
18 Madison
19 Belmont Cragin
20 Hermosa
21 Avondale
22 Logan Square
23 Humboldt Park
24 West Town
25 Austin
26 West Garfield Park
27 Edgewater
28 Near West Side
29 Near North Side
30 South Lawndale
31 Lower West Side
32 Loop
33 Near South Side
34 Armour Square
35 Douglas
36 Oaklawn
37 Fuller Park
38 Grand Boulevard
39 Kenwood
40 Washington Park
41 Hyde Park
42 Woodlawn
43 South Shore
44 Chatham
45 Avalon Park
46 South Chicago
47 Burnside
48 Calumet Heights
49 Roseland
50 Pullman
51 South Deering
52 East Side
53 West Pullman
54 Riverdale
55 Hegewisch
56 Garfield Ridge
57 Archer Heights
58 Brighten Park
59 Morgan Park
60 Bridgeport
61 New City
62 East End
63 Englewood
64 Chatham
65 West Lawn
66 Chicago Lawn
67 West Englewood
68 Englewood
69 Greater Grand Crossing
70 Ashburn
71 Auburn Gresham
72 Beverly
73 Washington Heights
74 Mount Greenwood
75 Morgan Park
76 Oakwood
77 Edgewater

*Note: The overweight or obesity estimates come from Chicago Public Schools students in grades Kindergarten, 6 and 9, adjusted for non-response and standardized to District-wide grade enrollment proportions, by community area of residence, 2010 - 11 school year.


Created by Shih-Hsi Huang, DePaul University, 2015.
Chicago, IL Shooting Hotspots and Level 1 Trauma Centers in 2013

Alex Williams

Teenage Birth Rates And Per Capita Income In Chicago, 2009
Map Created By Sydney Thai, 2013

Legend
Per Capita Income
- $8,000 - $15,000
- $15,001 - $30,000
- $30,001 - $45,000
- $45,001 - $60,000
- $60,001 - $75,000
- $75,001 - $90,000
- $90,001 - $100,000
- $100,001 - $125,000
- $125,001 - $150,000
- $150,001 - $200,000
- $200,001 - $250,000
- $250,001 - $300,000

Teenage Births: Births
Per 1,000 Females Aged 15-19
- 0.7 - 1.3
- 1.3 - 2.6
- 2.6 - 3.9
- 3.9 - 6.5
- 6.5 - 9.1
- 9.1 - 11.7

**Note: The 2009 national average for teenage birth rates was 59.1**
**Note: "0" denotes non-Chicago area**

Source: City of Chicago; Chicago Department of Public Health Epidemiology & Public Health Informatics Program

Total Methanol Released On-Site - Cook County, Illinois (2012)

Methanol Released (in pounds)
- 10
- 100
- 1,000
- 10,000

Created by Yuliya Raiko, February 2014.
2010-2012 Total Resettled Refugees Per State, As Percentage of State Population
By: Christa Kuntzelman

Refugees as Percent of State Population

- Less than 0.019
- 0.02 - 0.041
- 0.042 - 0.076
- 0.077 - 0.125
- More than 0.126

Source: State boundaries from TIGER/Line; Refugee Resettlement Data from Office of Refugee Resettlement (ORR); 2013 State Population from U.S. Census Bureau
DePaul Geography faculty with Health GIS credentials

• Dr. Julie Hwang
  • Diabetes research, patient recovery mapping
  • “Monitoring location specific physical activity via integration of accelerometry and geotechnology within patients with or at-risk of diabetic foot ulcers”* 
  *Journal of Diabetes Science and Technology (2016)

• Dr. Byungyun Yang
  • Masters thesis in Health GIS
  • Interactive web mapping
  • “Spatial Dependency and Heterogeneity of Adult Diseases: In the Case of Obesity, Diabetes and High Blood Pressure in the U.S.A,” Journal of the Korean Association of Regional Geographers (2010)
  • “Thinking about the equity for the emergency medical services” Journal of the Korean Association of Regional Geographers (2005)
To Learn More:

DePaul University courses:
GEO 441 – GIS for Community Development
GEO 346/446 – Health GIS

PH-GIS holds monthly talks at CDPH (subscribe to: GIS@LISTSERV.IT.NORTHWESTERN.EDU)
Objective: Where do the uninsured Americans live? *(data based on 2011-2015 Census data)*

Create a map to show
1) How to add data
2) Look at attributes/data in the table
3) Create a graduated color map to show percent of people with no Health Insurance Coverage by counties. Data was obtained from U.S. Census between 2011-2015.
4) How to select appropriate maps type
5) How to select the number of classes and break points on the map
6) How to see correlation between red/blue states and health insurance coverage
7) Conclusion:
   • See which state are affected
   • Which pockets within each state is affected
   • See correlations between political party affiliation and HC coverage
Objective: Where do the uninsured Americans live? (data based on 2011-2015 Census data)
Objective: Which gender is uninsured the most? *(data based on 2011-2015 Census data)*

Create a map to show

1) How to create new fields and compute predominant gender that is uninsured the most in each county. Use percentages instead of raw counts.
2) How to create a graduated color map to show dominant gender that is insured by US counties.
3) How to choose the right colors to show high to low female and male dominant areas.
4) Conclusion:
   - See which states have higher male/females who are not insured
   - What actions can be taken in areas where females aren’t insured. Similarly, what actions can be taken in areas where males are not/least insured.
   - Same technique can be applied to identify (1) What is the predominant type of disease in each area; (2) What is the predominant type of health care (private, public, Medicare, Medicaid, VA, etc.) offered in each state/county
Objective: Which gender is uninsured the most? (data based on 2011-2015 Census data)
Crowdsourcing Web Mapping

- GISCorps - http://www.giscorps.org/
- “Crowdsourced” GIS
WHO and CDC/ATSDR requested assistance from GISCOrps volunteers in digitizing the high resolution imagery for building points which would facilitate the preparation of the micro-plans for the upcoming vaccination campaigns in these areas.

26 MAY 2017 - 13 JUNE 2017

- 484,850 Total Structures Identified
- 242 Users Contributed
- Average User Created Over 2,000 Points
- 46 Countries Represented
- 3000 Maps Printed
Micro-planning exercise using satellite imagery

1. Define the area of interest and the type of vaccination campaign
2. Collect & prepare basemap using satellite & contextual information
3. Run a workshop with the field supervisors identifying their existing team areas
4. Field validation on the digitized microplan boundaries to have quality check and control
5. Using digitized microplan boundaries for operation planning, post campaign monitoring and resource allocation

**Define the scope**
- Determine the area to be covered (AOI)
- Identify the type of campaign
- Evaluate capacity of the country to carry out this exercise.
- Calculate the budget for the project
- Plan for phasing of the project

**Satellite imagery & allied data**
- Determine the availability of high resolution satellite imagery
- Supplement with open street map or google street map for thematic maps

**Basemap preparation**
- Producing map ratio and mapbook
- Printing the map
- For fixed point campaigns add the information on location of hospitals and health centers
- For the area border variation strategy, satellite information on the area border movement

**Microplanning Workshop**
- Invite the field vaccination teams and health officials for the workshop
- Encourage them to bring their existing microplans
- Train the data managers on the digitization process
- If the number of teams are large please stagger the teams presence in the workshop

**Field visit**
- Pick random areas in the field to do the field validation
- Plan the logistics of the travel arrangements
- Conduct checklists until results meet the level of expectations specified at the beginning.
- Think of an accurately mapped area as a process that can be replicated and scaled in other areas

**Possible outcomes**
- Redraw the boundaries of the teams areas
- Finding unvisited areas
- Identifying overlapping areas between the teams
- Cross validate the population count
- Accountability and transparency

**Personnel & Resources**
- Country team lead, stake holders
- Immunization team
- HQ - R0 country support team
- Core Mapping team

- Data manager, Core Mapping team
- Immunization team, Field vaccination team leads & health officials
- HQ - R0 country support team

- Core Mapping team
- Immunization team, field vaccination team leads & health officials and drivers
- HQ country support team

---

**Mainstream**
- The success of the microplanning exercise is judged by the level of usage of the digitized boundaries in the day today work flow
- Integrating the digitized boundaries and satellite maps in the operations plan
- Expand the microplanning exercise to other areas
- Print relevant maps and paste it in each health centers
- Use the boundaries for AM and other post campaign activities

---

**Personnel & Resources**
- Country team lead, stake holders
- Immunization team
- HQ - R0 country support team
- Core Mapping team

- Data manager, Core Mapping team
- Immunization team, Field vaccination team leads & health officials
- HQ - R0 country support team

- Core Mapping team
- Immunization team, field vaccination team leads & health officials and drivers
- HQ country support team
The first mOPV2 campaign is planned for 27-29 June, targeting more than 513,820 children under the age of five years.

Haut Lomami response plan
Hey guys, I'll be here for the next 4-5 hours.
Wow, you've sure been busy. We're almost at 147,000. That's fantastic 😊😊

- Hey, how are you doing?
- I'm doing well. Thanks for your help. 😊
- And you?
- I'm also doing well. 😊

- Hey Team. I'm just joining this project now and am about to start digitizing. You all have done great work so far. The instructions look pretty clear. Are all blue star squares of equal priority? Is there any other ranking or criteria for your help?
- No prioritization, go ahead and digitize any tile with a blue star. Great to have you onboard 😊
- Thanks for your help. 😊
- You're welcome. 🙌
Some tutorials to get you started: