

I know GIS and I have the software, why is it not happening (the way I hoped)?

Looking at implementation and use of GIS in a small-medium sized public health agency.

or

Seven things you should know before making a map with GIS

Marc Lefebvre

Manager, Population Health Assessment and Surveillance
Resources, Research, Evaluation and Development Division

Sudbury & District Health Unit

Community Data Program Webinar

June 22 , 2017

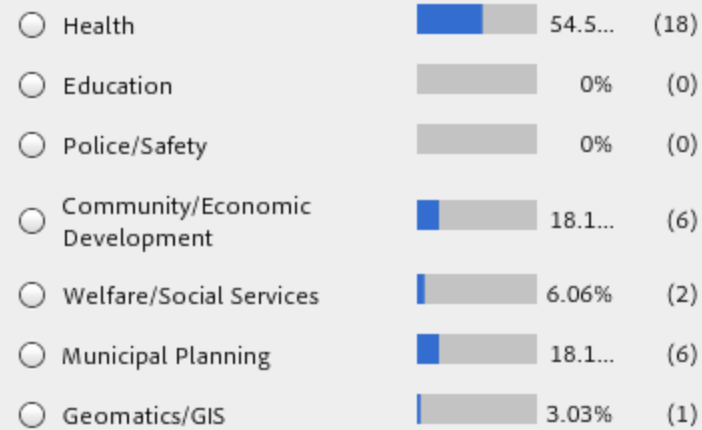
Bonjour, Hello, Aanii

- Territorial Acknowledgement
- Conflict of interest
- My purpose/hope
 - Teach, learn, share (maybe laugh a little)
- Some introductions, I'm Marc

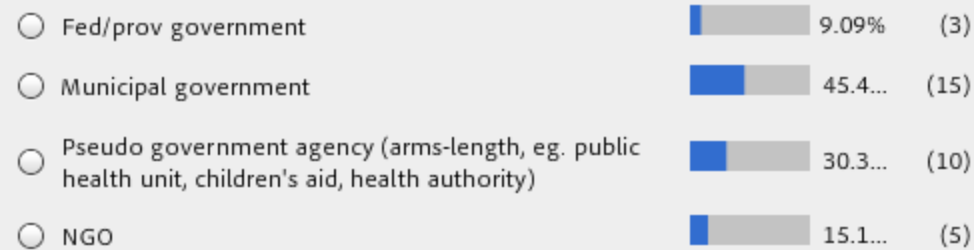
Manager, Population Health Assessment and Surveillance
Resources, Research, Evaluation and Development Division
Sudbury & District Health Unit (SDHU)

- You are....Get to know you poll

What sector do you work in?



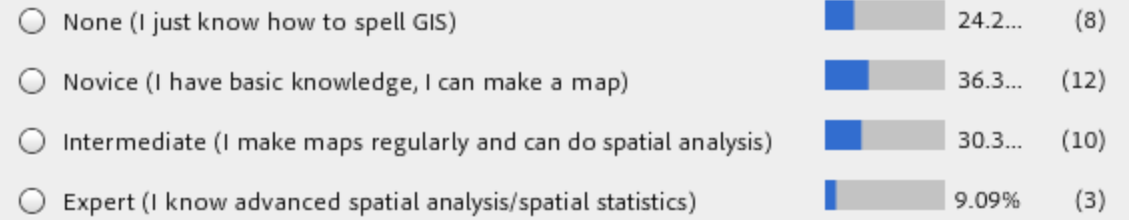
What sort of agency do you work for?



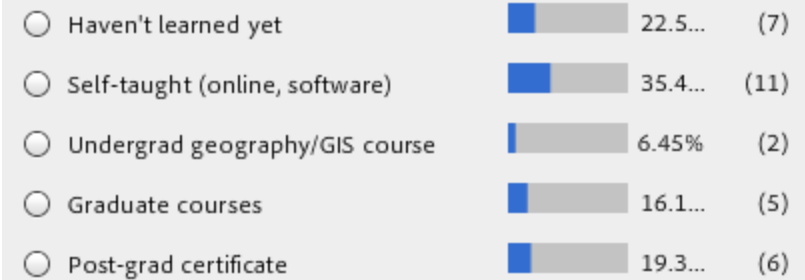
What is your role?



What's your background in GIS?



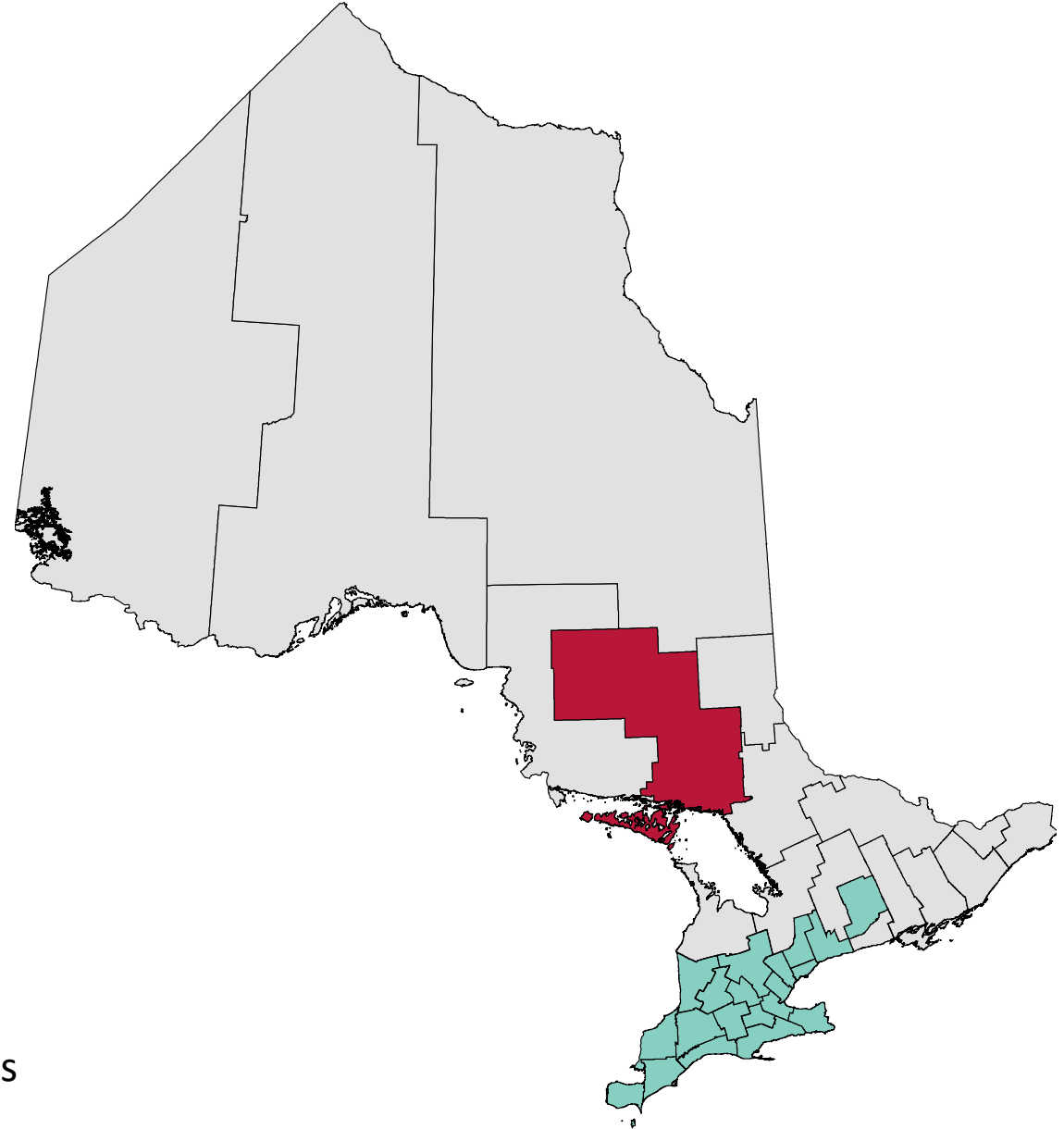
Where did you learn your GIS?



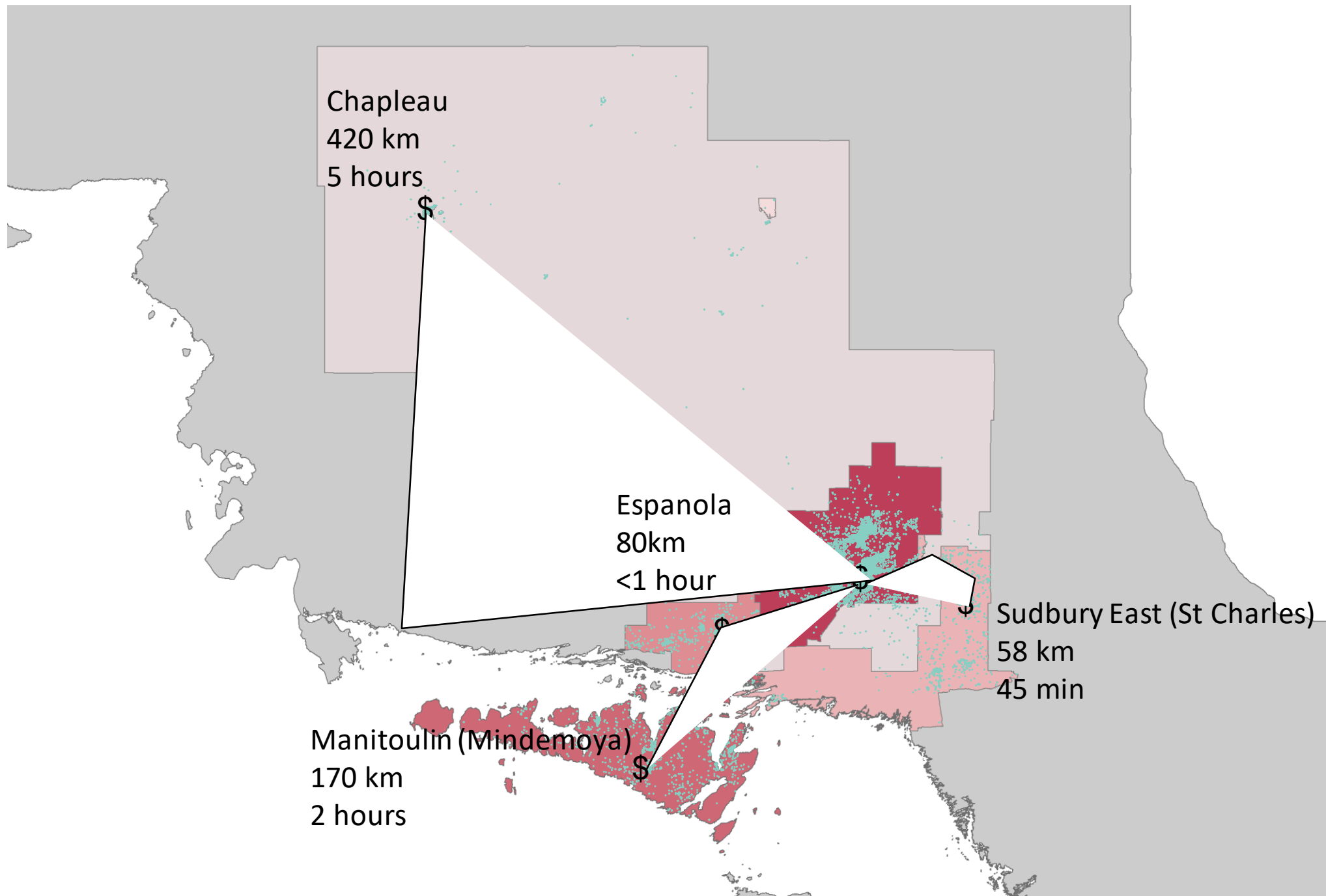
How often do you use GIS?



Sudbury & District Health Unit (SDHU) Geography 101



All distance and travel time estimates from Google Maps
Populations from Statistics Canada 2011 Census
Area. Statistics Canada Cartographic Boundary Files 2011

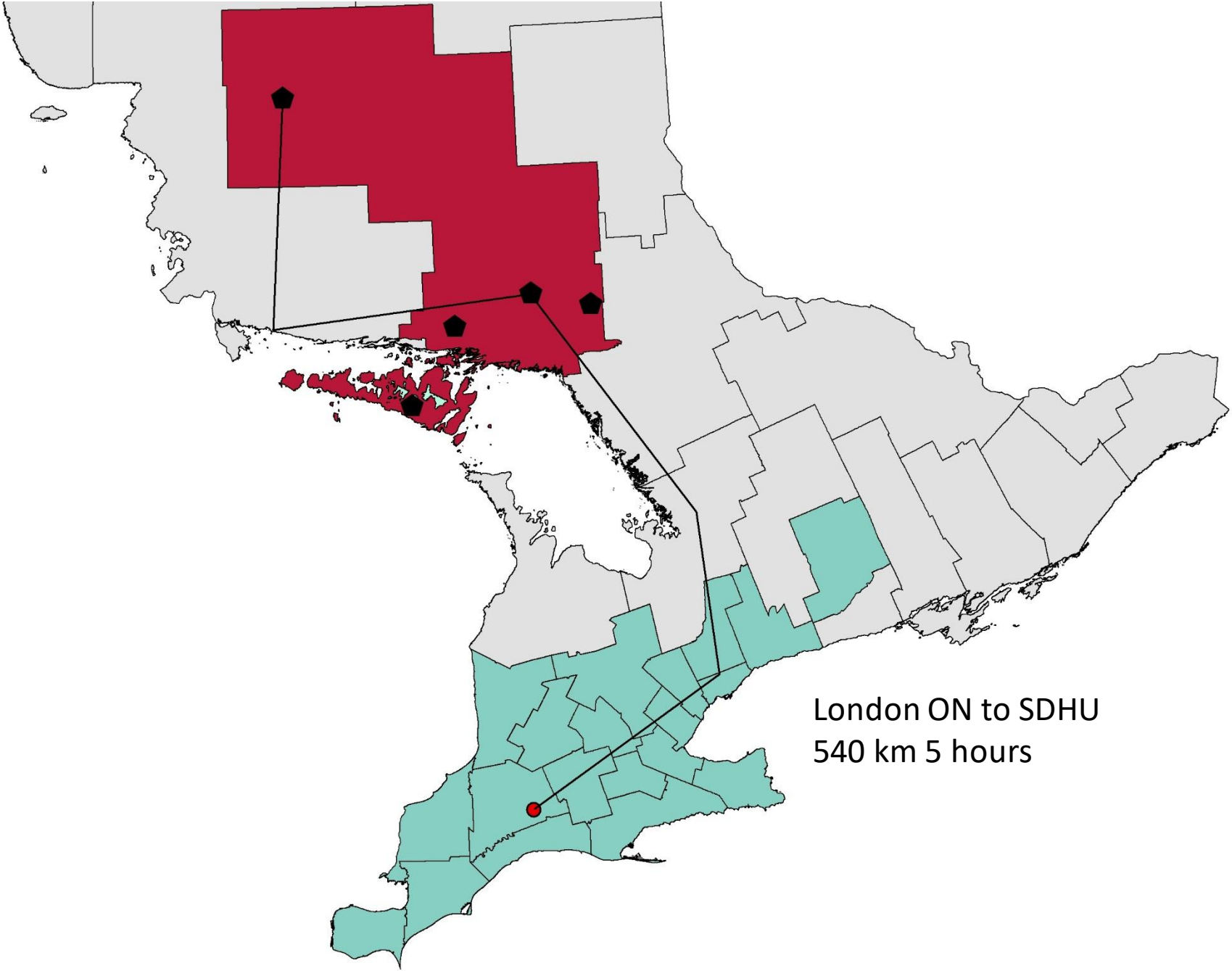


Chapleau
420 km
5 hours

Espanola
80km
<1 hour

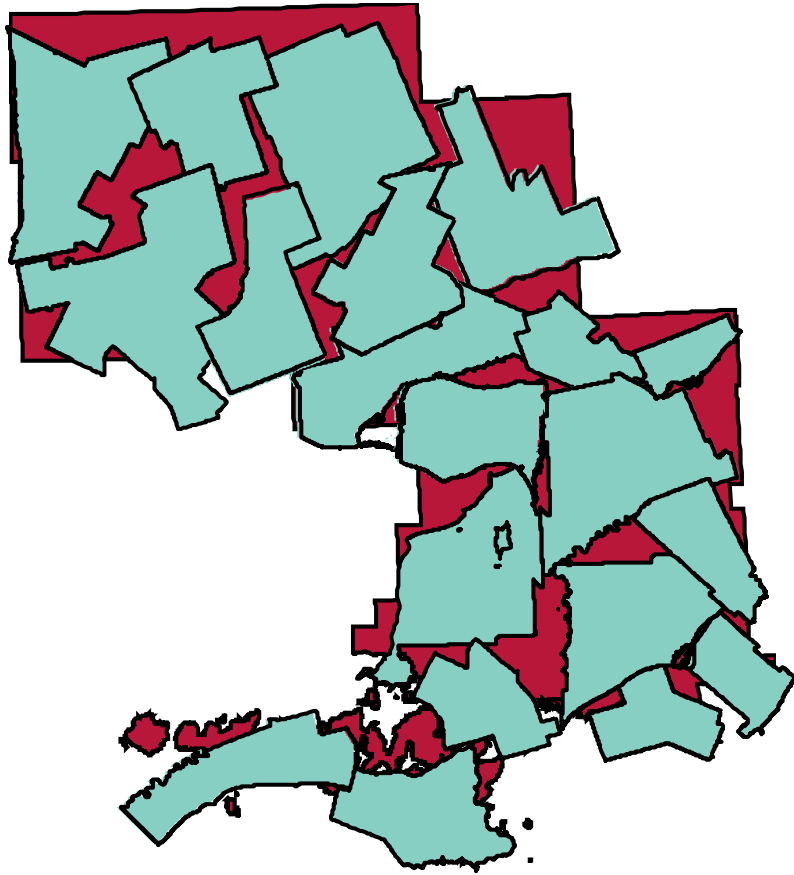
Manitoulin (Mindemoya)
170 km
2 hours

Sudbury East (St Charles)
58 km
45 min



Chapleau to SDHU
main office
420 km
5 hours

London ON to SDHU
540 km 5 hours




SDHU:
Pop'n 194,620
Area 50,000sqkm
Density 3.9 person/sqkm



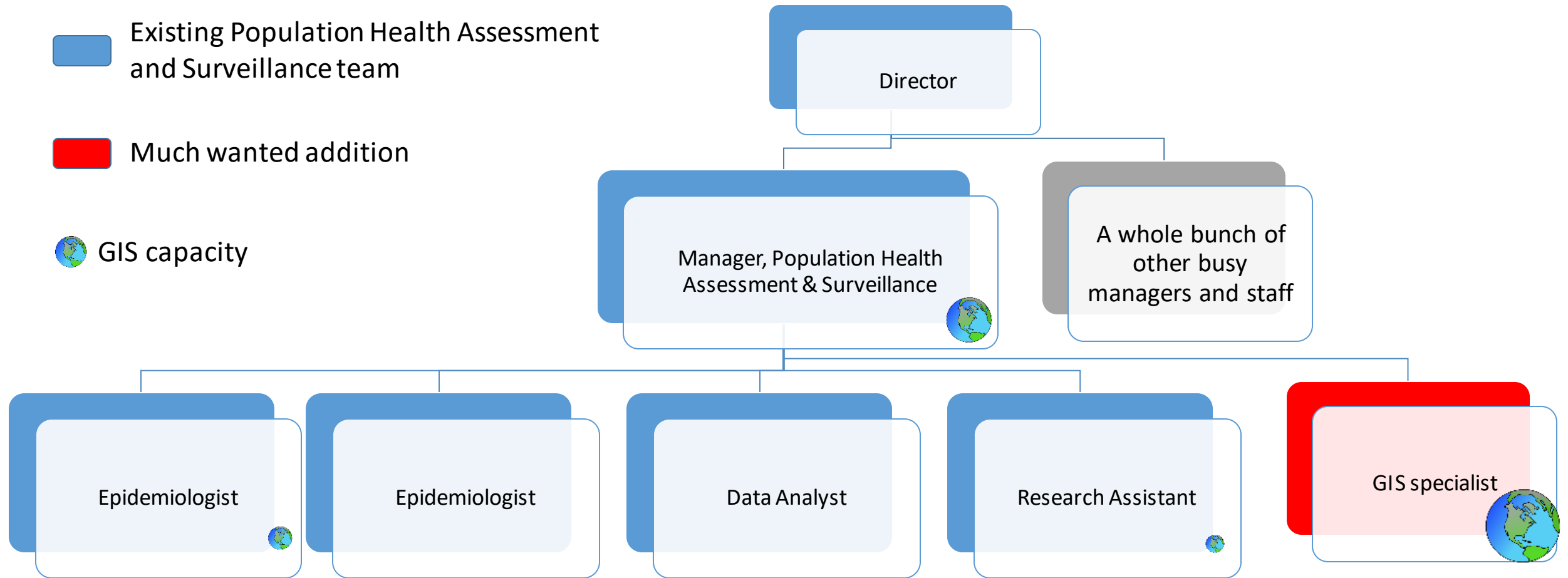
Select South 20:
Pop'n 10,351,785
Area 45,000sqkm
Density 230.0 persons/sqkm

GIS in the SDHU Resources, Research, Evaluation & Development Division: my dream

 Existing Population Health Assessment and Surveillance team

 Much wanted addition

 GIS capacity




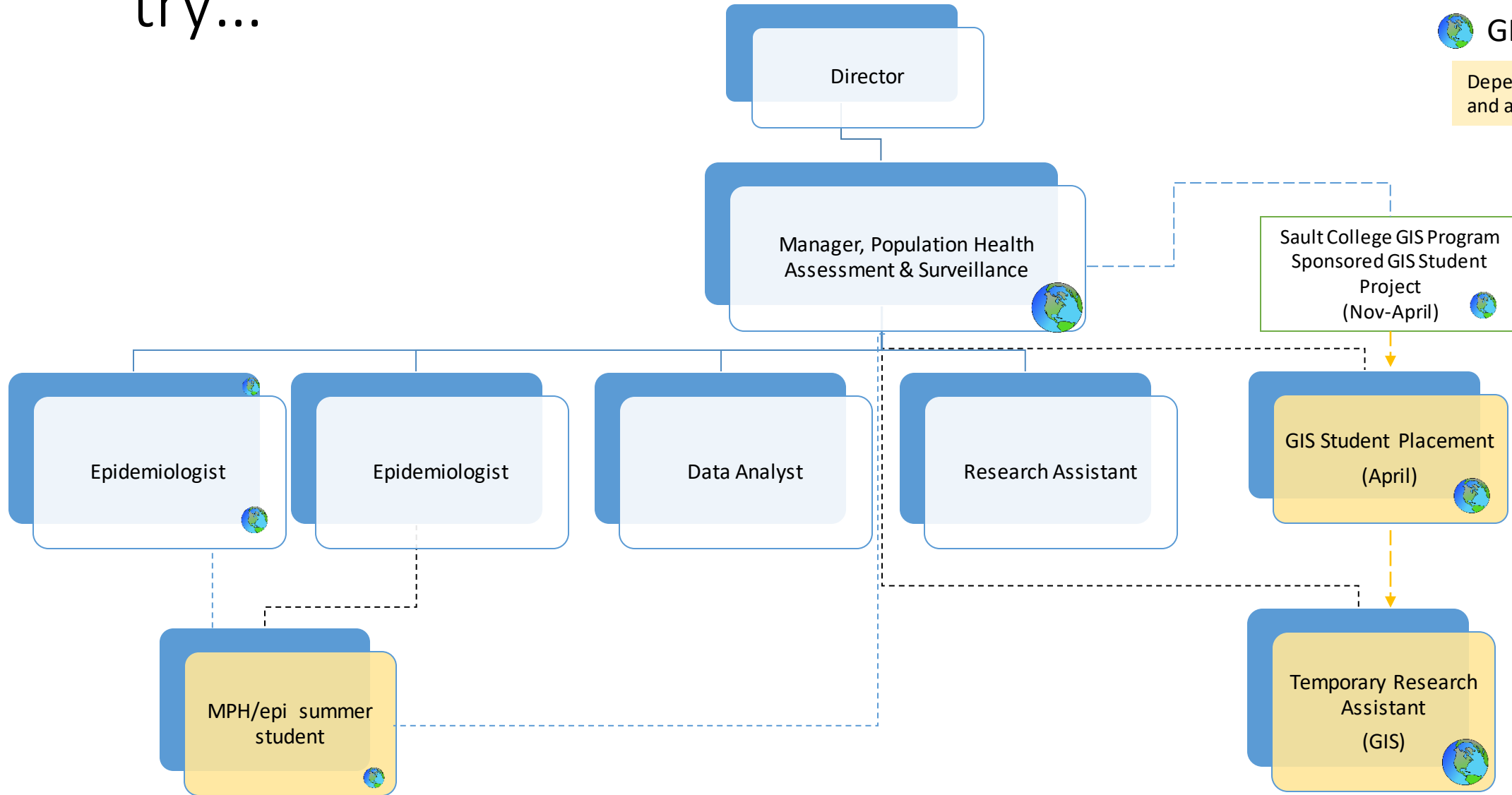
My reality



Disclaimer: This is NOT my desk!

“You can’t always get what you want...But if you try...”

 GIS capacity
Depending on Funding and availability



Some GIS/mapping/Geoviz sw

+ Extensions, scripts and Add-ons



C++



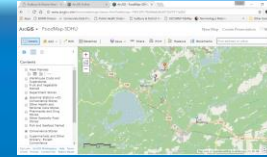
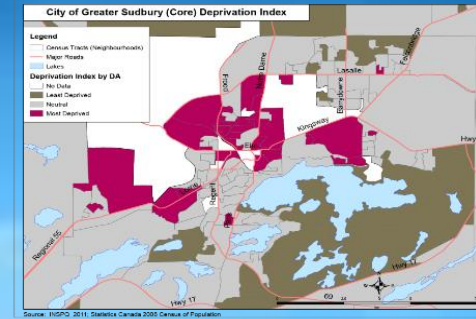
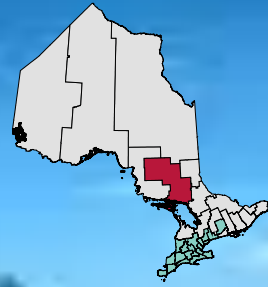
python™



How we use GIS at SDHU

Some examples

Public



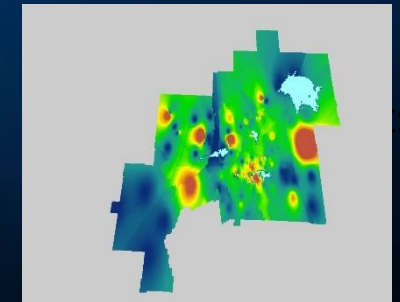
Stakeholder/
limited distribution

Internal

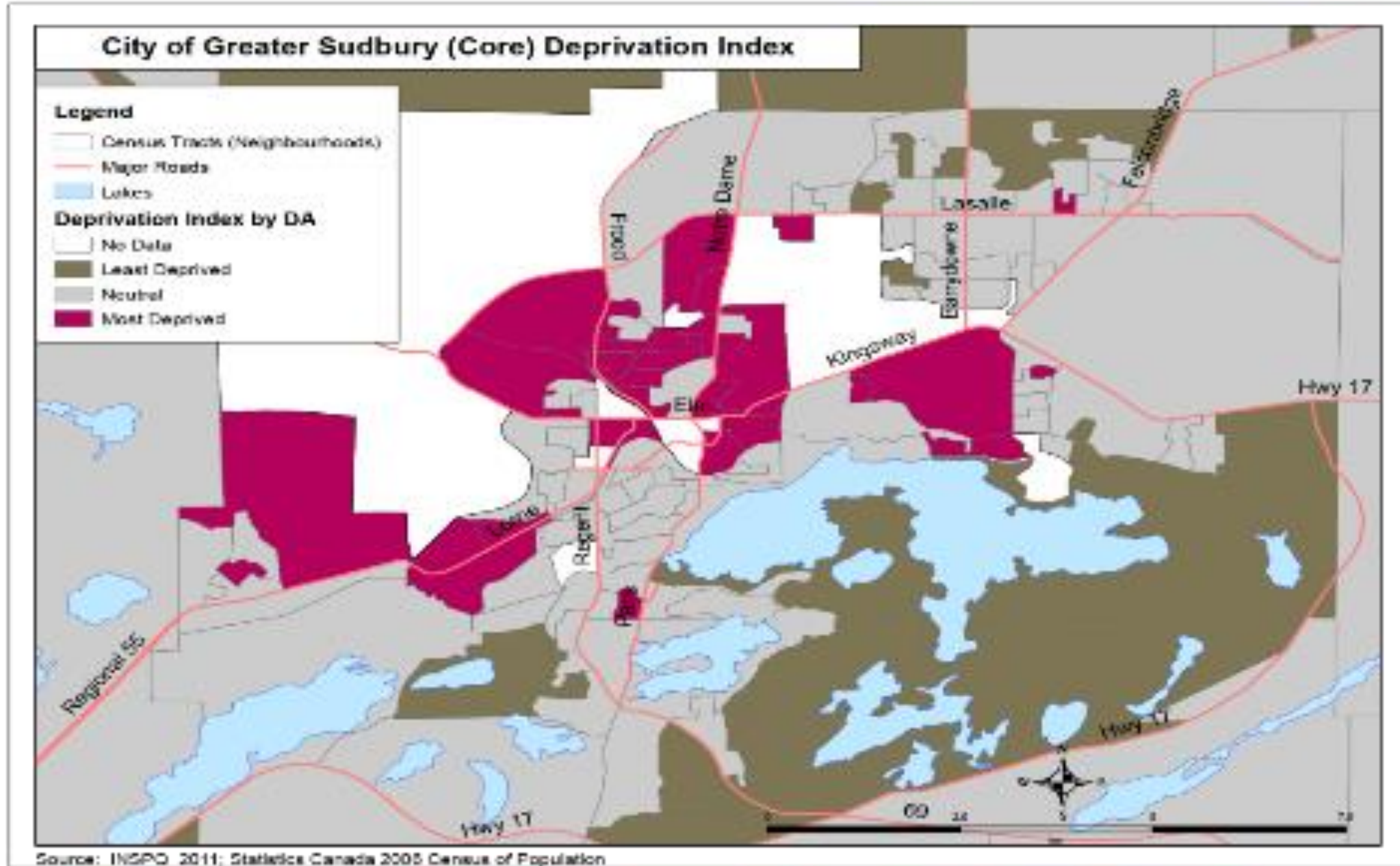
- Alcohol vs Schools
- Breastfeeding survey sampling
- Beach monitoring
- Sewer & Flooding complaints
- Extreme temperature events
- Jurisdictions
- Immunization Exemptions
- Demographics
- Sexual Health
- Pertussis
- Influenza care seeking

Exploratory Spatial
Data Analysis

How good are the data?
Will this be a good visual?
What happens when I...



Public



Stakeholder/limited distribution

Sudbury & District Health Unit | ArcGIS Online | ArcGIS - FoodMap-SDHU | Marc

www.arcgis.com/home/webmap/viewer.html?webmap=74912ffc7f8d46eb96d072bf1911e5bf

Apps | BORN Ontario | Community Data Prog | Public Health Ontario | Sudbury & District He | GCSWbP FileWay | Terminology | Nationa | Other bookmarks

ArcGIS ▾ FoodMap-SDHU New Map Create Presentation Marc ▾

Details Add Edit Basemap Save Share Print Measure Bookmarks Find address or place

Contents

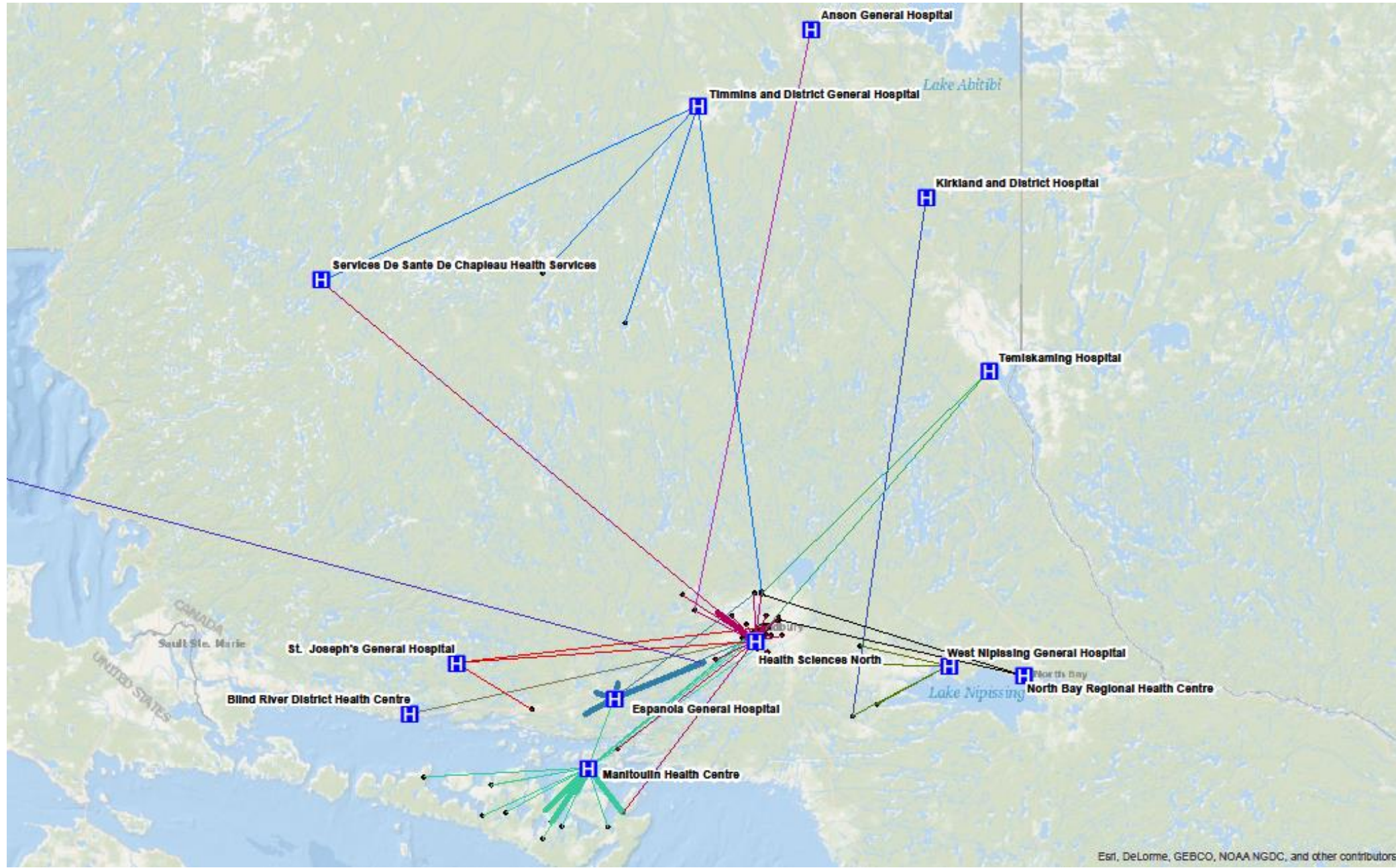
- Meat Markets
- Warehouse Clubs and Superstores
- Fruit and Vegetable Market
- Department Stores
- Gasoline Stations with Convenience Stores
- Other Health and Personal Care Stores
- Pharmacies and Drug Stores
- Other Specialty Food Stores
- Fish and Seafood Market
- Convenience Stores
- Supermarkets and Other Grocery; Except Convenience

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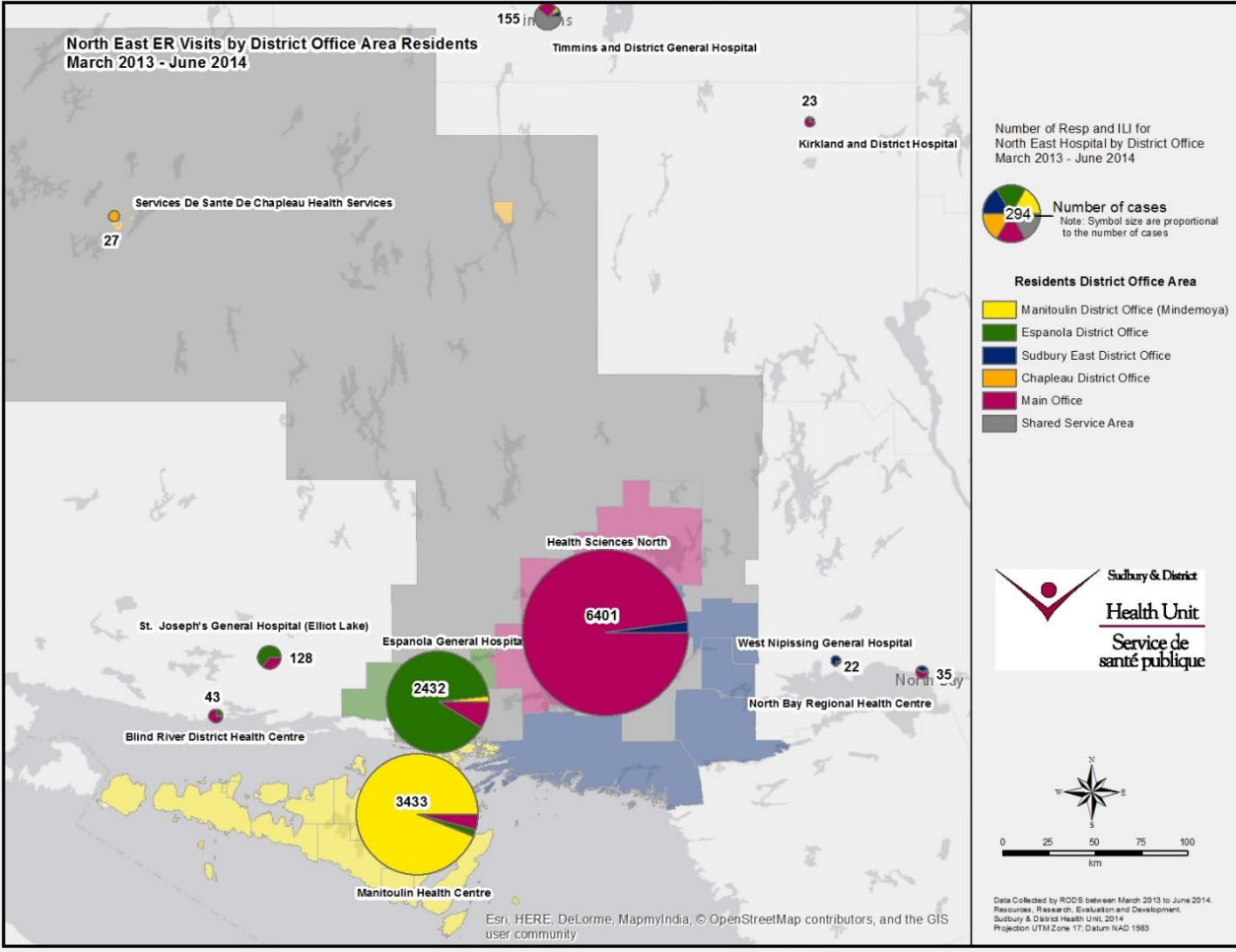
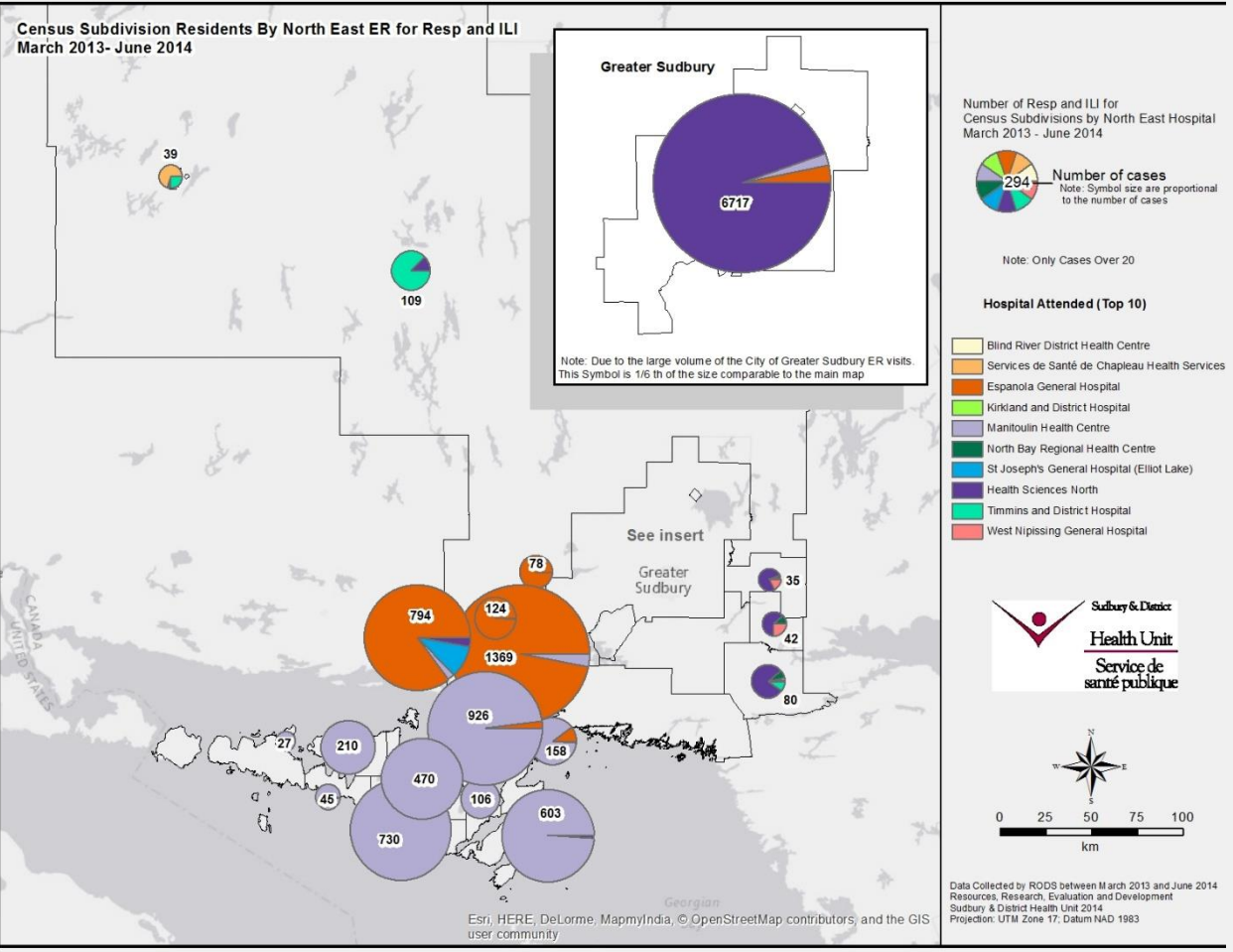
Map data © OpenStreetMap contributors, CC-BY-SA

POWERED BY esri

Internal



Internal



TBD

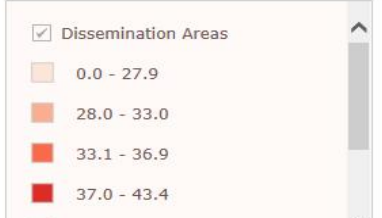
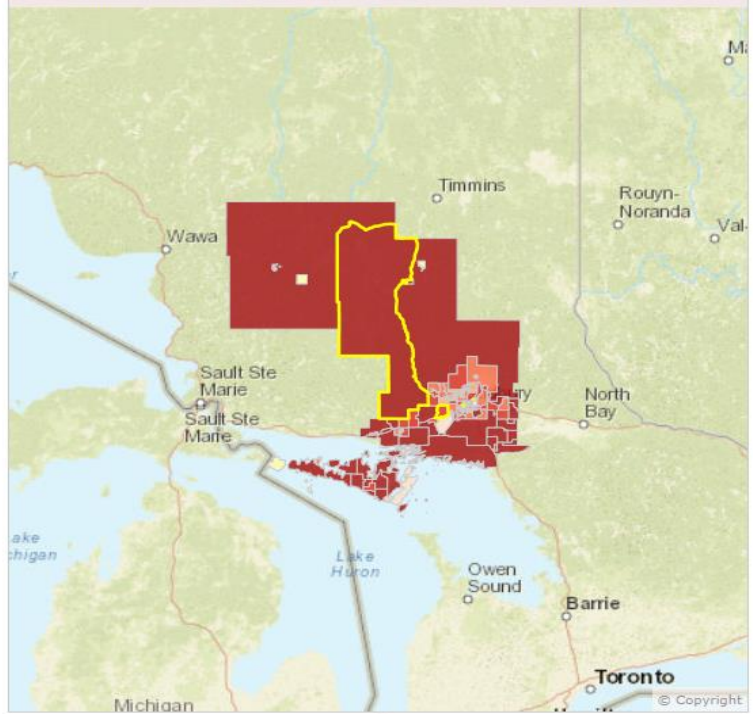
Geography Filter / +
Data Map | Tabular Key



Compare Areas by Pie Chart
Compare Areas by Bar Chart

Help Print Share

Families and Households >> Population married with children (2011)



Refers to the classification of census families into married couples (with or without children of either and/or both spouses), common-law couples (with or without children of either and/or both partners), and lone-parent families by sex of parent. A couple may be of opposite or same sex. A couple with children may be further classified as either an intact family or stepfamily, and stepfamilies may, in turn, be classified as simple or blended. Children in a census family include children living with them.

Canadian Census: SDHU Geographical Areas vs. SDHU Overall

Indicator	Area	Local No.	Local Percent	SDHU Percent	Lowest	SDHU Avg.	Highest
Population							
Languages							
Martial Status							
Families and Households							
Population married with children (2011)	35530359	35.0	23.3	35.4	0.0		72.7
	35530254	115.0	46.0	35.4	0.0		72.7
	35520086	60.0	57.1	35.4	0.0		72.7
	35530335	85.0	40.5	35.4	0.0		72.7
Population married without children (2011)	35530359	90.0	60.0	32.0	0.0		64.3
	35530254	25.0	10.0	32.0	0.0		64.3
	35520086	20.0	19.0	32.0	0.0		64.3
Population living common-law with children (2011)	35530335	80.0	38.1	32.0	0.0		64.3
	35530359	5.0	3.3	8.8	0.0		40.0
	35530254	35.0	14.0	8.8	0.0		40.0
	35520086	10.0	9.5	8.8	0.0		40.0
	35530335	20.0	9.5	8.8	0.0		40.0
	35530359	5.0	3.3	7.4	0.0		33.3





What you should know before making maps with GIS

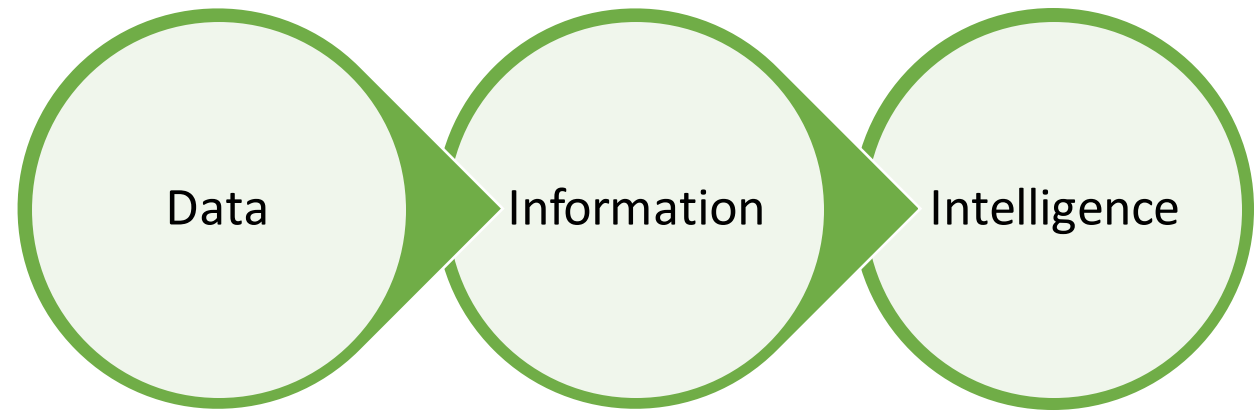
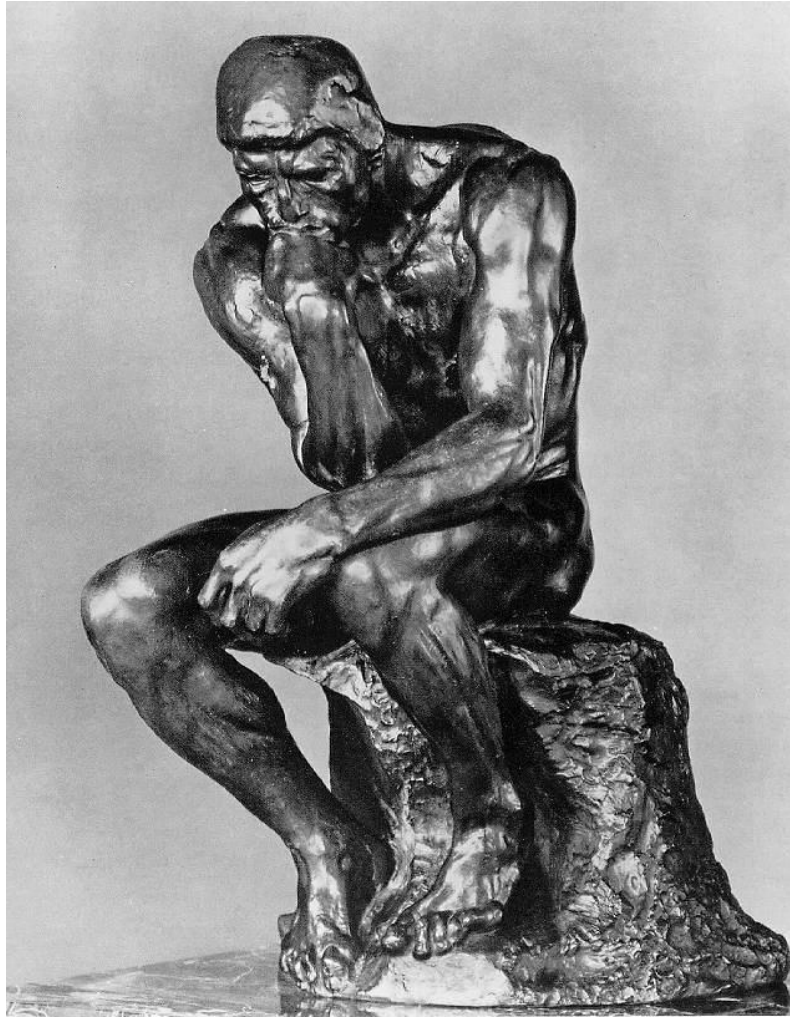
1. Basic Cartography



Who can make a map?



Who should make maps?



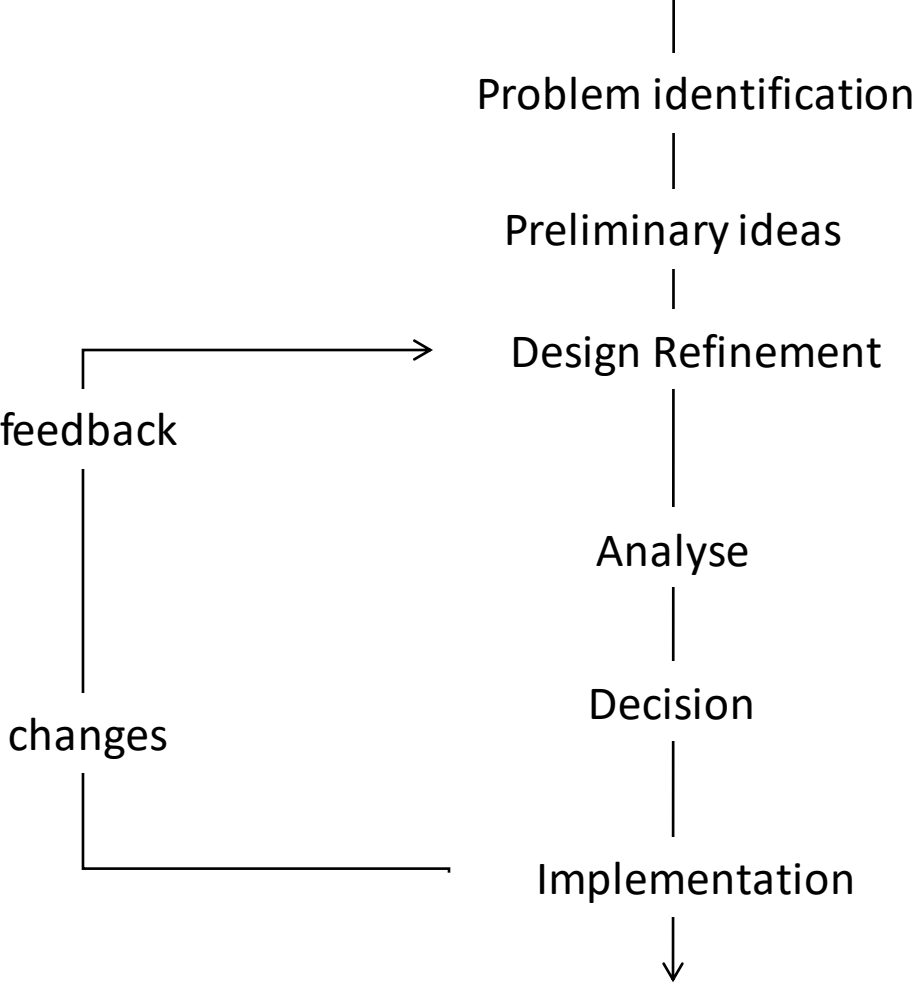
Snap! I thought I coined this

“If a picture is worth a thousand words, then a map is worth a million.” *Ordnance Survey, Great Britain*

“Whereas cartography is the art and science of mapmaking, cartographic design concerns the map user. It governs the design of a map and it is the cartography that ensures the intended message is delivered both efficiently and aesthetically.”

<https://www.ordnancesurvey.co.uk/resources/carto-design/>

The Design Process - IT IS ITERATIVE!



Adapted from Dent, Borden D. 1993

Types of Maps

1. General Purpose (reference) maps

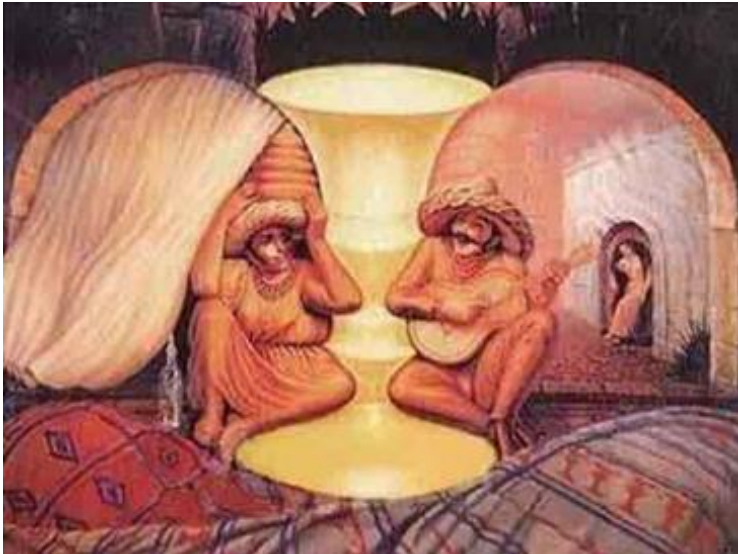
- Emphasis is on location

2. Thematic (special purpose, single topic, statistical map)

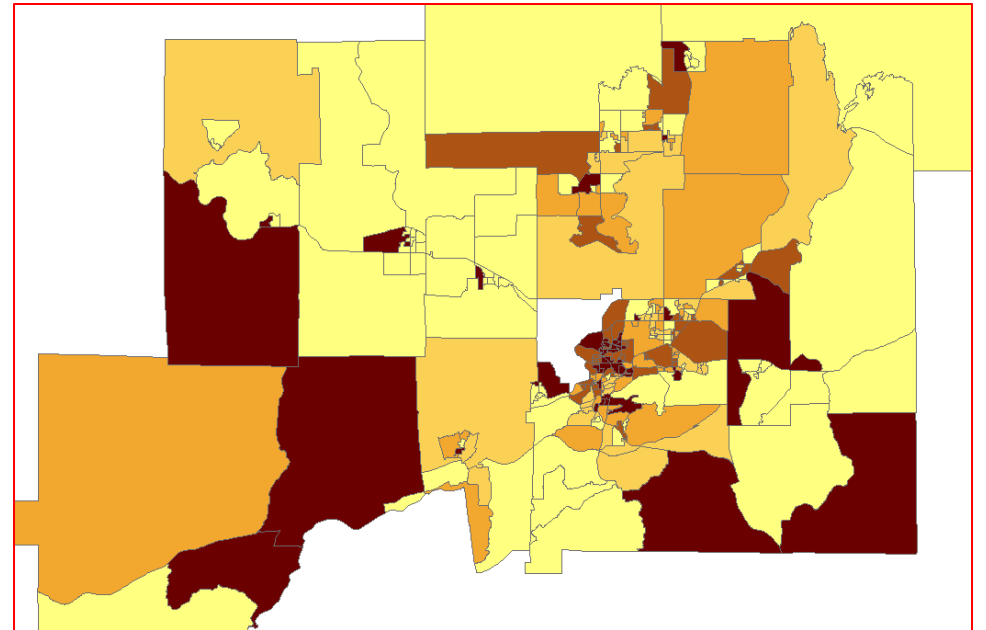
- Particular features or concepts
- Structural Characteristics of distance and directional relationships, patterns of location, spatial attributes of magnitude change
(Dent pg 6)
- Excludes topographic Maps

Thematic Maps

- Qualitative
 - spatial distribution or location of Nominal data
- Quantitative
 - spatial aspect of numerical data: Ordinal or Interval/Ratio scale



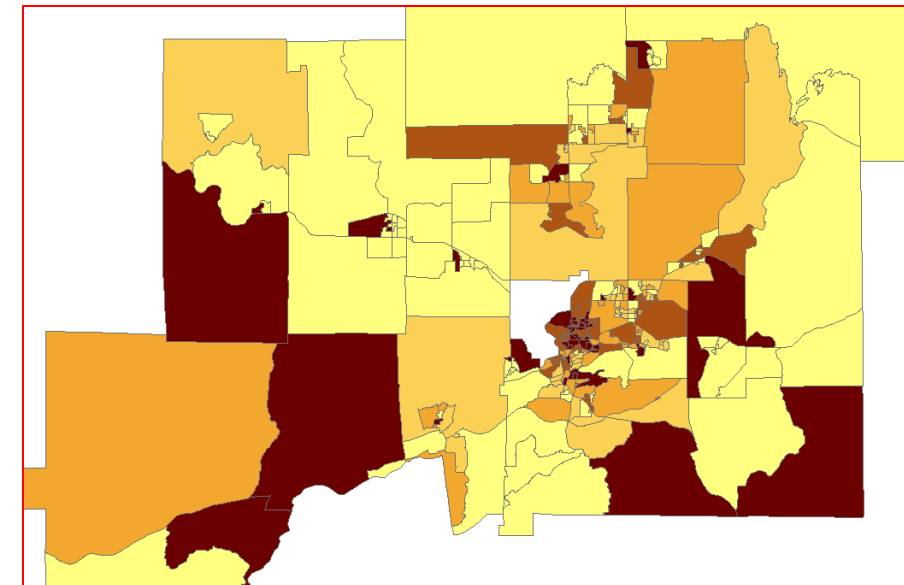
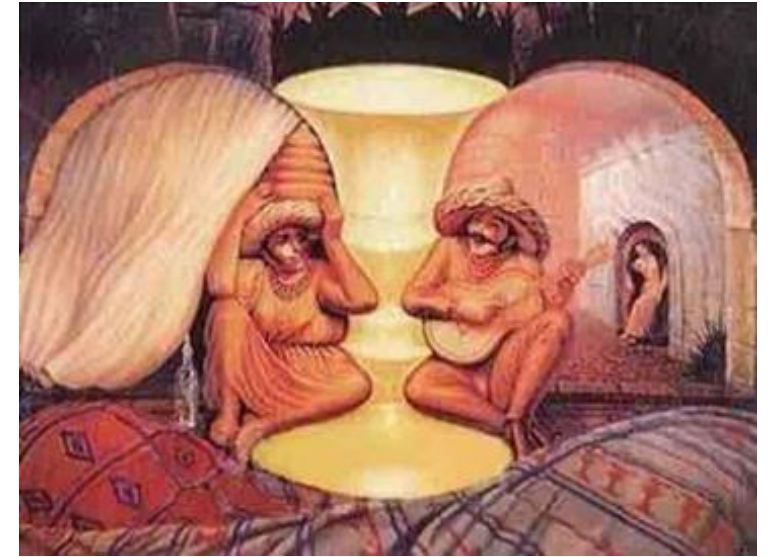
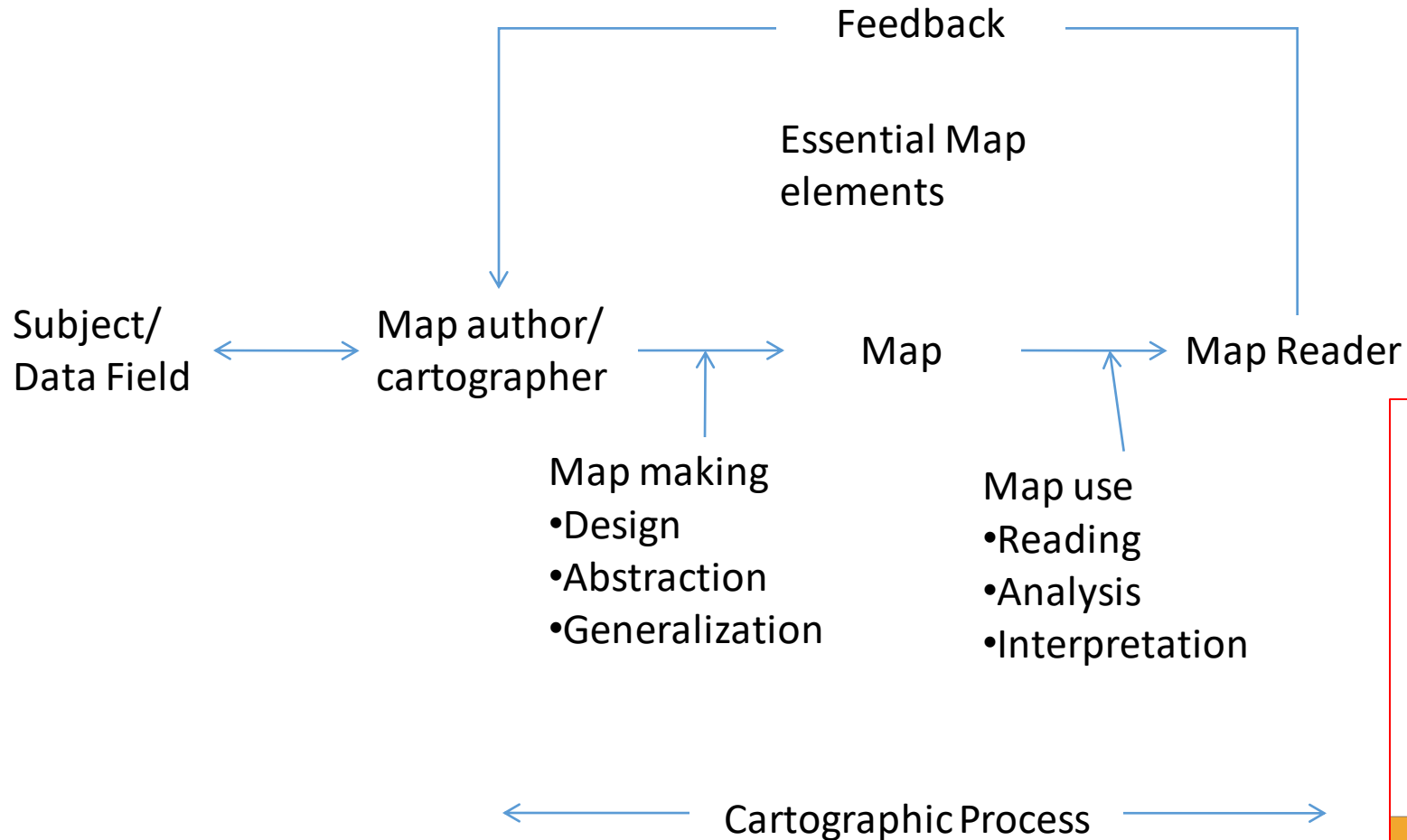
Gestalt!



Components of Thematic Maps

1. Geographic or Base map (locational info for context)
Include only amt of info necessary to convey the map message
 2. Thematic Overlay
- User must integrate these two visually and intellectually
Simply and Clearly

Thematic Map Communication



UK Ordnance Survey

Cartographic design principles

- Understanding of user requirements
- Consideration of display format
- A clear visual hierarchy
- Simplicity
- Legibility
- Consistency
- Accessibility
- Good composition

Ontario Ministry of Natural Resources and Forestry



Map Design Considerations for Accessibility

Ministry of Natural Resources and Forestry
Mapping & Information Resources Branch

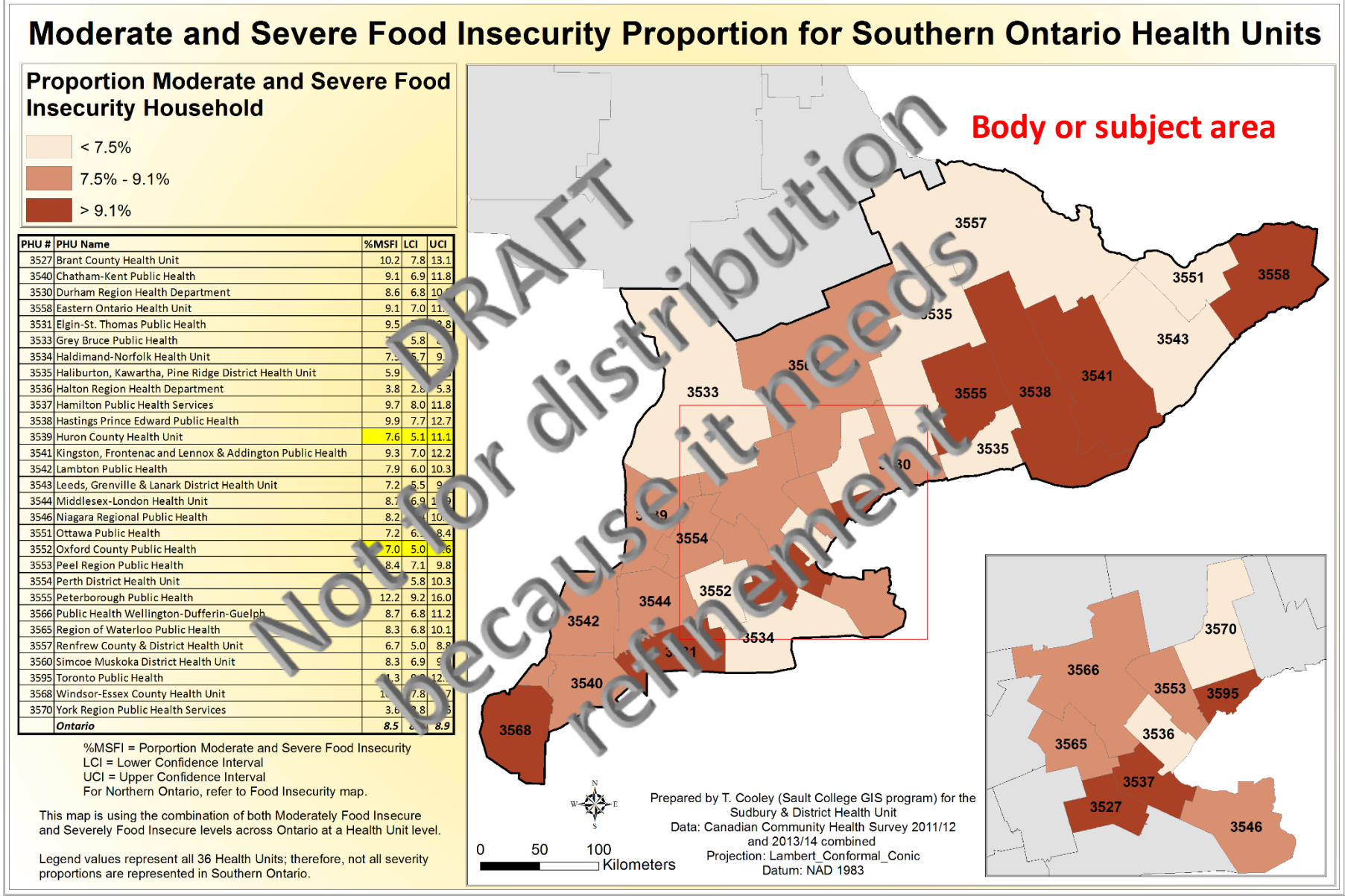
January 10, 2017

Basic Cartographic Elements (Design Units)

Neatline/Borders

Title
& Subtitles

Legend/Key



Notes


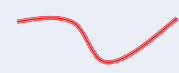
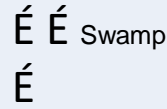
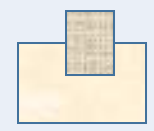







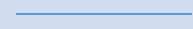

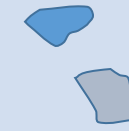







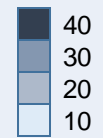
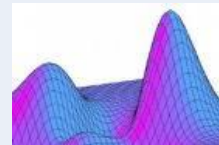
- Explanatory Text
- Sources
- Date
- Author
- Projection

Scale

Orientation

Insets (Locator/Extent/detail maps)

Geographic Variables and Representation (Phenomena vs. Data)

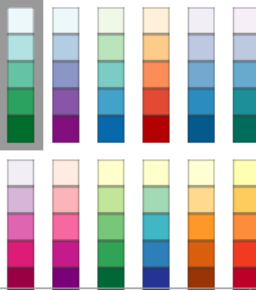
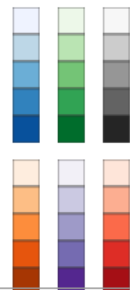
Scale of Measurement	Representation			
	Point	Line	Area	Surface Volume
Nominal	<ul style="list-style-type: none"> • Town ⋈ Mine 	 River  Road	 Swamp  Census Area	
Ordinal	 Large  Medium  Small  Large  Medium  Small	 Roads Major  Minor  Trail	 Industrial Region  Major  Minor	
Interval-Ratio	<p>Repetition</p> <p>Graduated</p>  	 Contour (Isarithms)  Flowlines	 	

Symbol Dimensions and Map Type

Symbol Dimension	Map Type	
	Qualitative	Quantitative
Shape	X	
Size		X
Colour <ul style="list-style-type: none">•Hue•Value (light/dark)•Saturation (Intensity/purity)	X	X X
Pattern <ul style="list-style-type: none">•Orientation•Arrangement•Texture	X X	X

Some help - Must bookmark! ColorBrewer


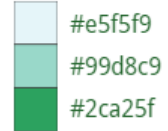
Number of data classes: 3 ⓘ how to use | up BuGn class 1 | logs | js | credits
Nature of your data: ⓘ
 sequential diverging qualitative

Pick a color scheme:
Multi-hue: 
Single hue: 

Only show: ⓘ
 colorblind safe
 print friendly
 photocopy safe

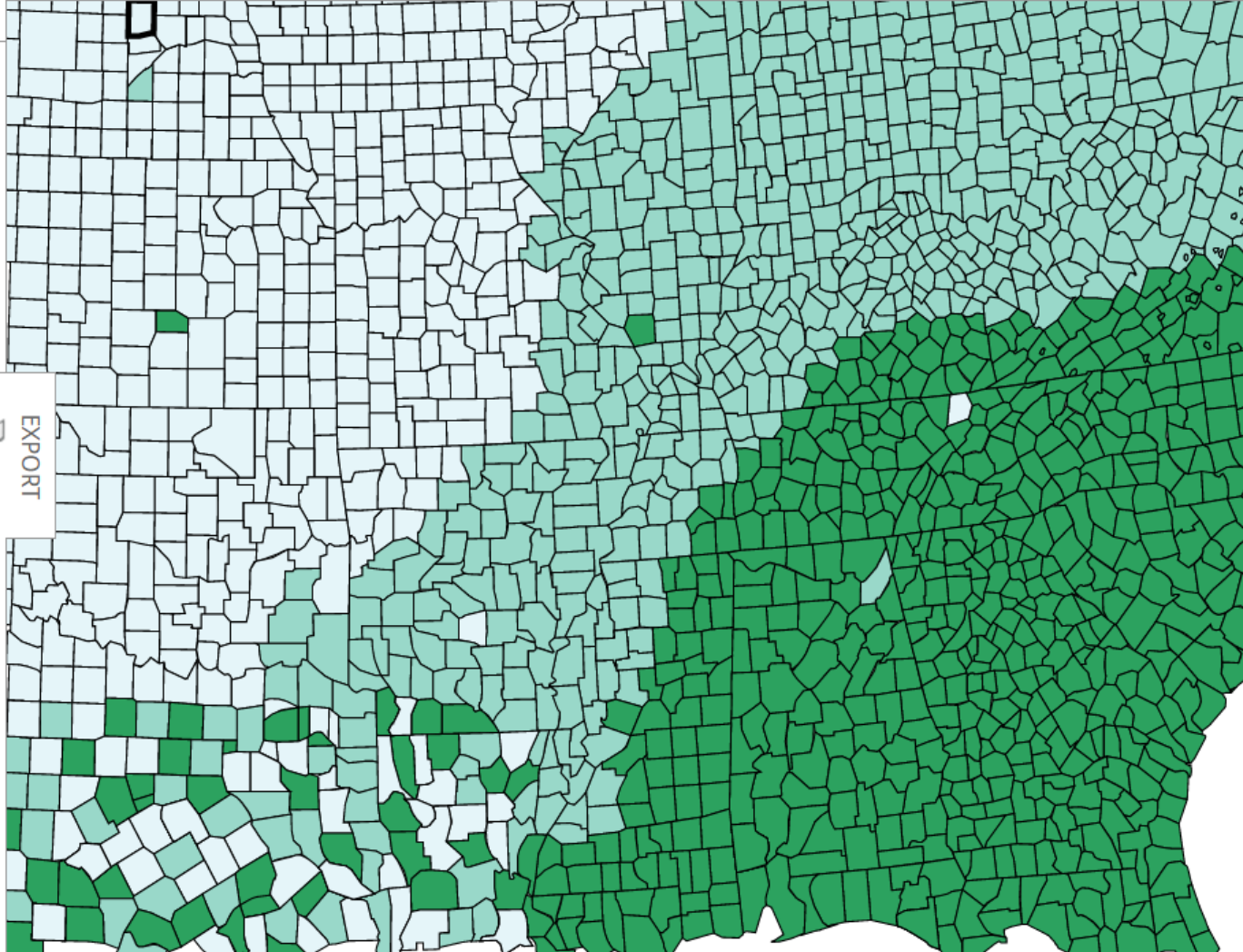
Context: ⓘ
 roads
 cities
 borders

Background:
 solid color terrain
color transparency

3-class BuGn ⓘ
EXPORT 
HEX ▼

#e5f5f9
#99d8c9
#2ca25f

COLORBREWER 2.0
color advice for cartography

BuGn class 1
RGB: 229,245,249
CMYK: 10,0,0,0
HEX: #e5f5f9



Must read...at least the first few chapters

- *Thematic Cartography and Geovisualization*, Slocum et al.

or

- *Cartography: Thematic Map Design*, Dent et al.

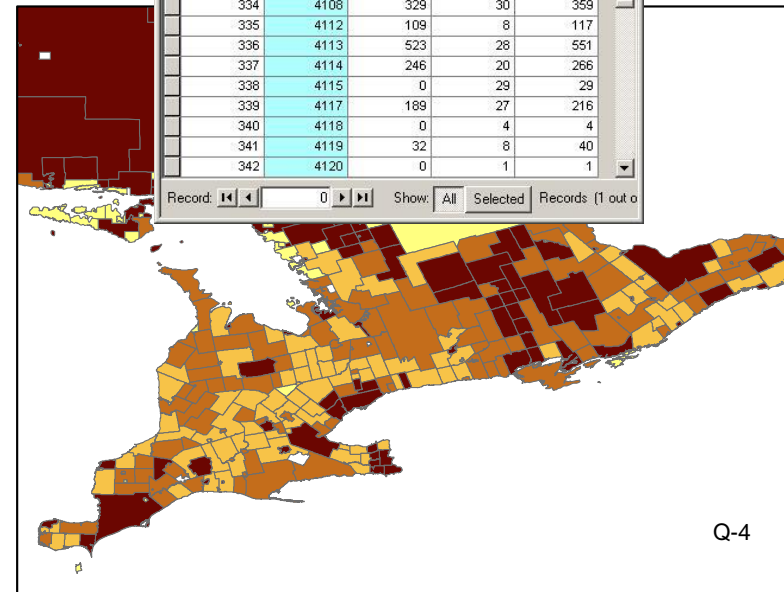
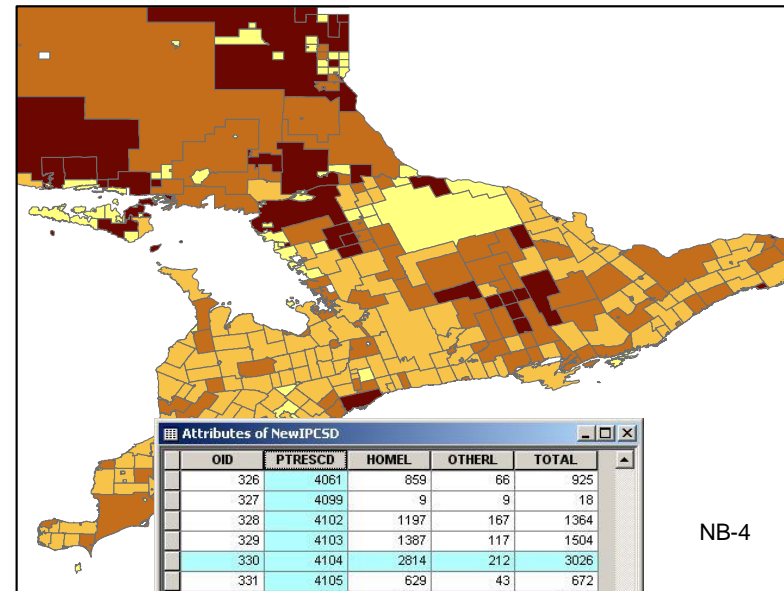
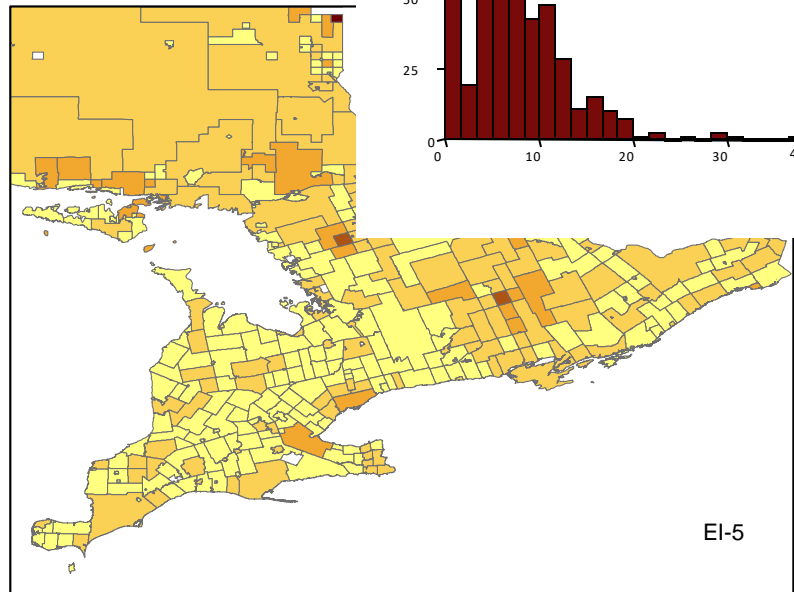
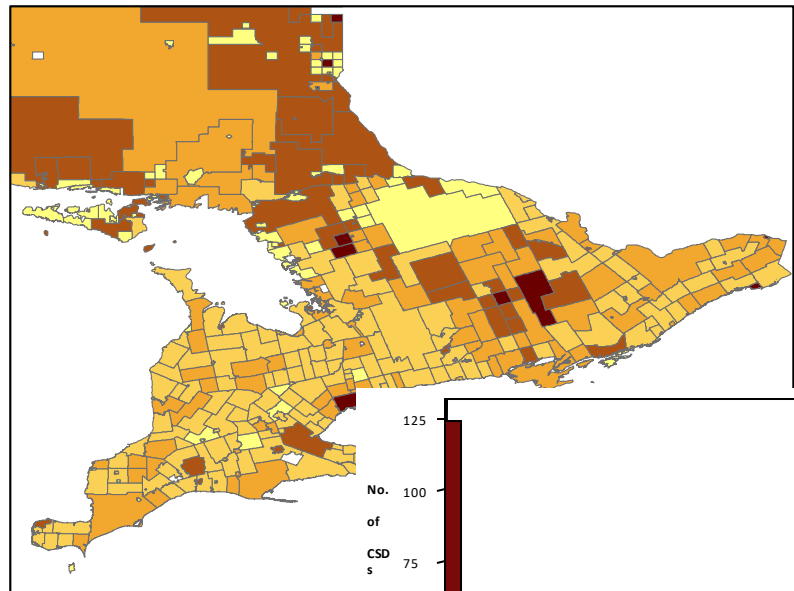
This one you should read through and through

- *How to lie with Maps*, Mark Monmonier

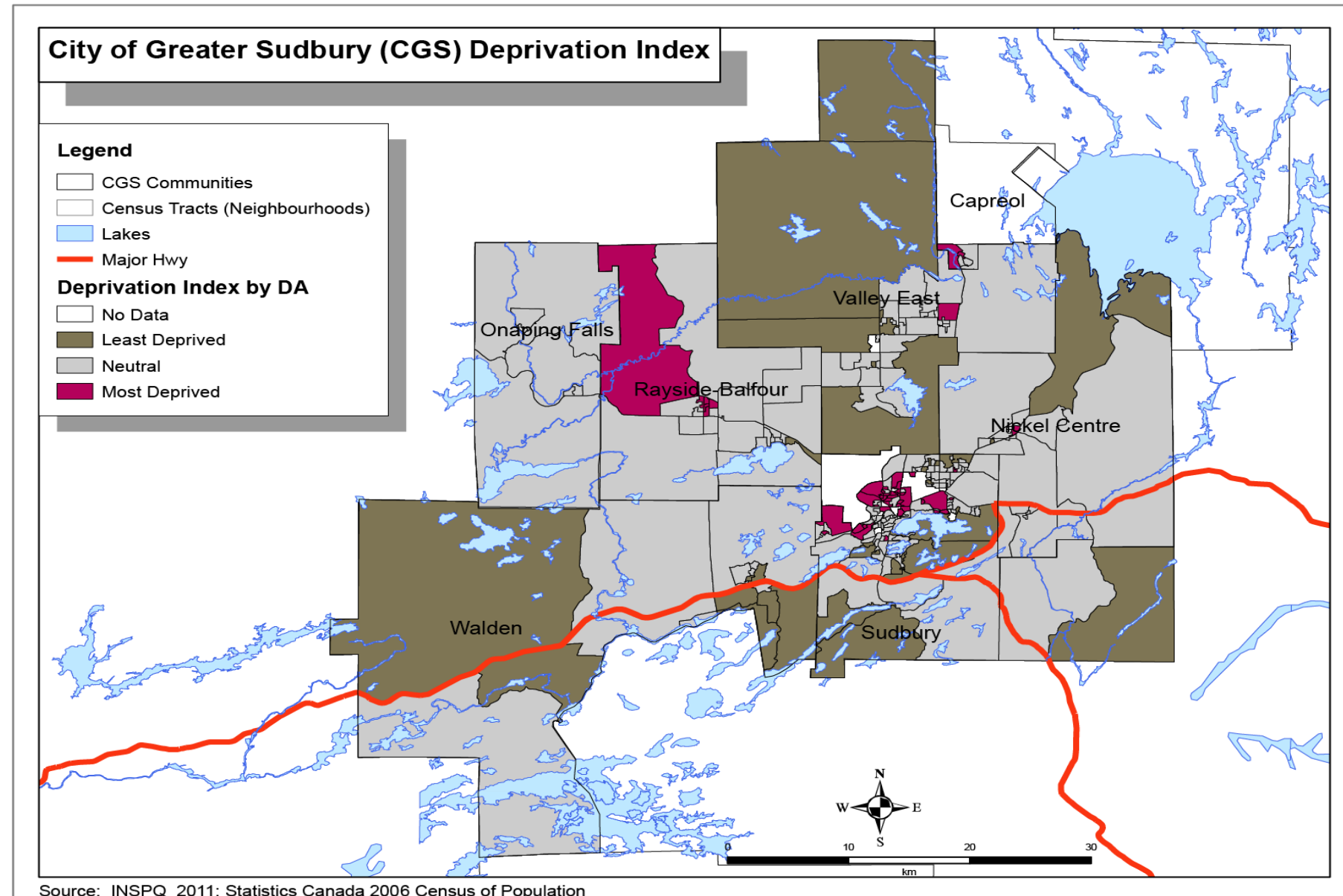
But beware of wizards and black boxes!



Know your Cartography – and get to know your data







Choropleth maps have draw backs!







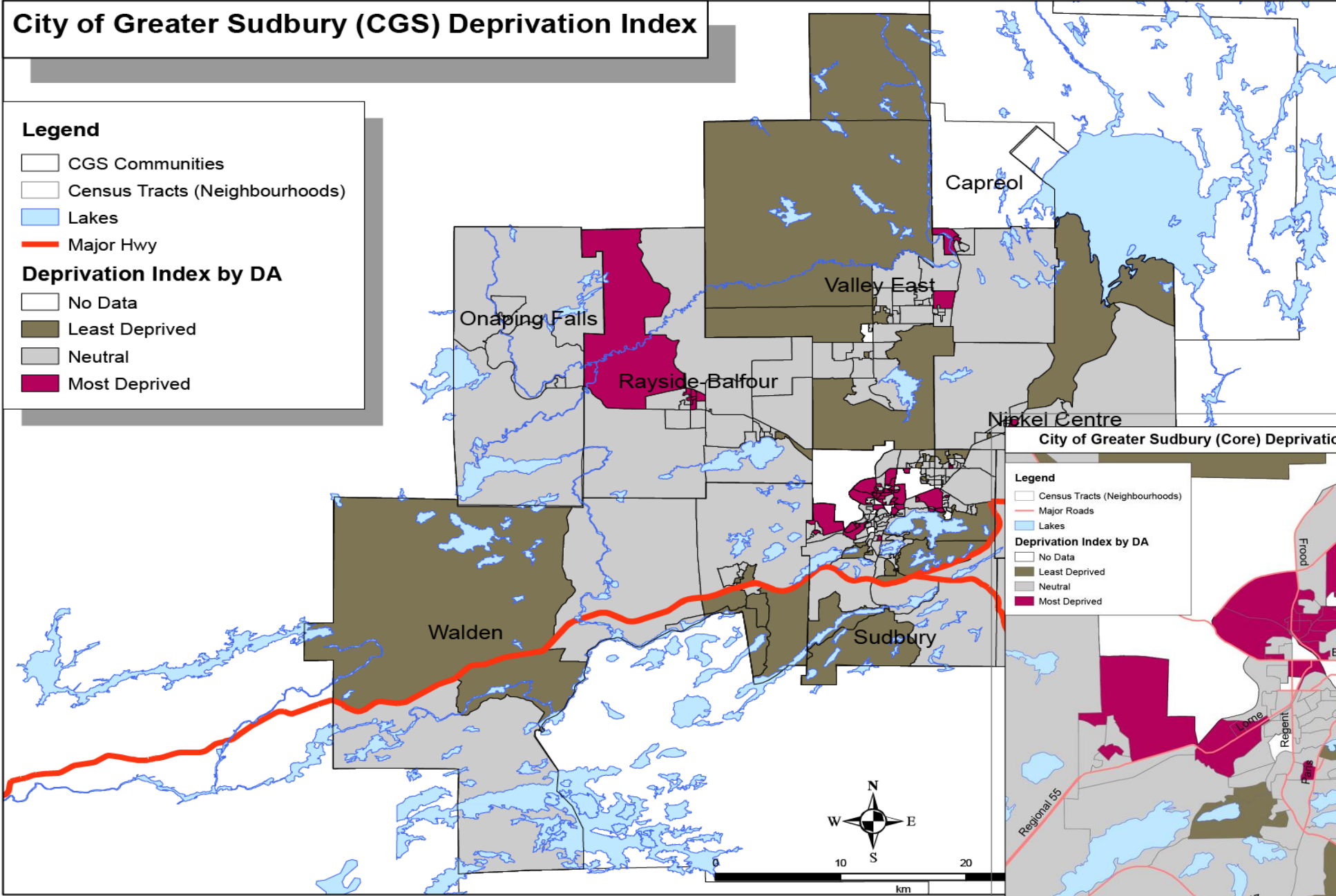
City of Greater Sudbury (CGS) Deprivation Index

Legend

-  CGS Communities
-  Census Tracts (Neighbourhoods)
-  Lakes
-  Major Hwy

Deprivation Index by DA

-  No Data
-  Least Deprived
-  Neutral
-  Most Deprived



Source: INSPQ 2011; Statistics Canada 2006 Census of Population

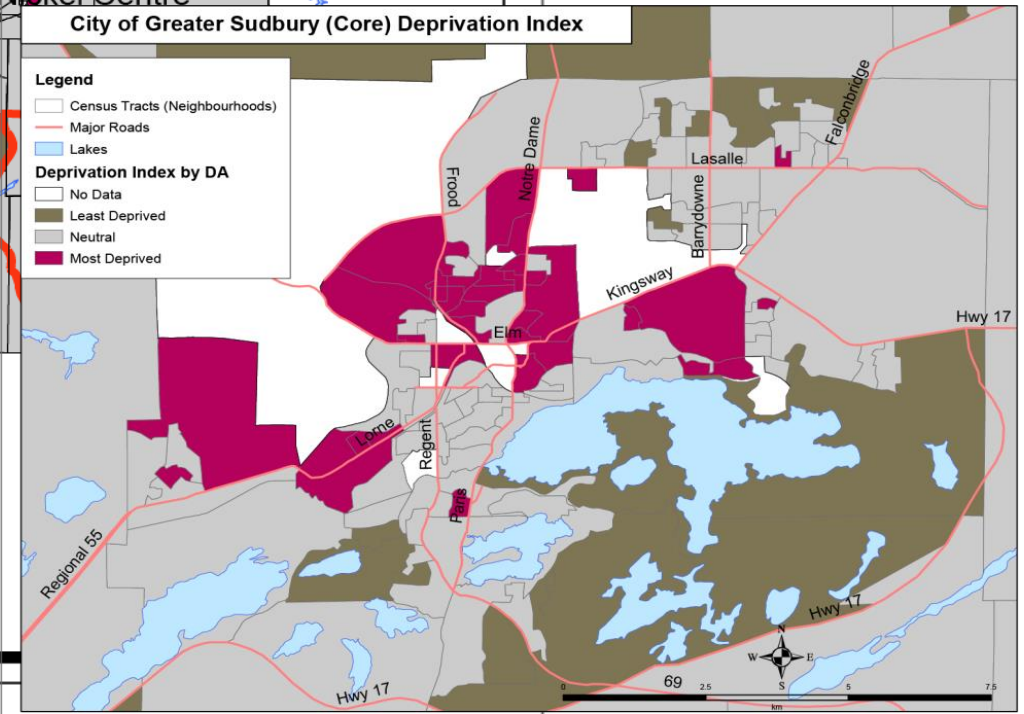
City of Greater Sudbury (Core) Deprivation Index

Legend

-  Census Tracts (Neighbourhoods)
-  Major Roads
-  Lakes

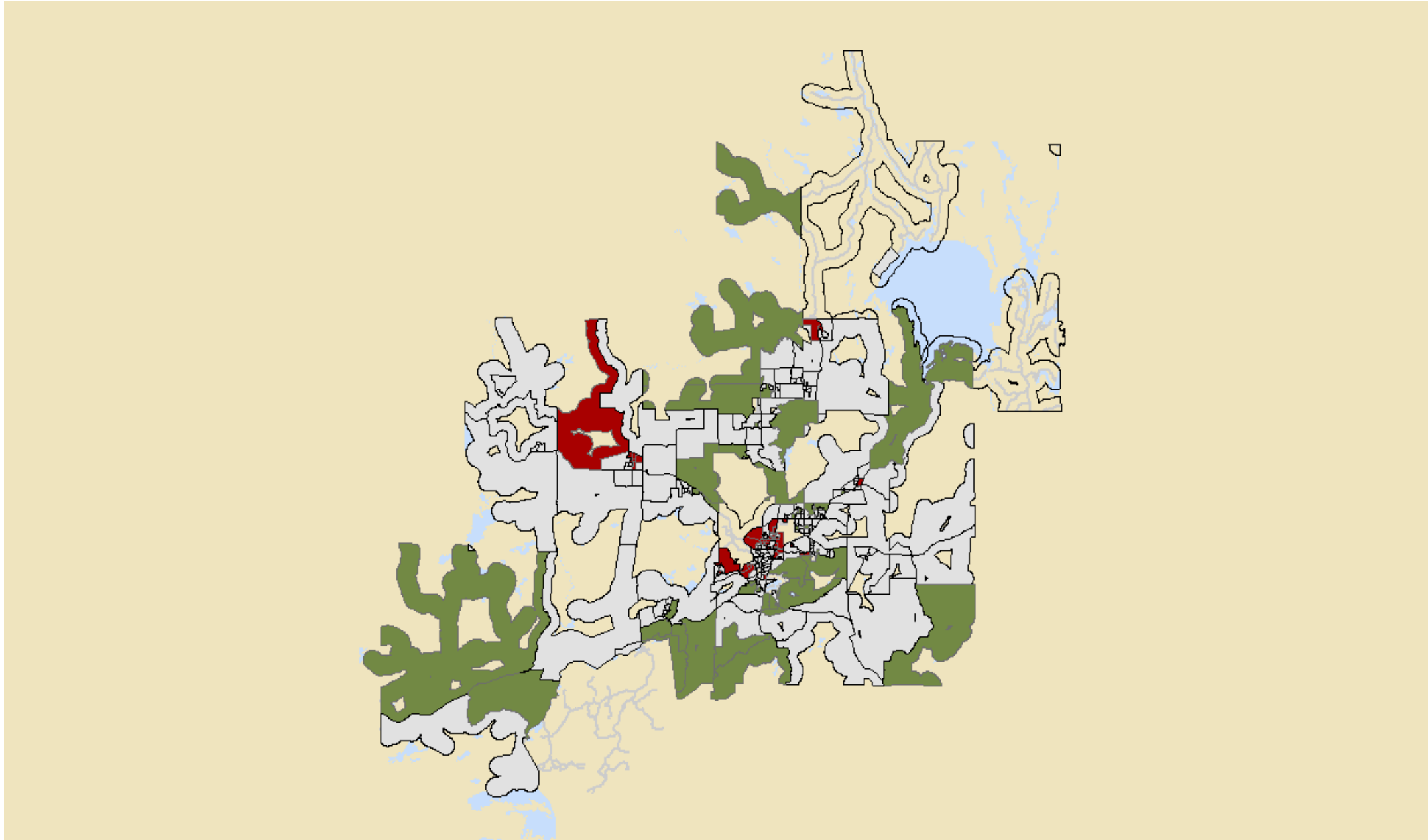
Deprivation Index by DA

-  No Data
-  Least Deprived
-  Neutral
-  Most Deprived

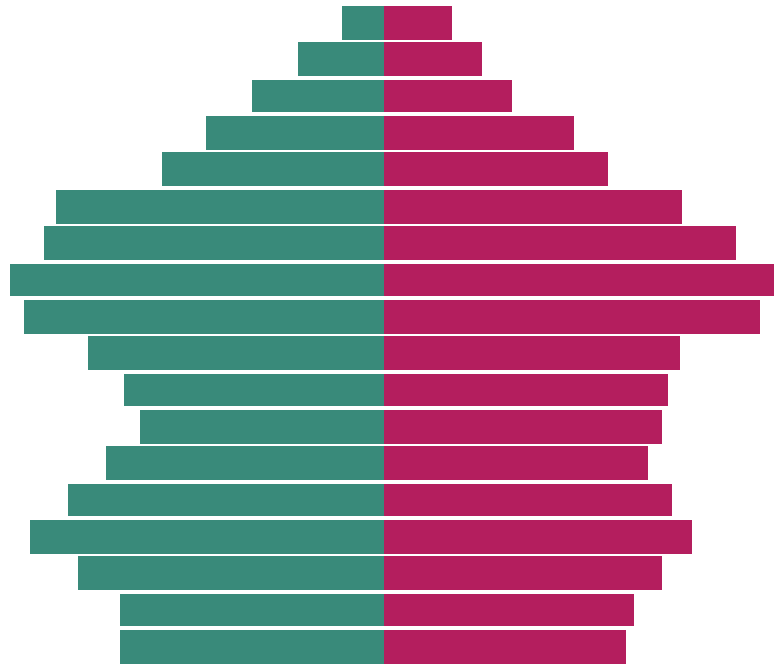


Source: INSPQ 2011; Statistics Canada 2006 Census of Population

Dasymetric mapping – not sure that's better



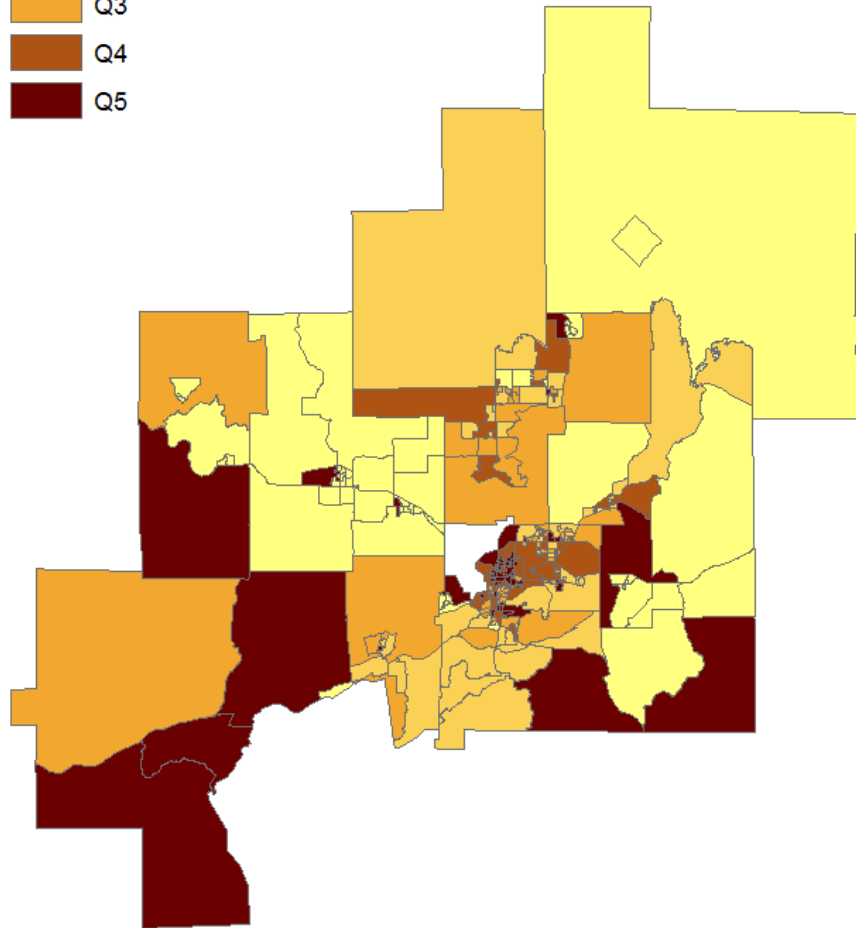
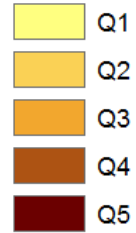
Not all areas are created equal!
Know your subject & data...



...to ensure responsible communication - Map Literacy
E.g. ER visits Crude rate vs. Age-standardized rate

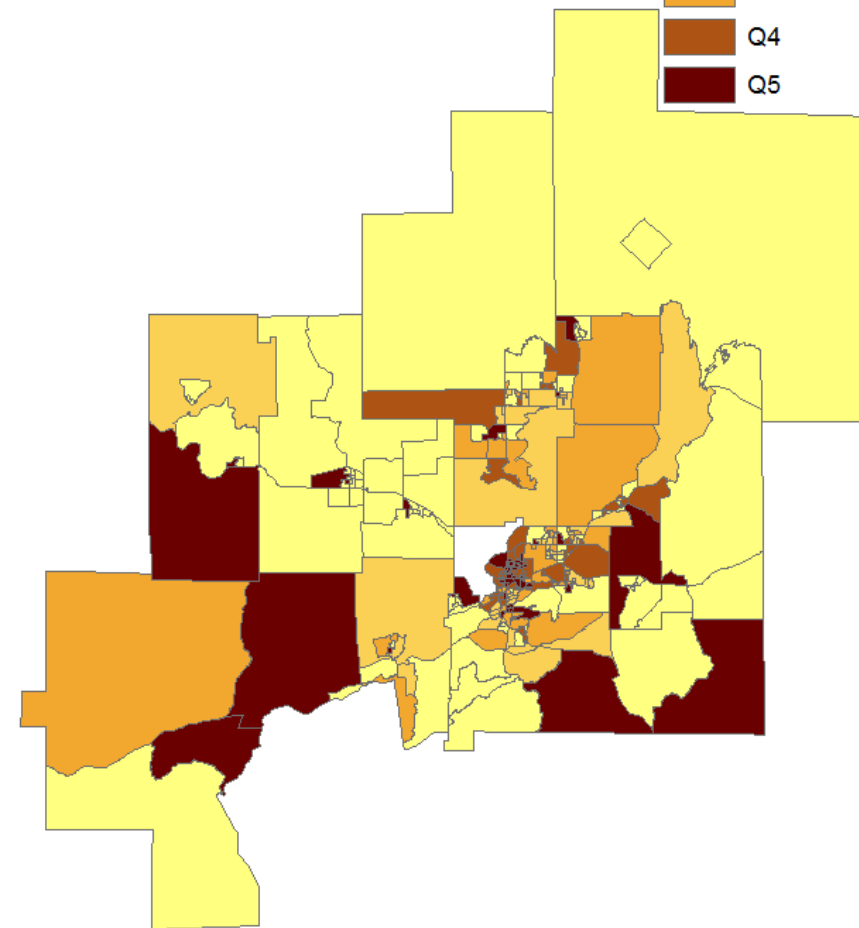
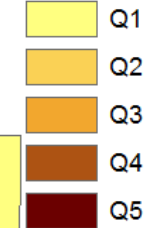
GSD_DA_2016

CrudeRt



GSD_DA_2016

AdjRt





EXCEPTION!

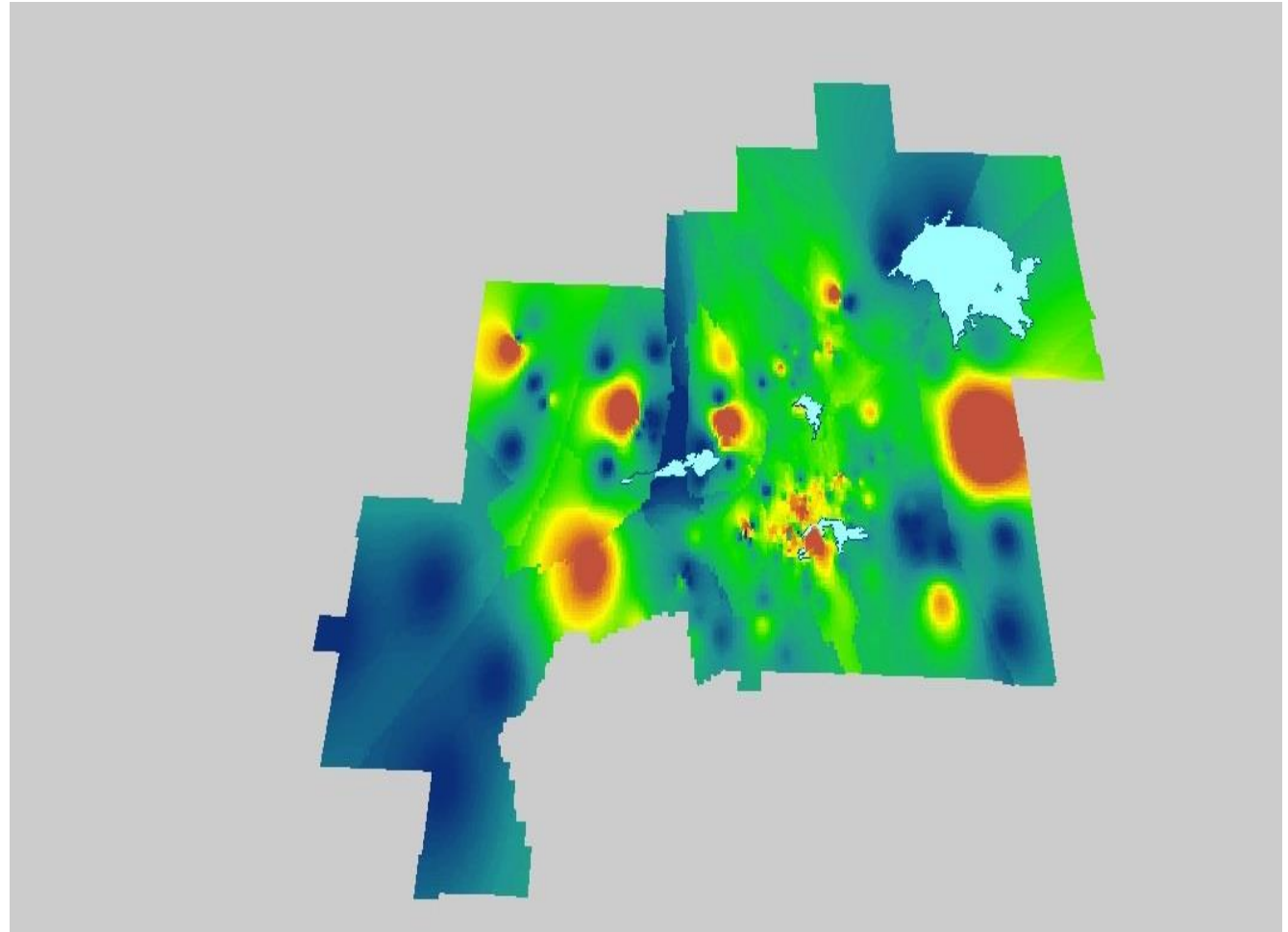
Cartographic conventions and design can be put on hold when doing Exploratory Spatial Data Analysis (ESDA)

What you should know before making maps with GIS

2. What is GIS

GIS: beyond desktop mapping

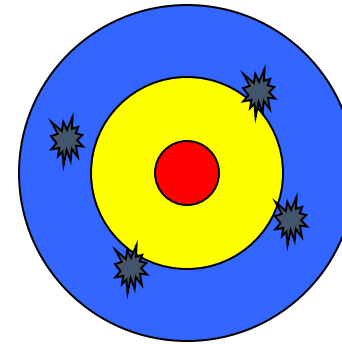
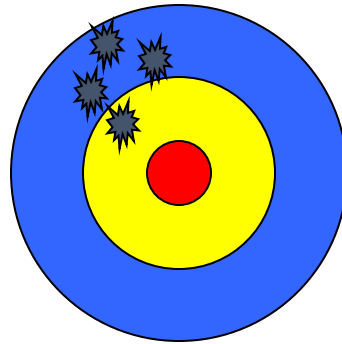
- Basic Spatial Analysis
 - Buffers
 - Spatial Queries
 - Incorporates +++ tools
- Advanced spatial analysis
 - Spatial stats
 - Modelling
- Exploratory Spatial Data Analysis (ESDA)
 - It's like a 2D (even 3D) histogram
 - Spot outliers
 - Find errors



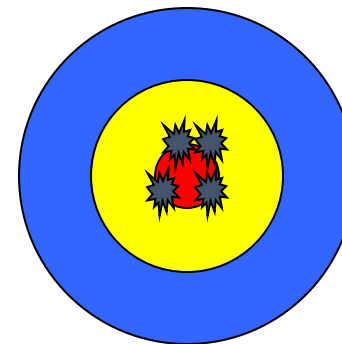
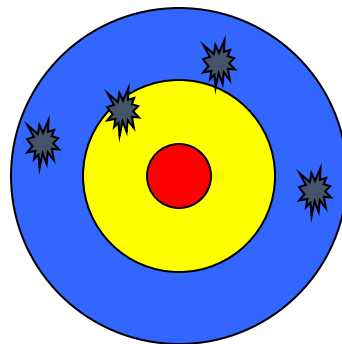
What you should know before making maps with GIS

3. Precision vs. Accuracy and Error propagation

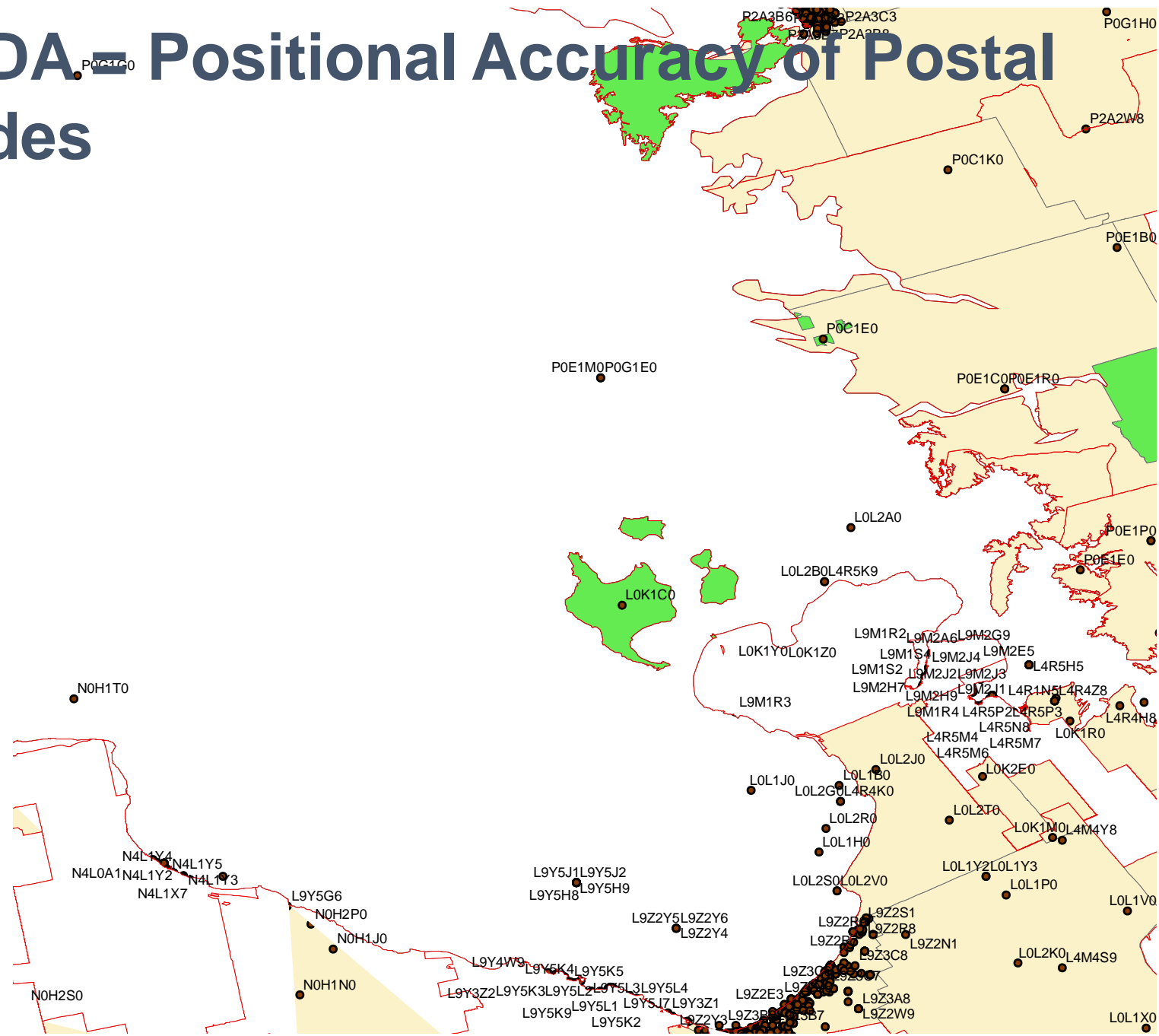
DATA -Accuracy vs. Precision



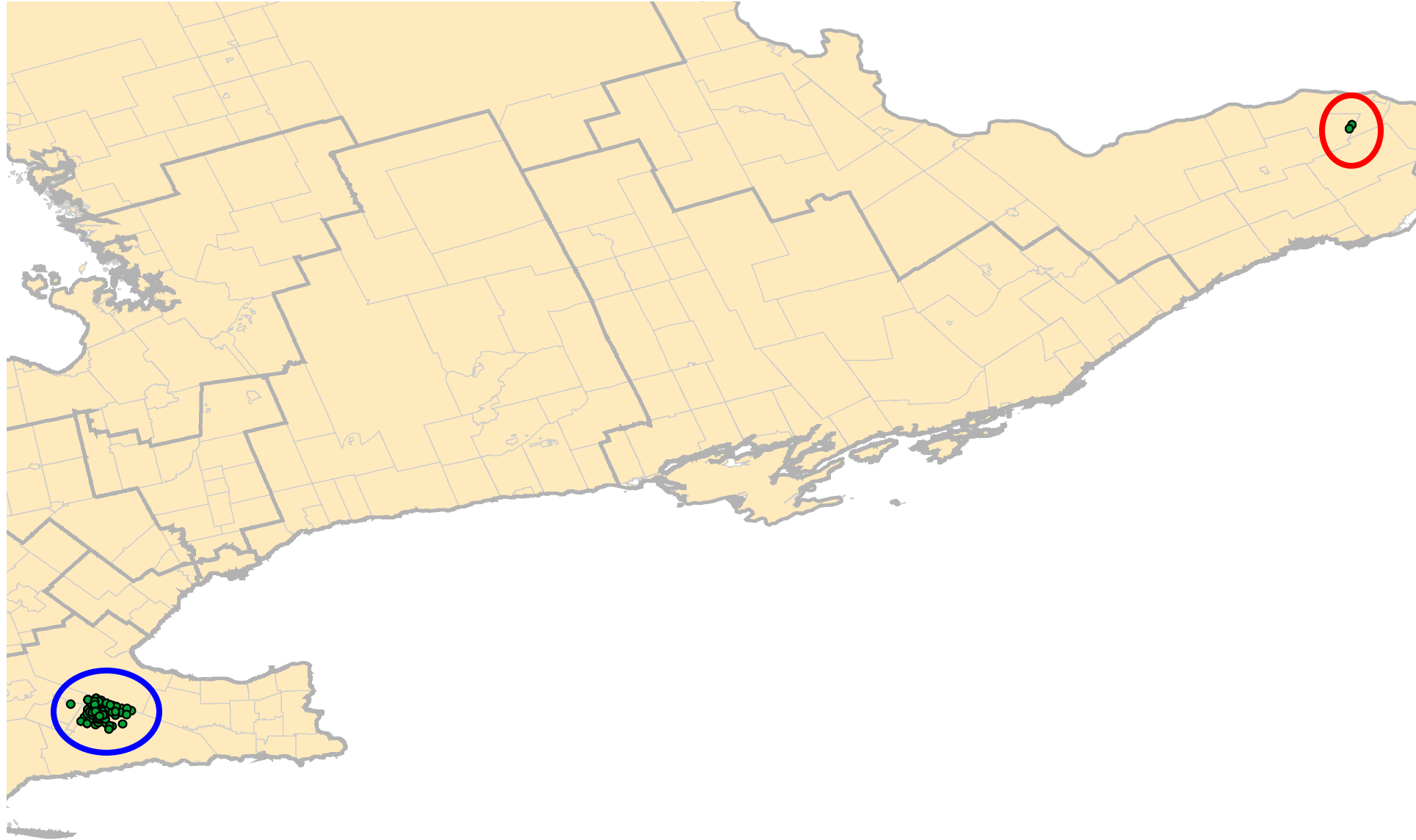
Just because you can map it, don't presume it's in the right place!!



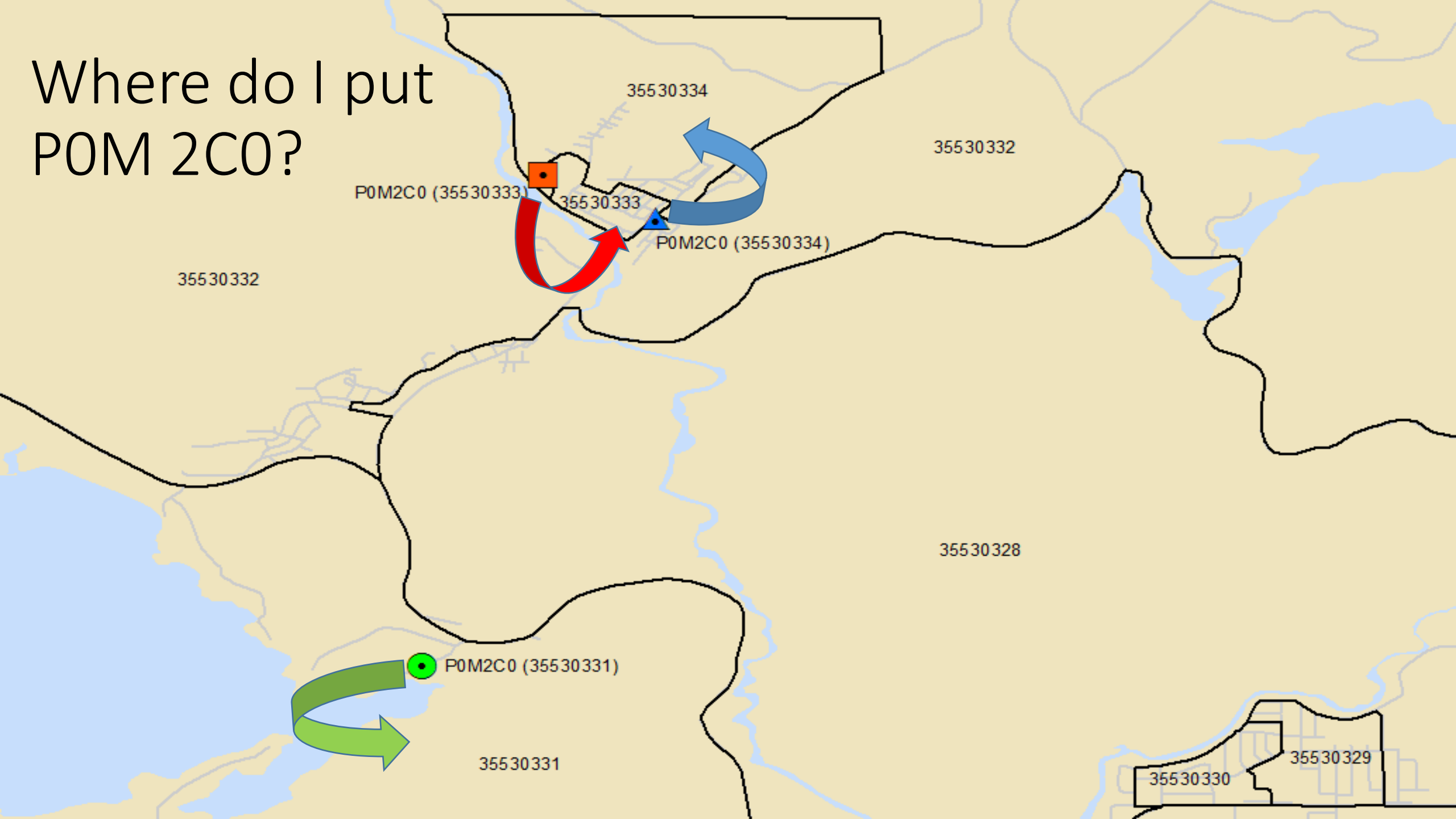
ESDA = Positional Accuracy of Postal Codes



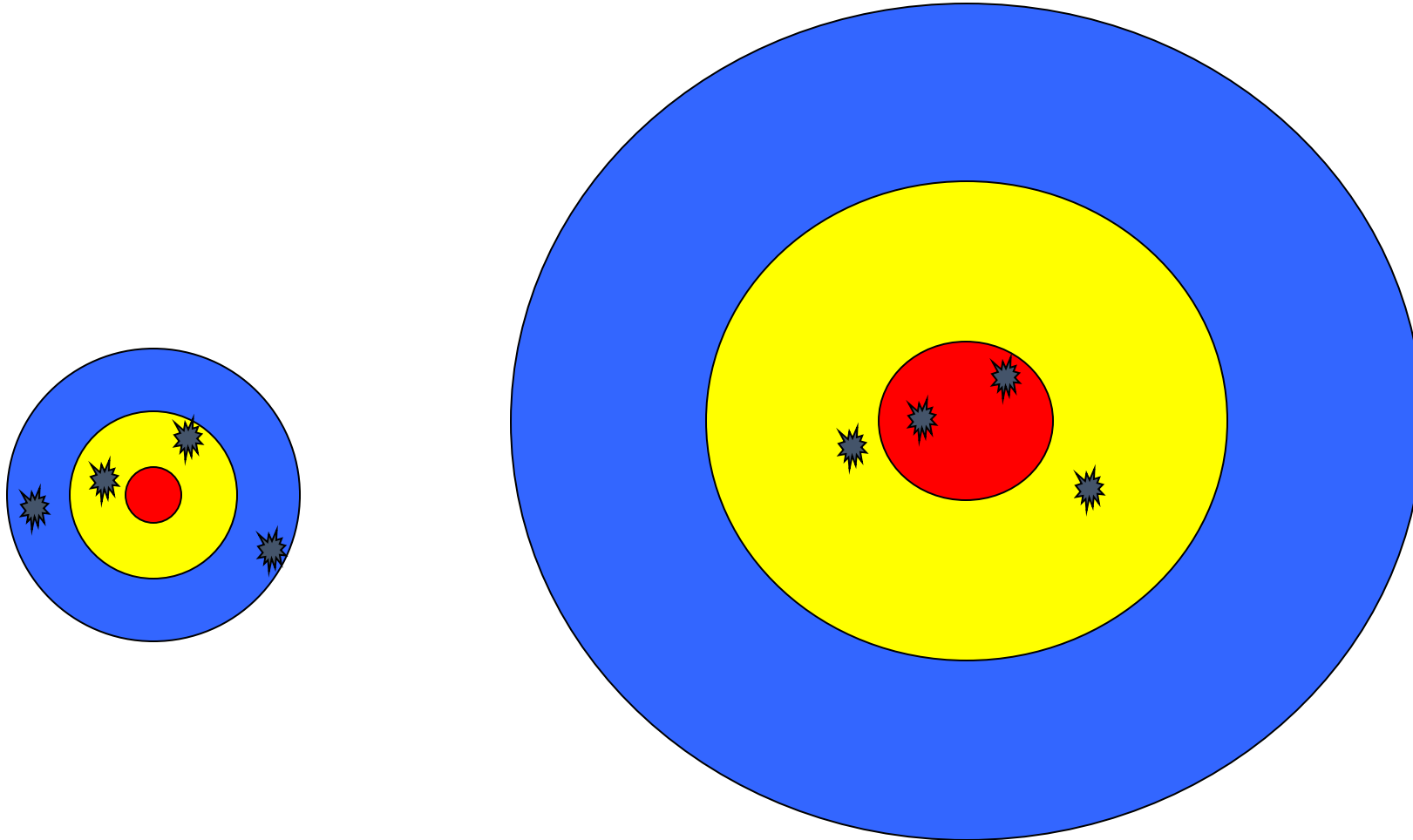
ESDA = Positional Accuracy FSA = N3W



Where do I put
POM 2C0?

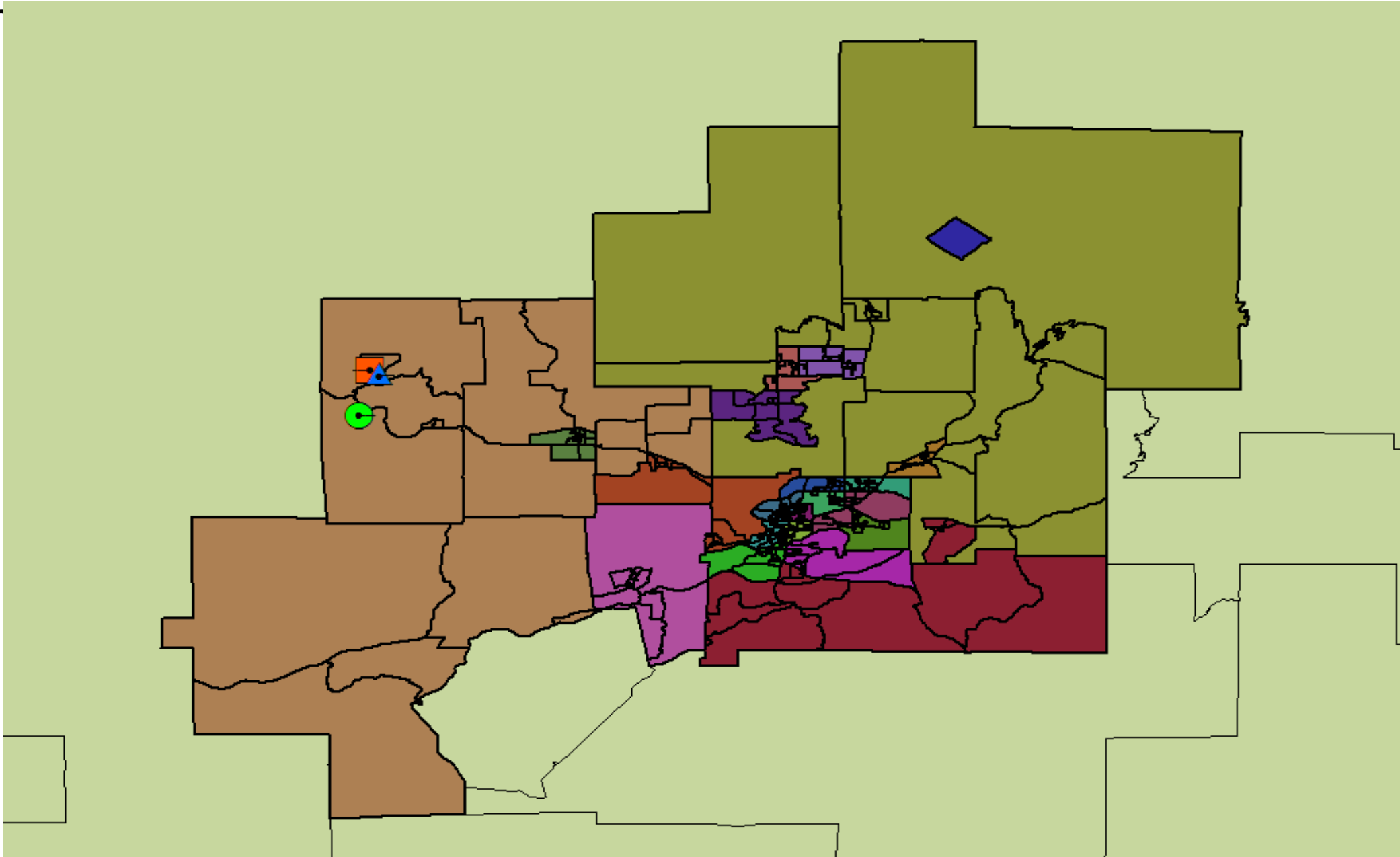


You could grow your target

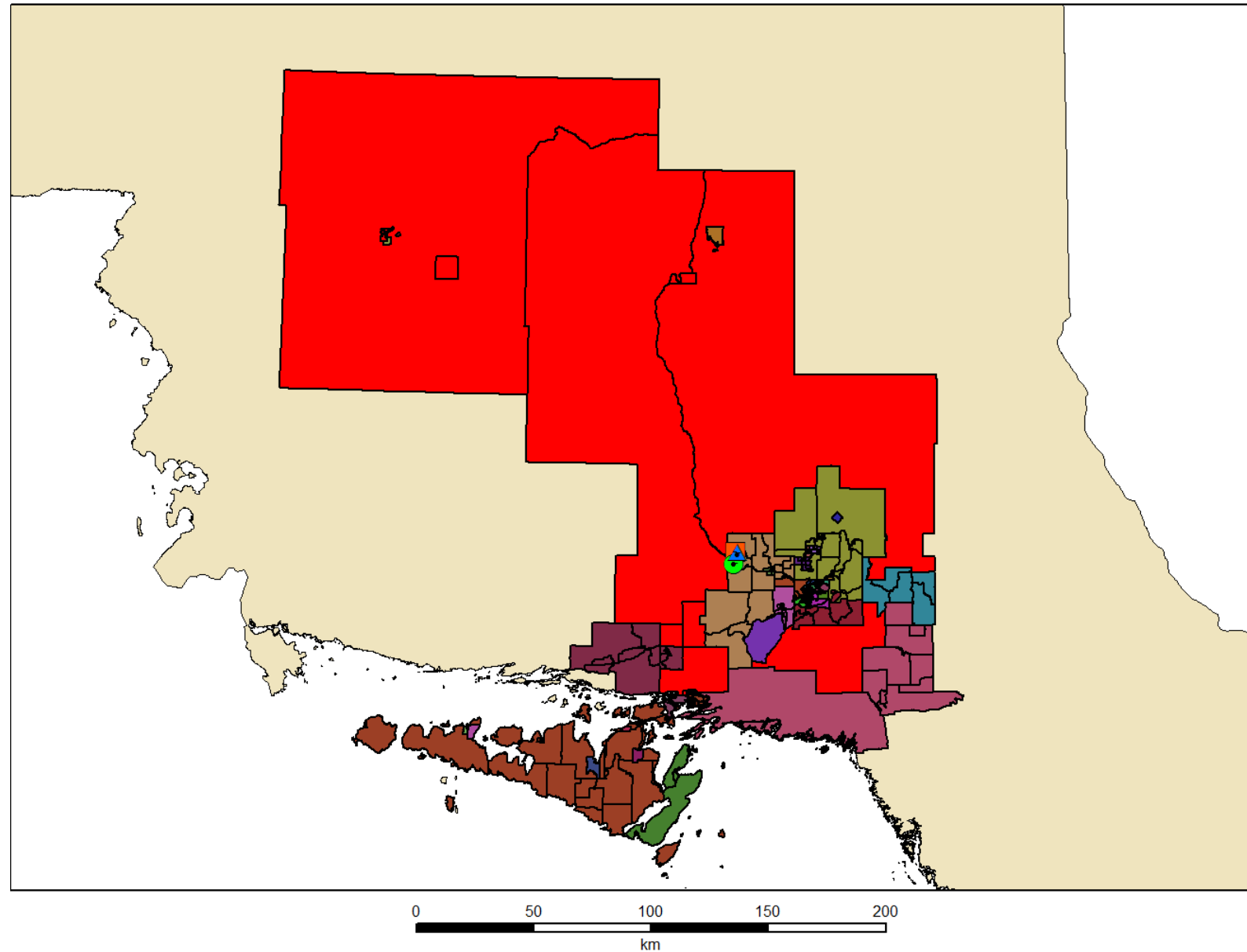


Use a larger geographic area, CT, Aggregated Dissemination Areas, that should work!

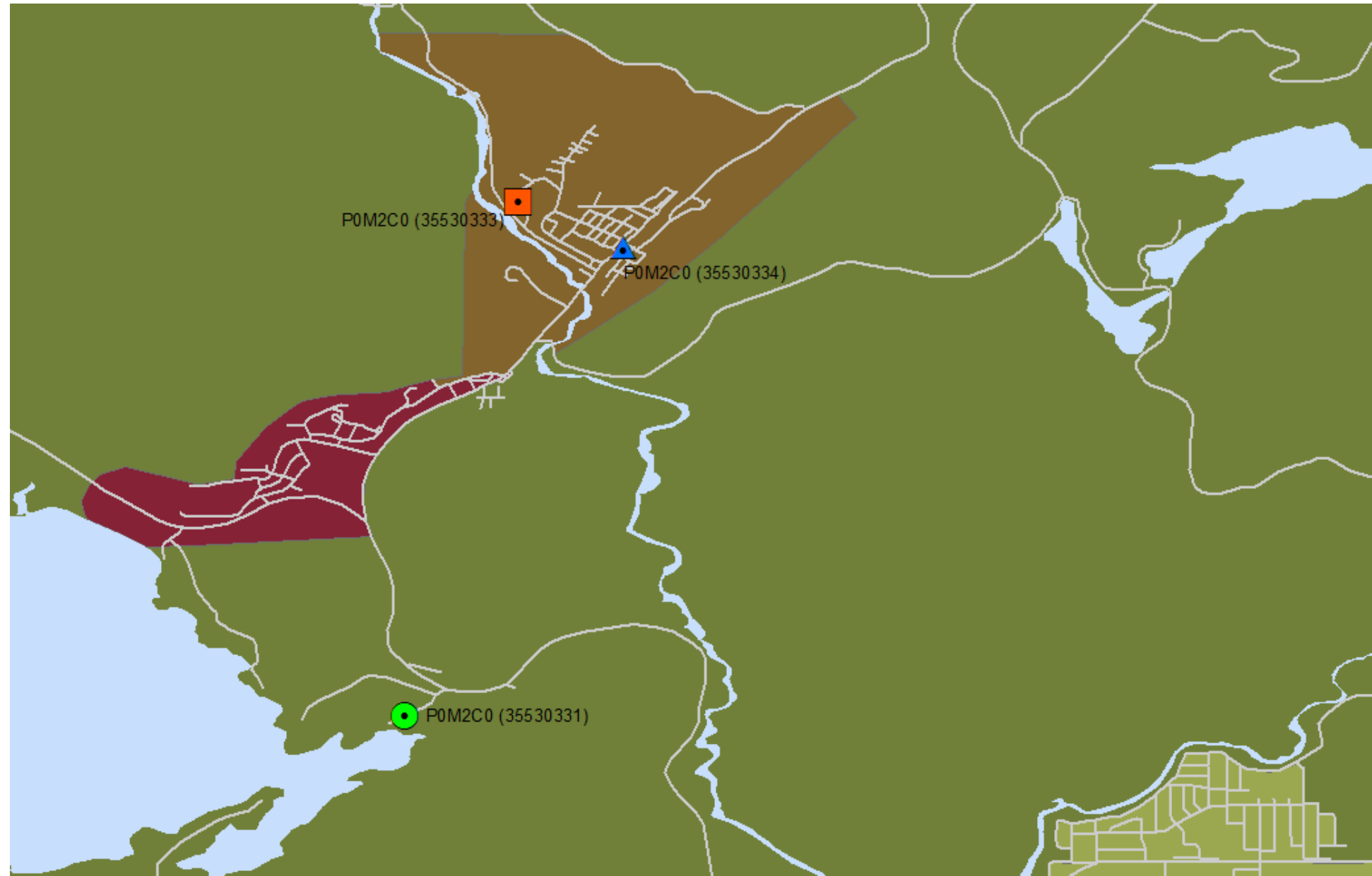
Using the new Aggregated Dissemination Areas (ADA). Hr



But some are awfully big!

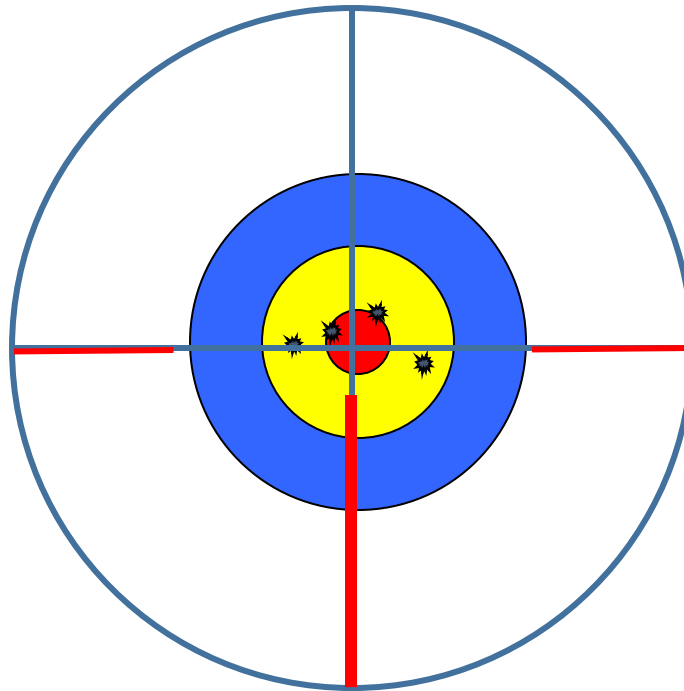


Custom Geography – that's better



You can try to be even more precise - snipe it!

Surely, geocoding using street addresses would help!



Careful, that thing's loaded!

But beware of wizards and black boxes!



E.g. Geocoding challenges with street addresses

Using a GIS and Spatial Statistics
to Model Demand for
Emergency Medical Services
in the City of Sudbury, Ontario

MA Thesis, Marc Lefebvre

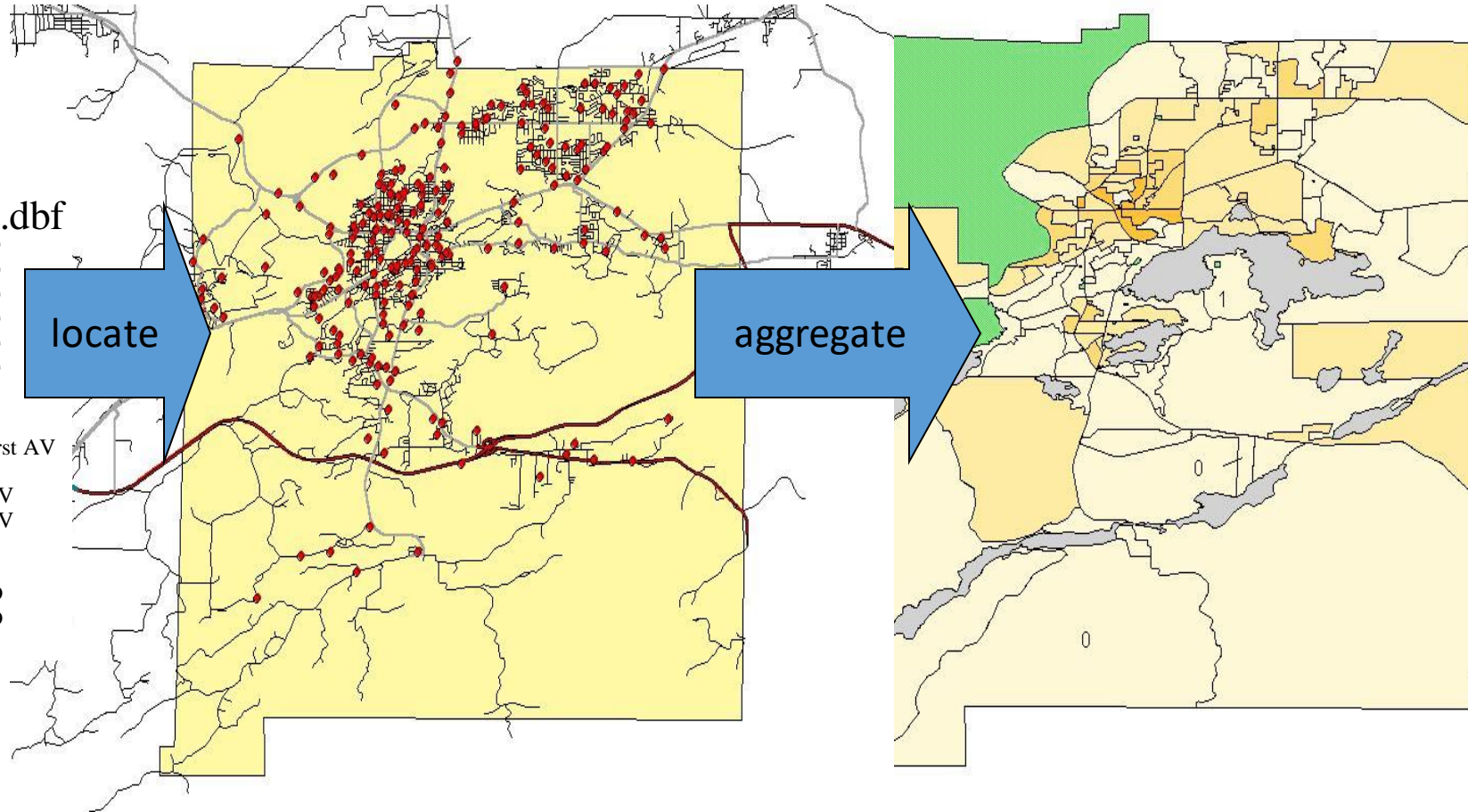
If I could

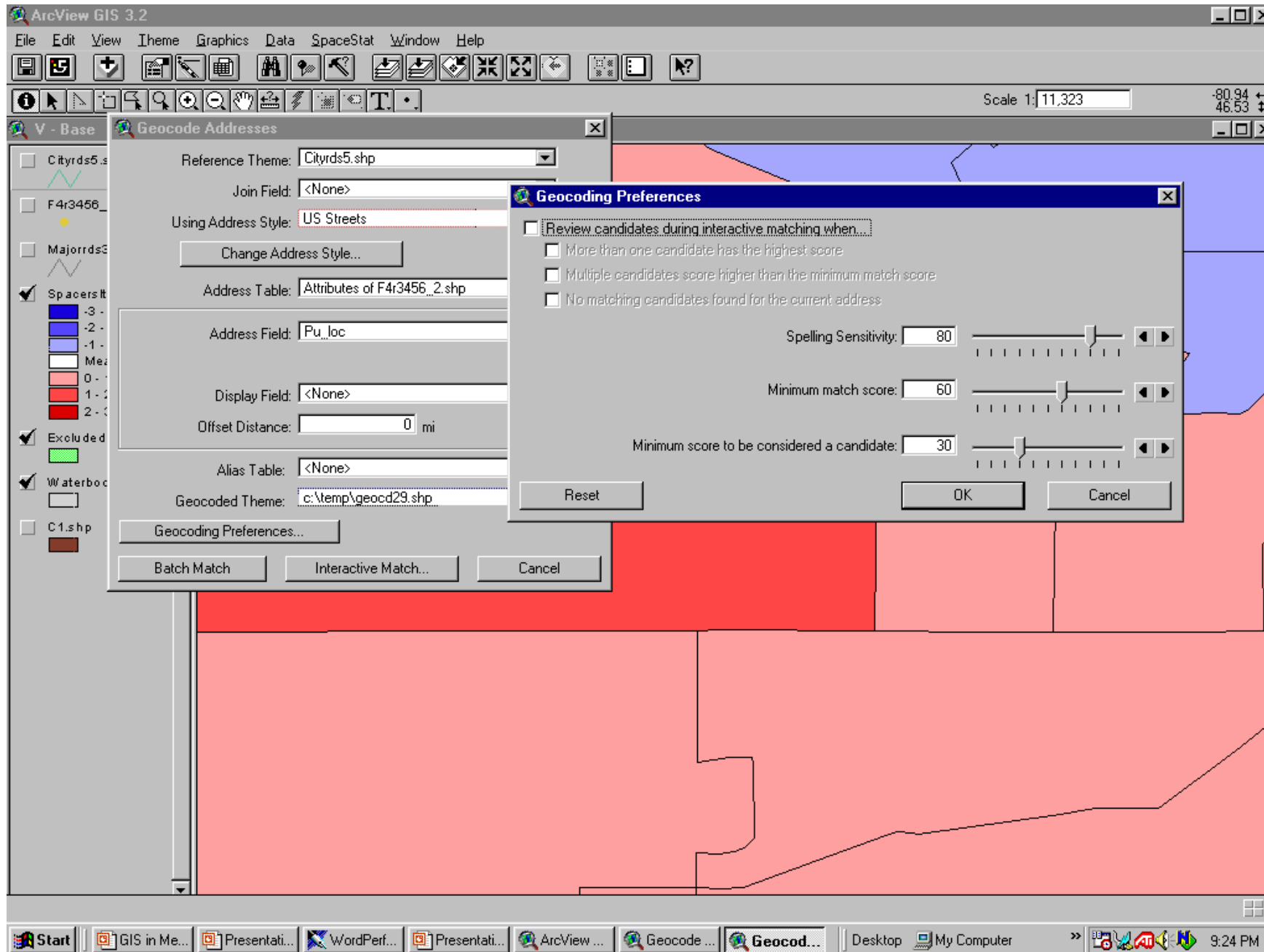
Address.dbf

123 Queen ST
125 Queen ST
129 Queen ST
129 Queen ST
129 Queen ST
129 Queen ST
234 King ST
250 King ST
King ST & First AV
10 Short AV
111 Second AV
117 Second AV
200 First AV
23 Long DR
18 Bulmer RD
40 Bulmer RD

locate

aggregate





Yes that's actually ArcView 3.2!

Error Type – Events File

- Typos
 - Street name, number, direction, type
- Wrong data
 - Street, municipality
- Old data (previous address)
- No data
- Transpositions
 - Apartment 2 at 61 Regent Street = 2-61 Regent ST
 - NOT 61-2 Regent ST

Error Source - Events File

- Data Collection
 - Collected error –paramedic given wrong address
 - Created error - paramedic enters a different address/municipality than he/she responded to, or misspells
- Database Entry
 - Transcribed error from above
 - Created error e.g., the pick up town “Sudbury” entered as Sudbur6y [*sic.*], or Suysudbury [*sic.*]

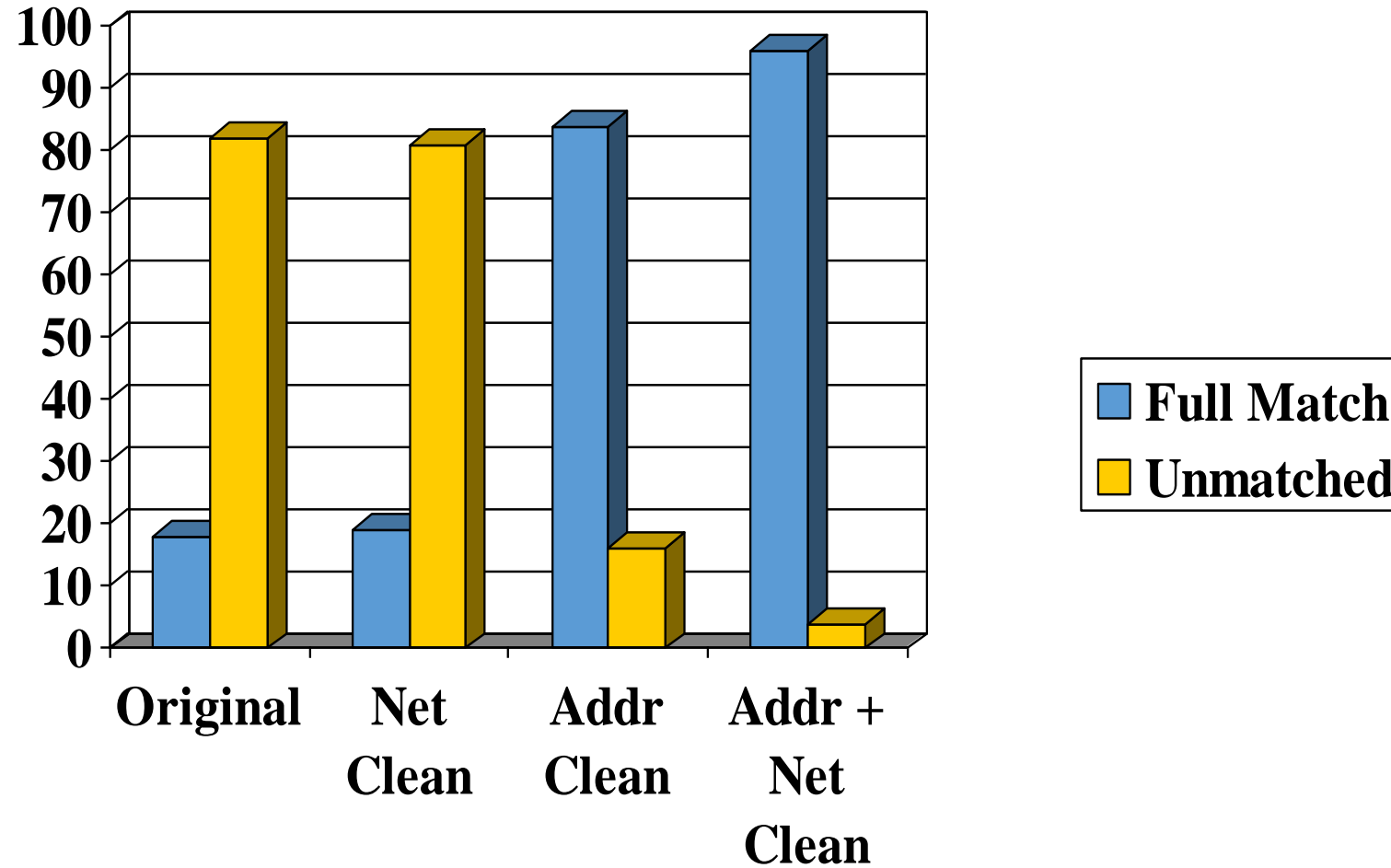
Error Type - Street Network File

- Outdated address ranges
- Missing address ranges
- Wrong address ranges
- Missing streets

Error Source - Street Network File

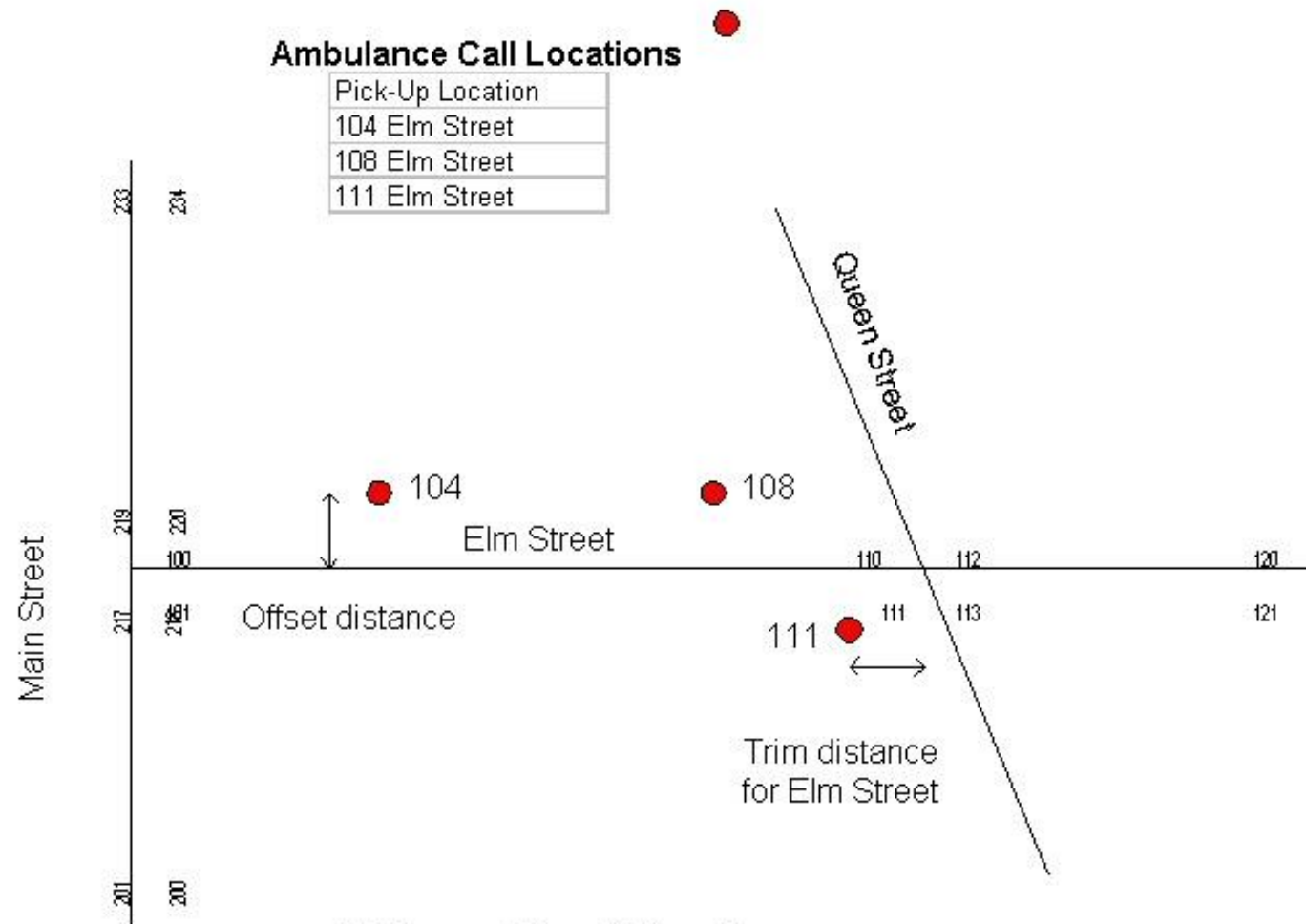
- Street name changes
- Street direction (NSEW) eliminated
- E911 requirements, municipal addressing
- New development
- Sloppy GIS

Geocoding Results



Even if addresses were 100%

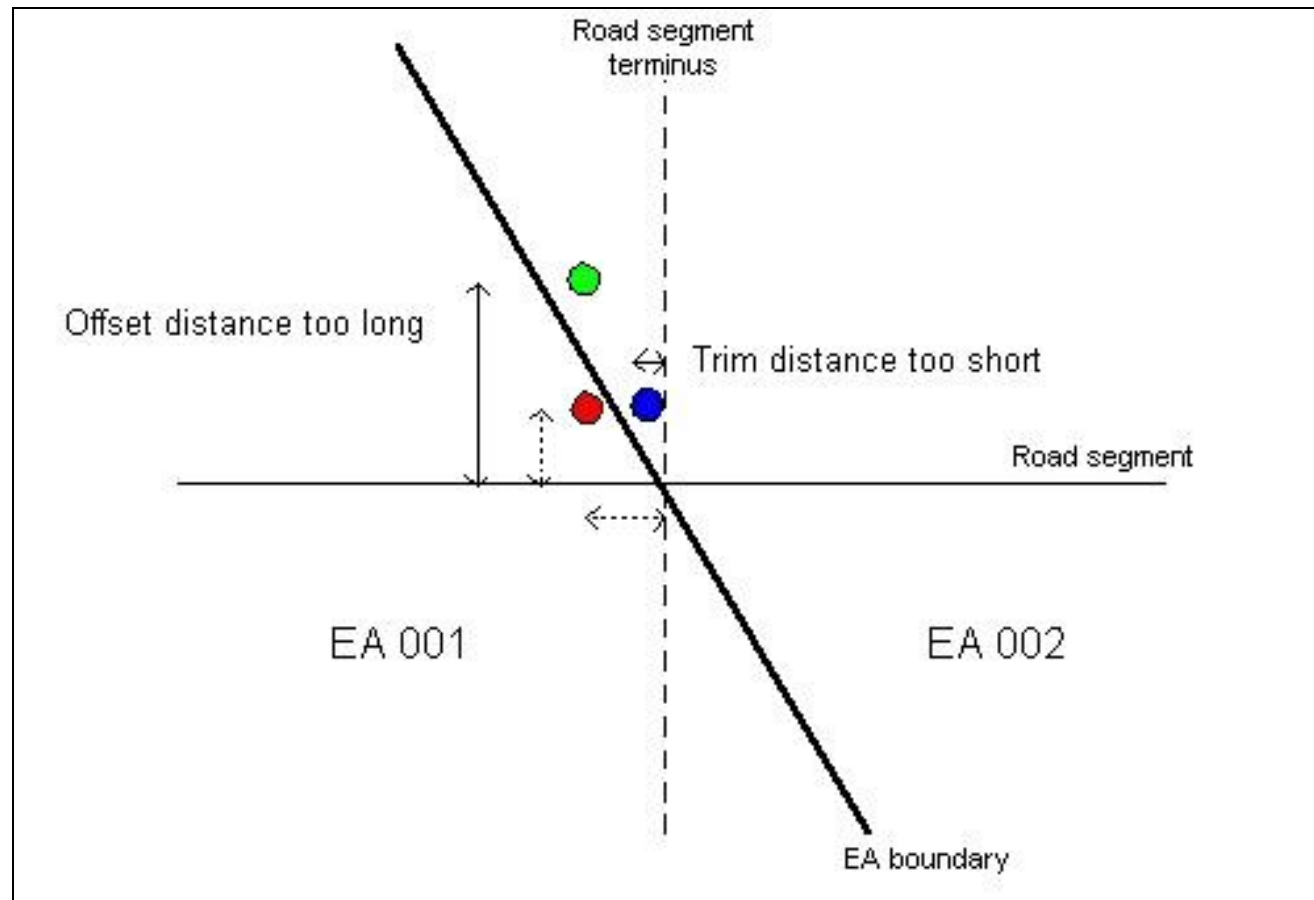
Watch the Overlay!!!



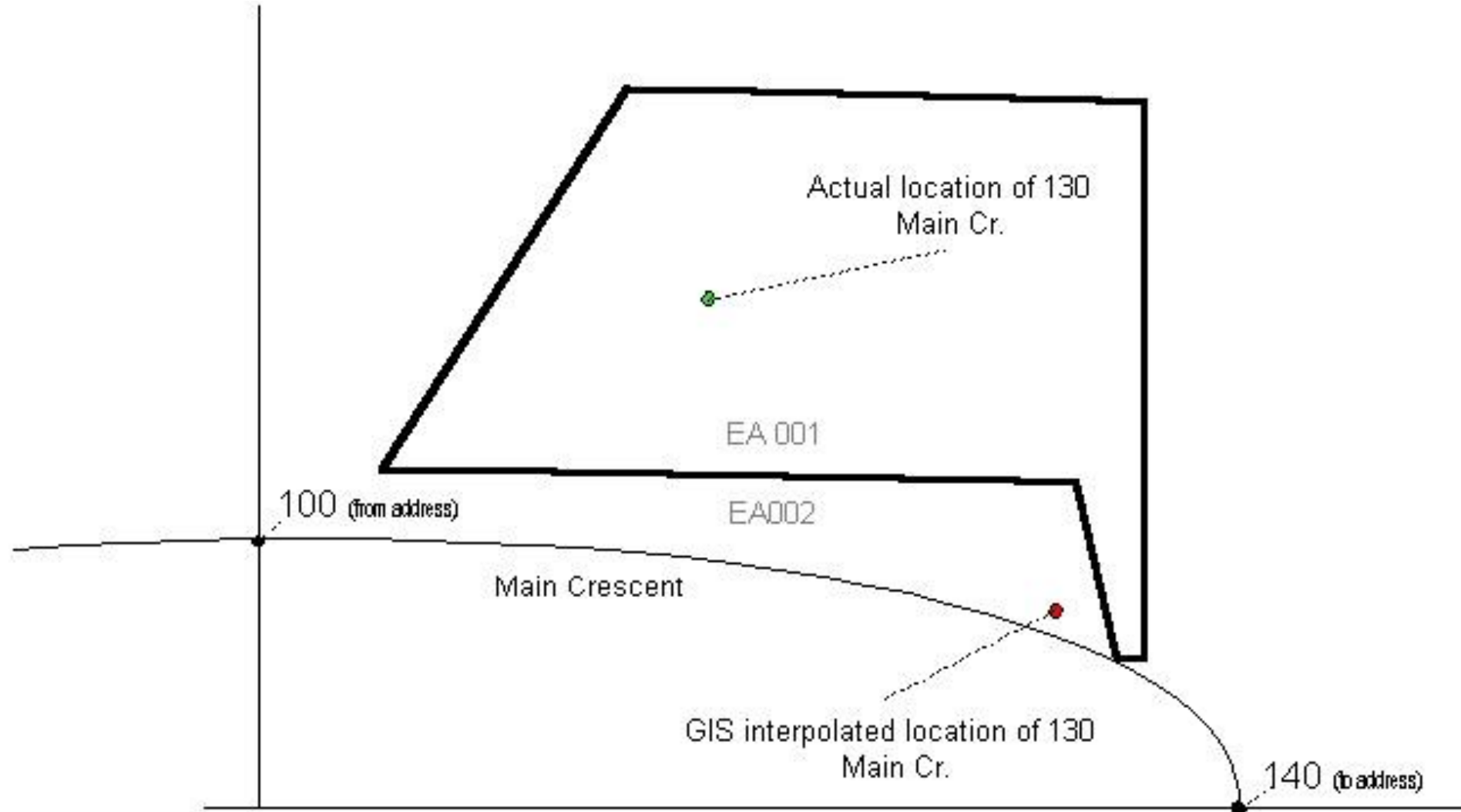
Addressed Road Network

Streetnam	LeftFrom	LeftTo	RightFrom	RightTo
Elm	100	110	101	111
Elm	112	120	113	121
Queen	24	38	25	39
Queen	40	60	41	61
Main	201	217	200	218
Main	219	233	220	234

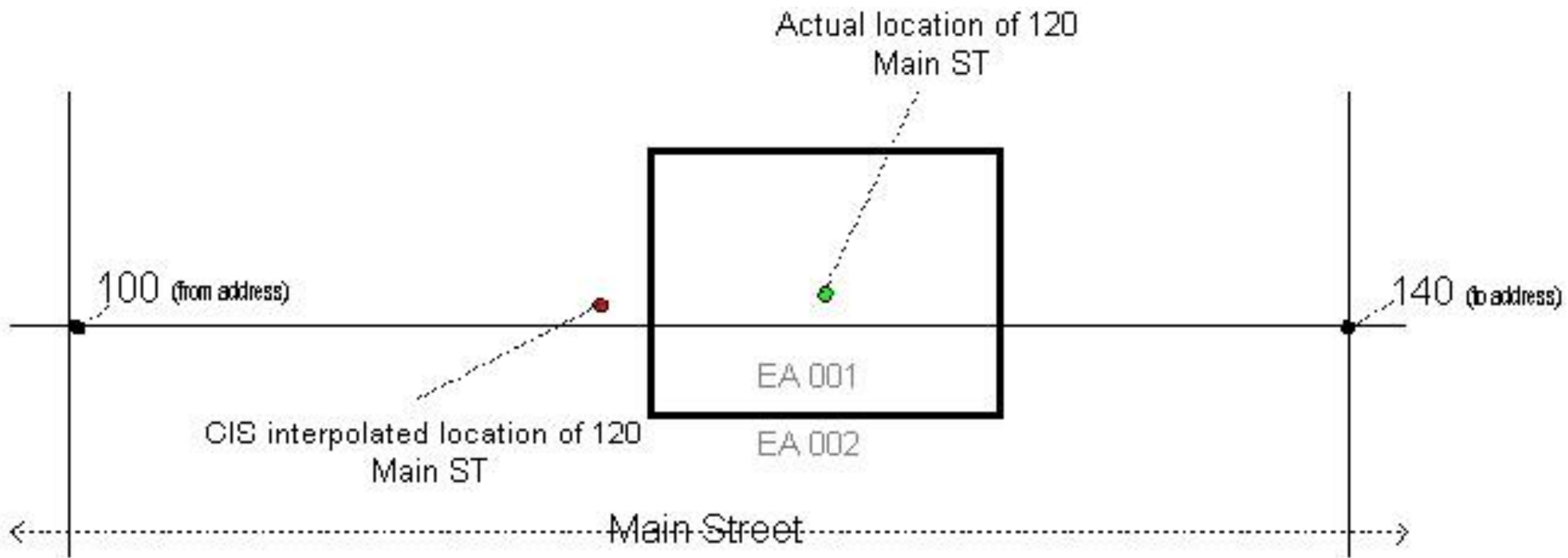
What if.....



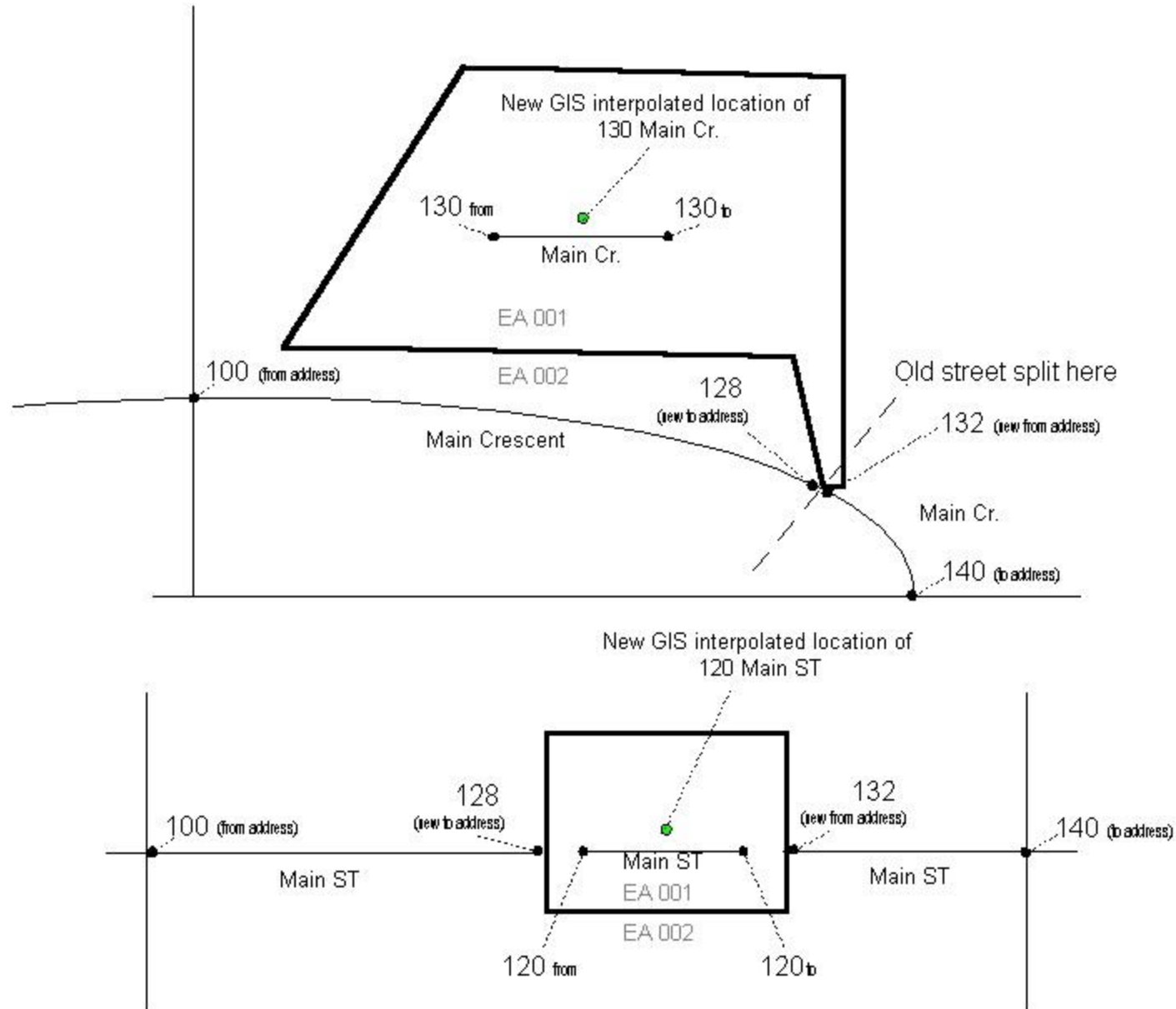
Irregular Areas



Small Areas



Network Modifications



Error Reduction?

- Delimited Address Elements

CALLID	ADDRESS
12346	123, King, St, North, apt 5
12347	58, St. Adelaide, St, ,2

Error Reduction?

- Separate Address Elements

CallID	Street Number	Street Name	Street Type	Street Direction	Apt
12346	123	King	ST	N	5
12347	58	Saint Adelaide	ST		2

- better to concatenate than to parse

Error Reduction

- Soft with hardcopy
 - SOP / Memos
 - Quality checks
- Hard with software
 - Electronic Patient Records
 - Forced Entry
 - Drop down lists
 - Valid entries only
 - Look up tables
 - Regular Network Updates

Tip ESDA

- When geocoding street addresses,
- Set strictest parameters 100%

Geocoding Options

Matching Options

Place Name Alias Table... <None>

Spelling sensitivity:

Minimum candidate score:

Minimum match score:

Intersections

Connectors: Separate connectors by a space, e.g. "& @ , /"

Output Options

Side offset:

End offset: %

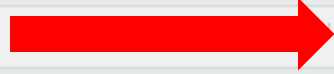
Match if candidates tie

Output Fields

X and Y coordinates Standardized address

Reference data ID Percent along

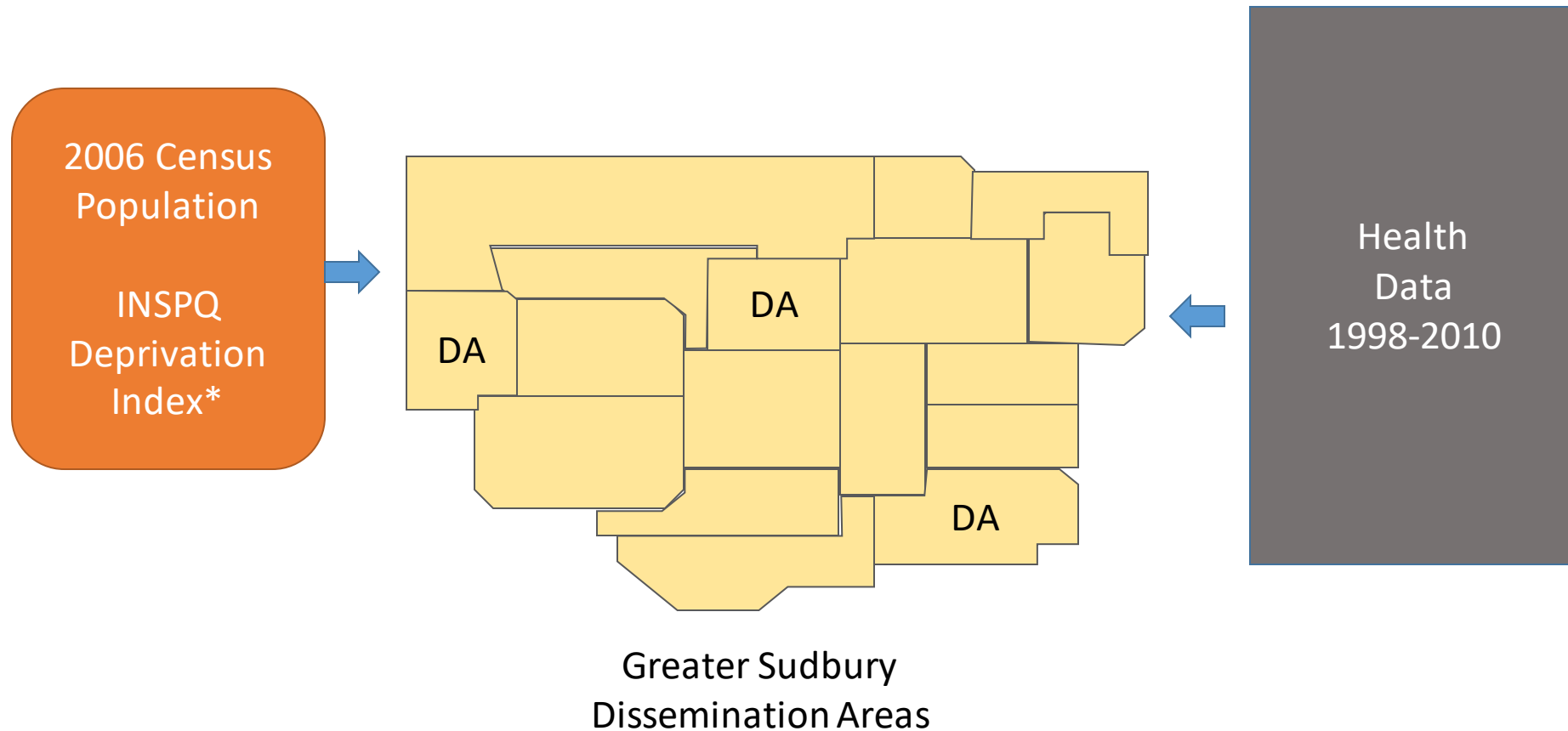
OK Cancel



What you should know before making maps with GIS

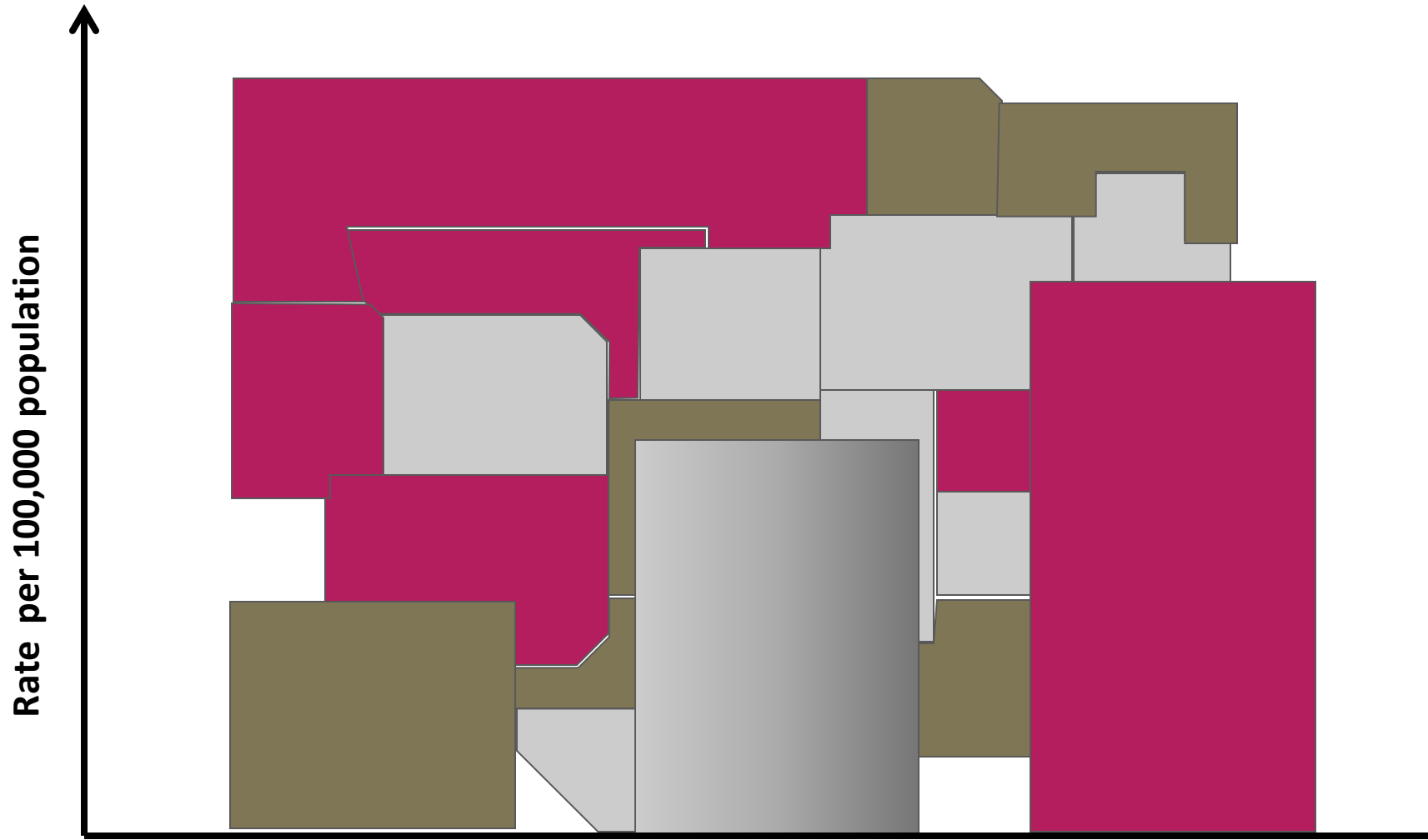
4. Ecological Fallacy

Ecological Analysis



* A deprivation index for health planning in Canada R. Pampalon, PhD (1); D. Hamel, MSc (1); P. Gamache, BSc (1); G. Raymond, BSc (2)
Chronic Diseases in Canada, Vol 29, No 4, 2009. http://www.phac-aspc.gc.ca/publicat/cdic-mcbc/29-4/pdf/CDIC_MCC_Vol29_4_ar_05-eng.pdf
INSPQ: <http://www.inspq.qc.ca/santescope/indexdefavo.asp?NoIndD=9>

Rate of 'X' per 100,000 Population, by Deprivation Index



Least deprived areas



Neutral areas







Most deprived areas





Deprivation Index

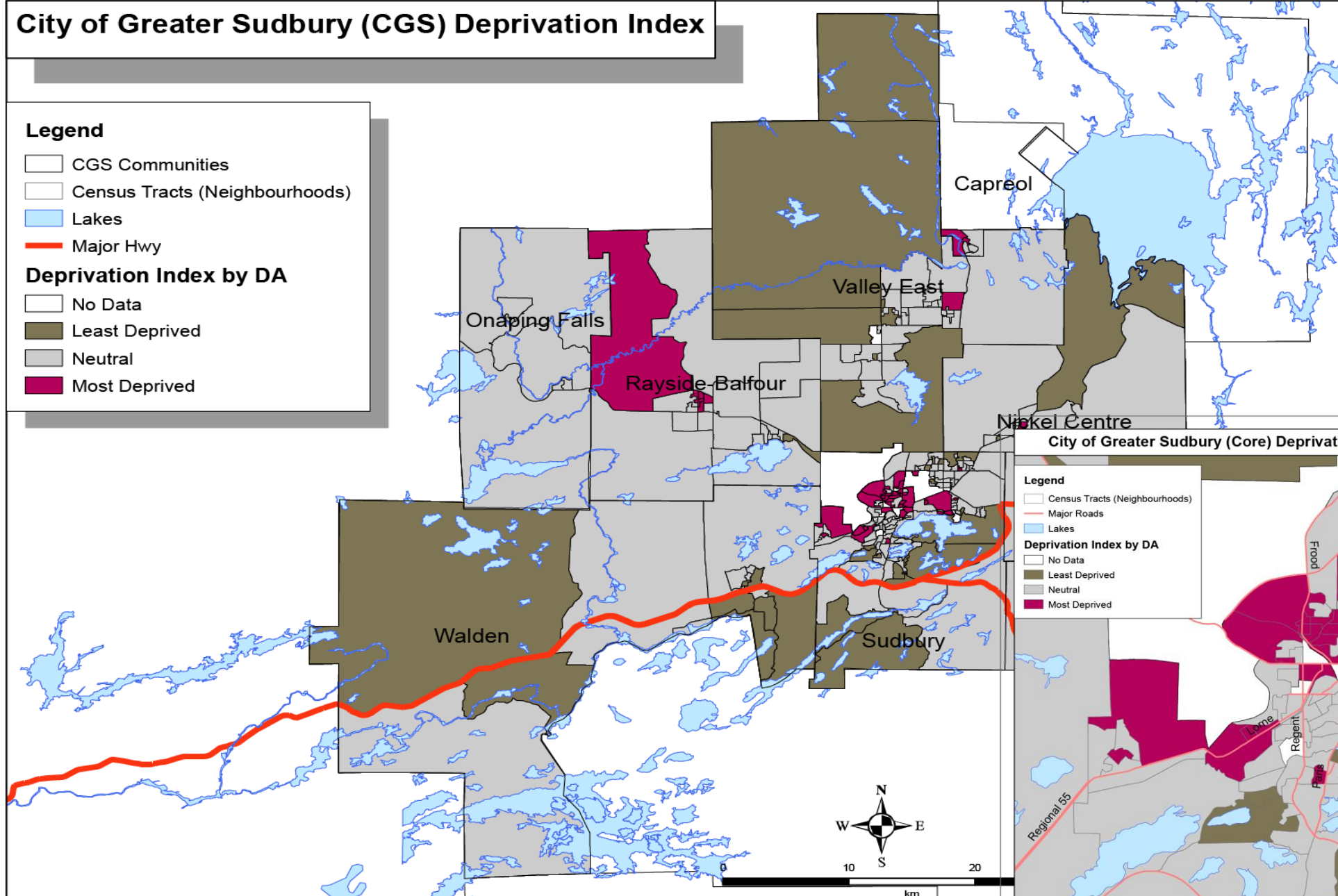
City of Greater Sudbury (CGS) Deprivation Index

Legend

-  CGS Communities
-  Census Tracts (Neighbourhoods)
-  Lakes
-  Major Hwy

Deprivation Index by DA

-  No Data
-  Least Deprived
-  Neutral
-  Most Deprived






Source: INSPQ 2011; Statistics Canada 2006 Census of Population

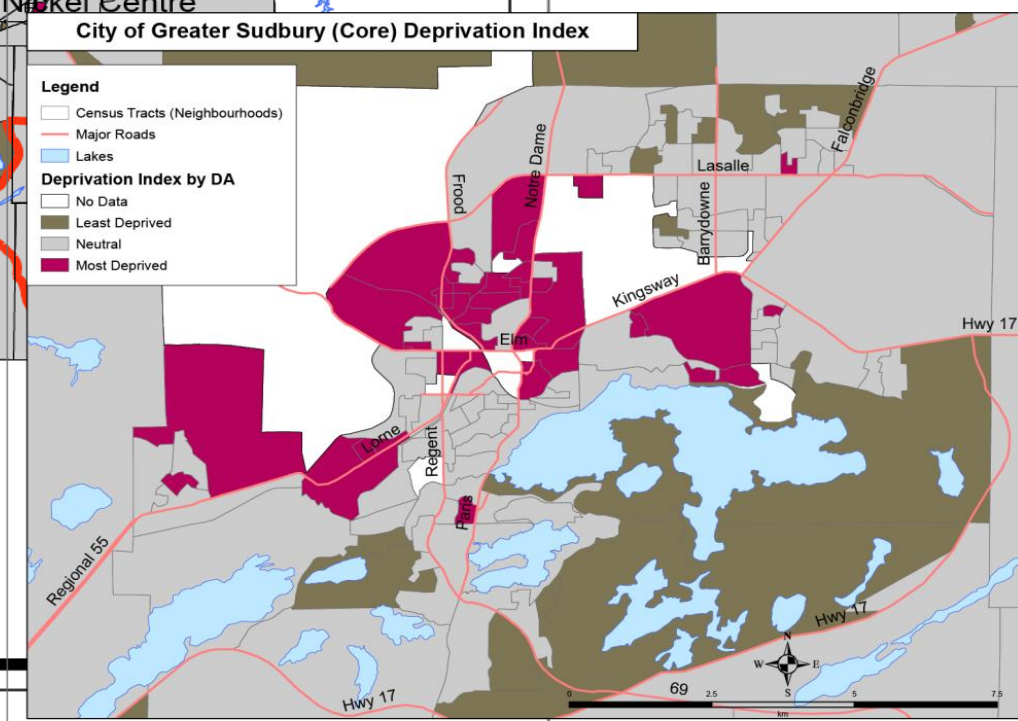
City of Greater Sudbury (Core) Deprivation Index

Legend

-  Census Tracts (Neighbourhoods)
-  Major Roads
-  Lakes

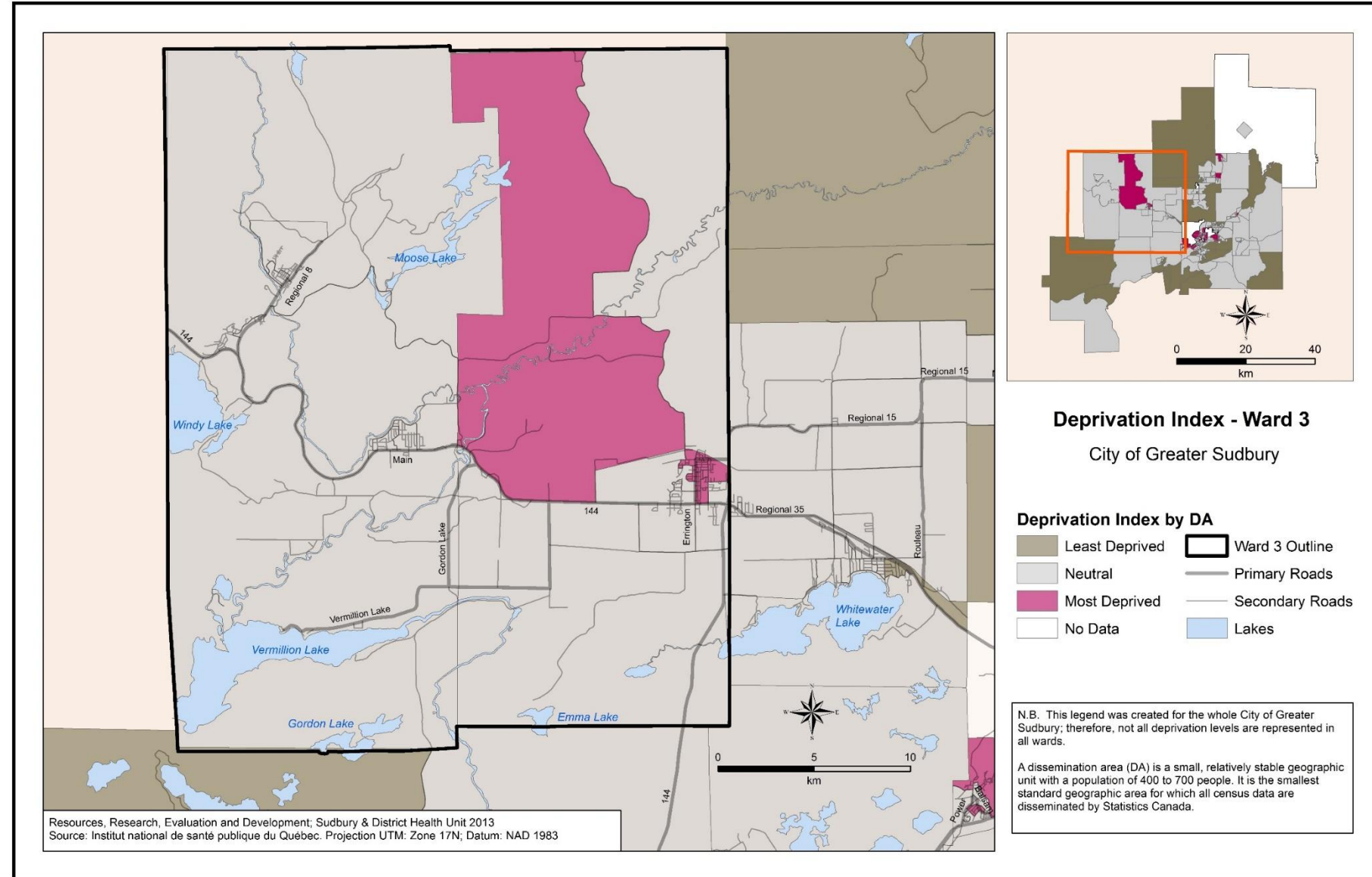
Deprivation Index by DA

-  No Data
-  Least Deprived
-  Neutral
-  Most Deprived



Source: INSPQ 2011; Statistics Canada 2006 Census of Population

But some got hung up on details



What you should know before making maps with GIS

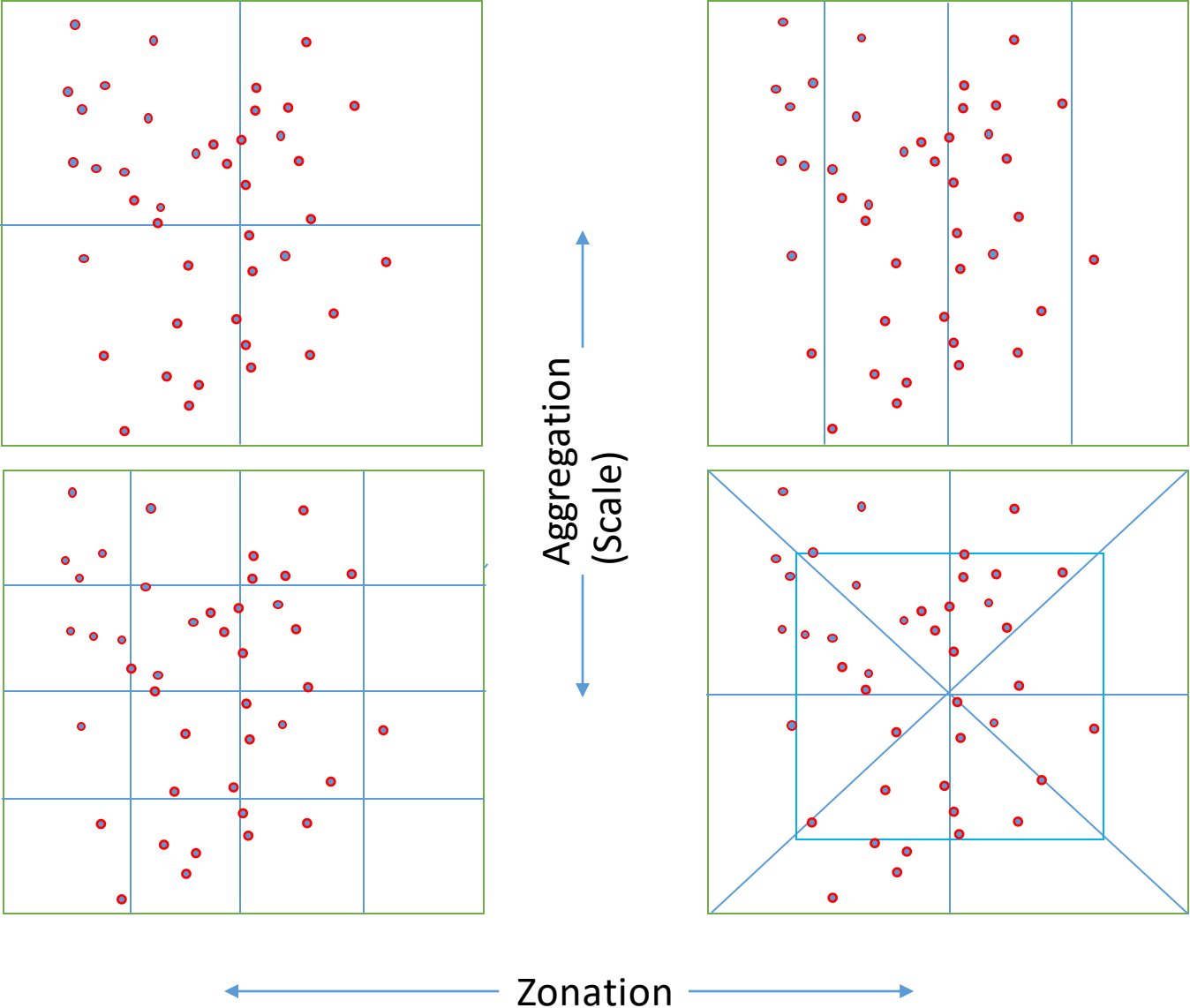
5. The MAUP

The Modifiable Areal Unit Problem (MAUP)

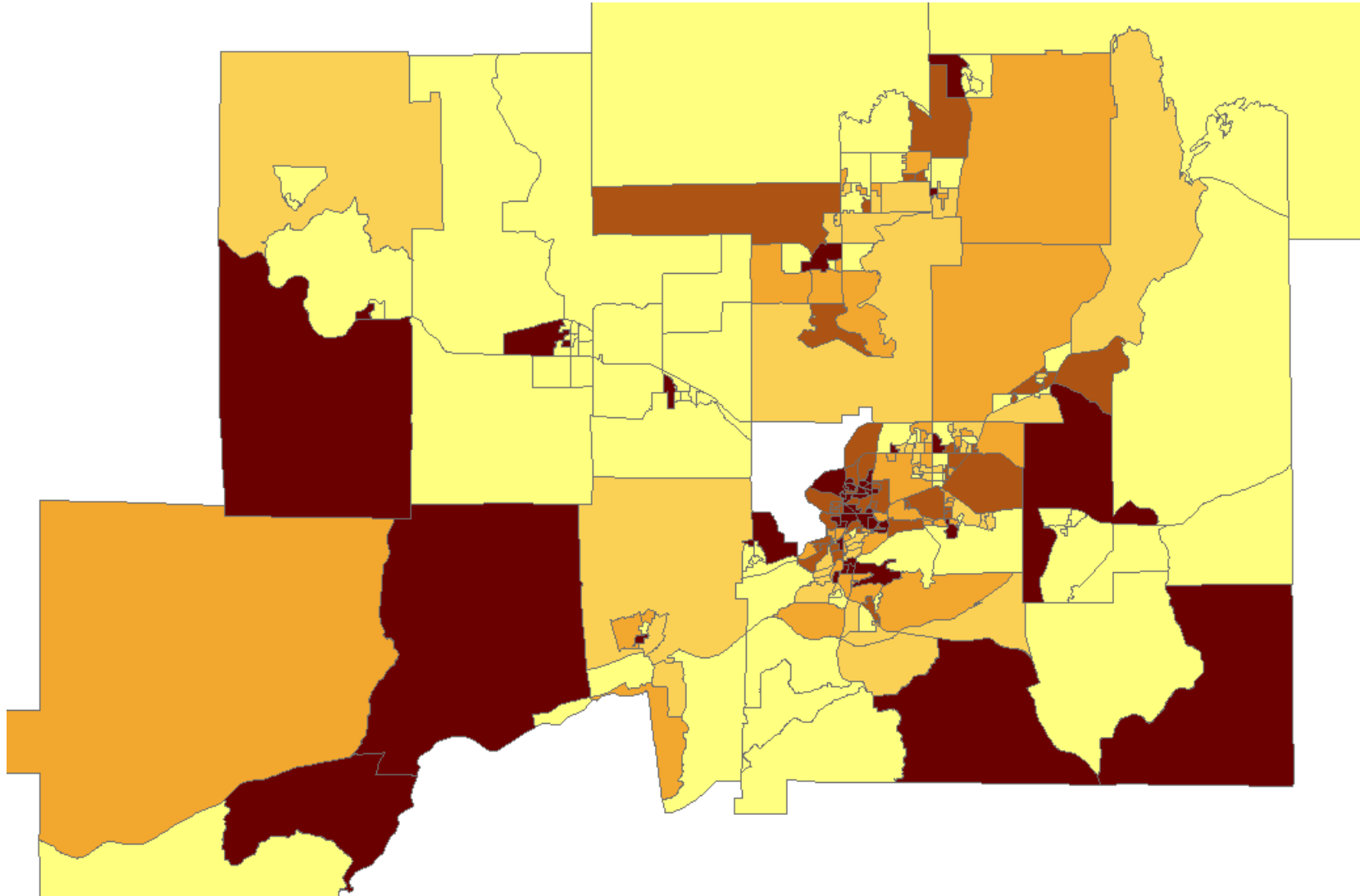
How you slice the pie matters

- 1. Aggregation (scale effect)
- 2. Zonation effect

Consider when defining Custom Geo
Or running analysis at varying scales and zones



How different would this picture be?

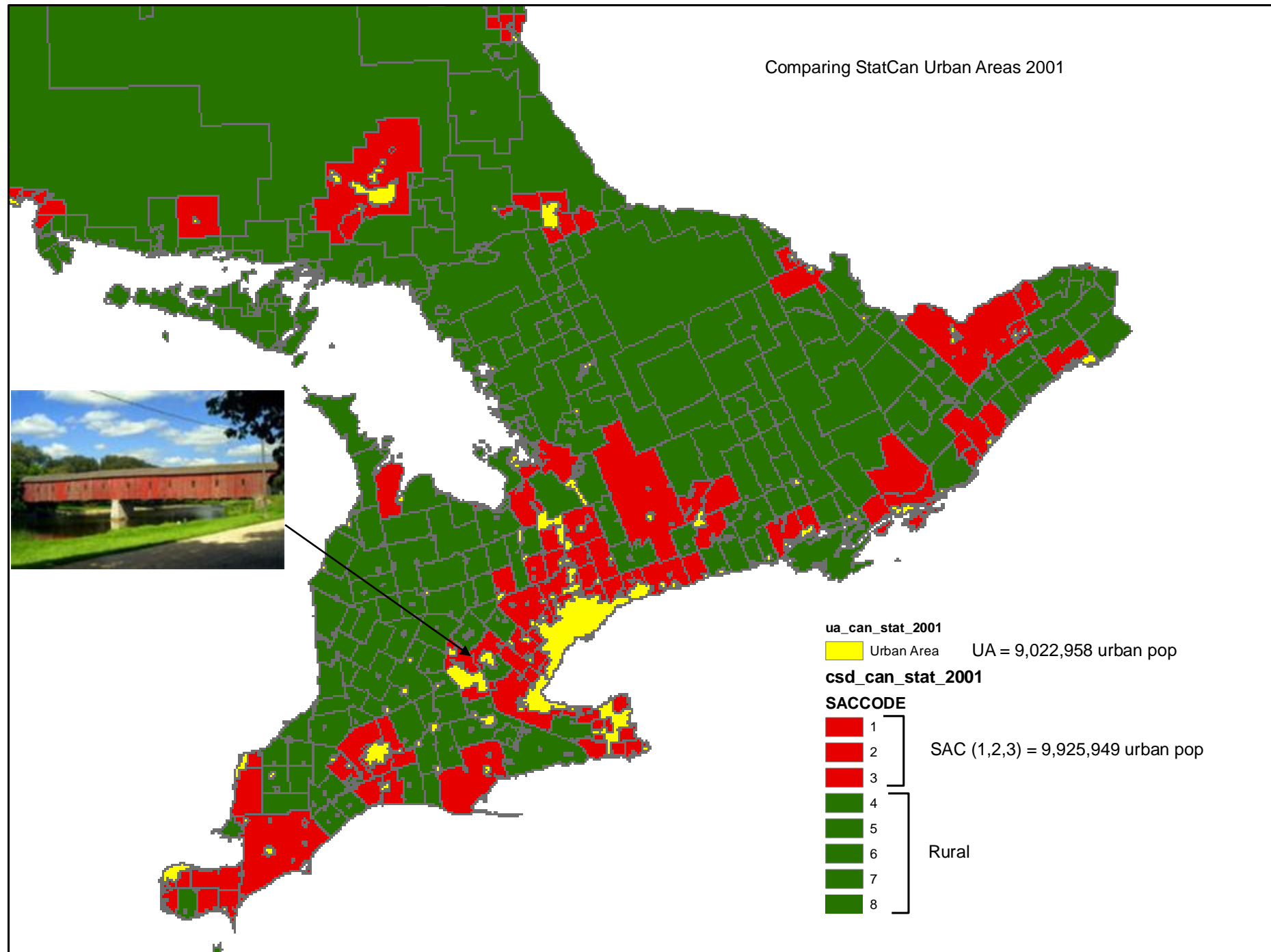


What you should know before making maps with GIS

6. What your data looks like (data literacy
and intimacy)

How data are defined/coded

E.g. Rural vs. urban



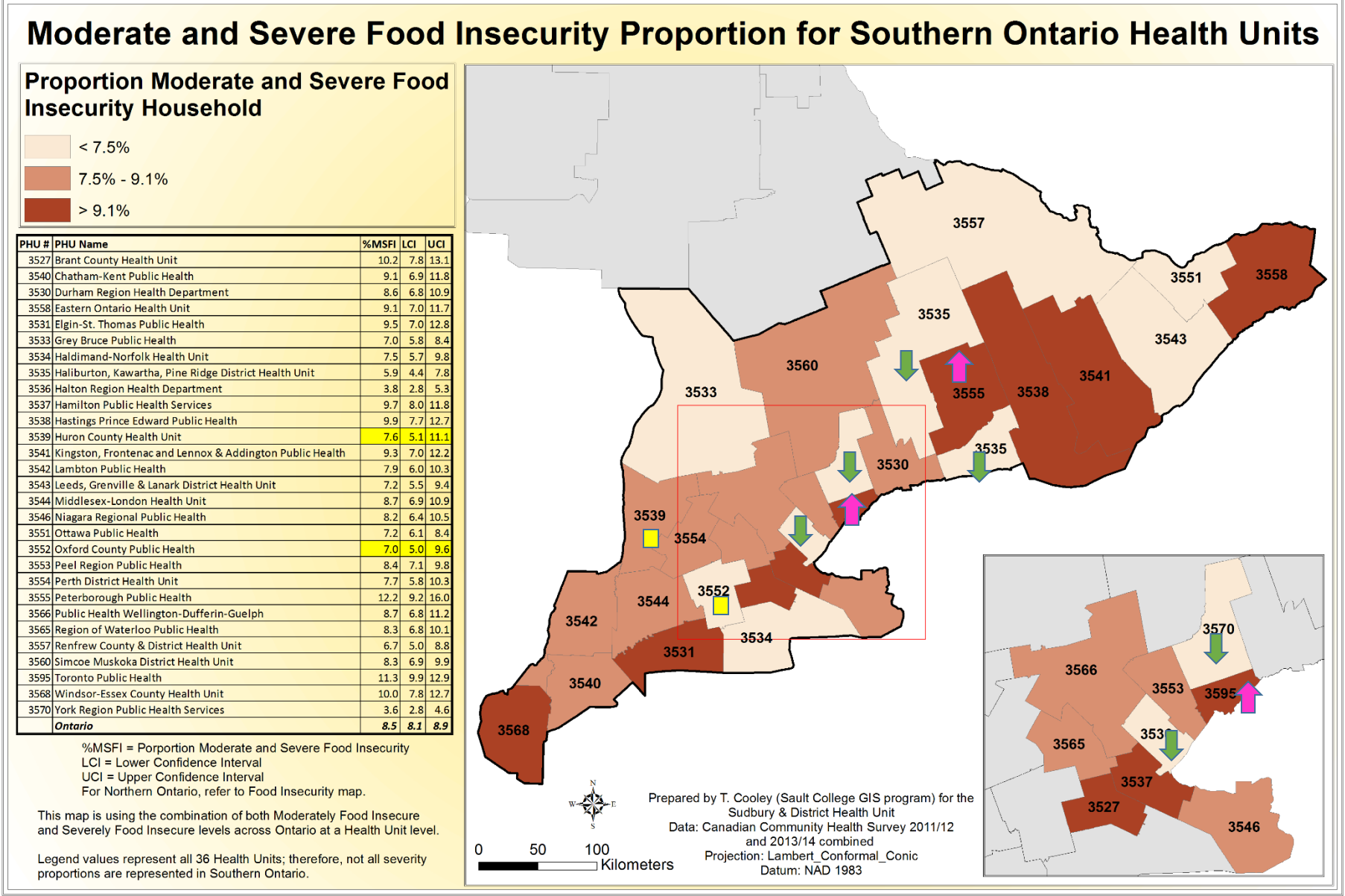
How data are collected E.g. CCHS

Statistically different than province overall

↑ Higher

↓ Lower

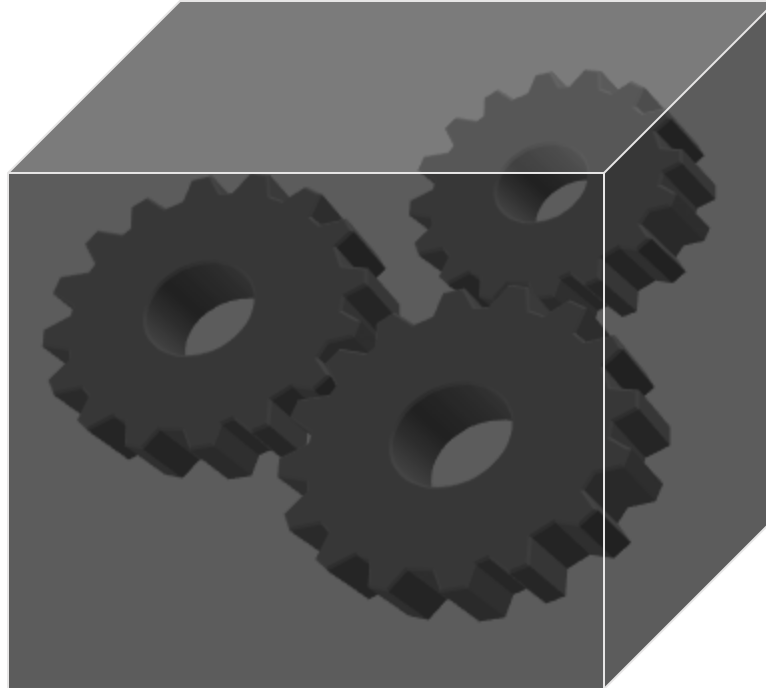
■ Release with caution due to high sampling variability



What you should know before
making maps with GIS

7. Assumptions and Parameters

What goes on in the Black Box?



You set parameters, make choices

Know the defaults and beware

The Moran's I statistic for spatial autocorrelation is given as:

$$I = \frac{n}{S_0} \frac{\sum_{i=1}^n \sum_{j=1}^n w_{i,j} z_i z_j}{\sum_{i=1}^n z_i^2} \quad (1)$$

where z_i is the deviation of an attribute for feature i from its mean ($x_i - \bar{X}$), $w_{i,j}$ is the spatial weight between feature i and j , n is equal to the total number of features, and S_0 is the aggregate of all the spatial weights:

$$S_0 = \sum_{i=1}^n \sum_{j=1}^n w_{i,j} \quad (2)$$

<http://pro.arcgis.com/en/pro-app/tool-reference/spatial-statistics/h-how-spatial-autocorrelation-moran-s-i-spatial-st.htm>




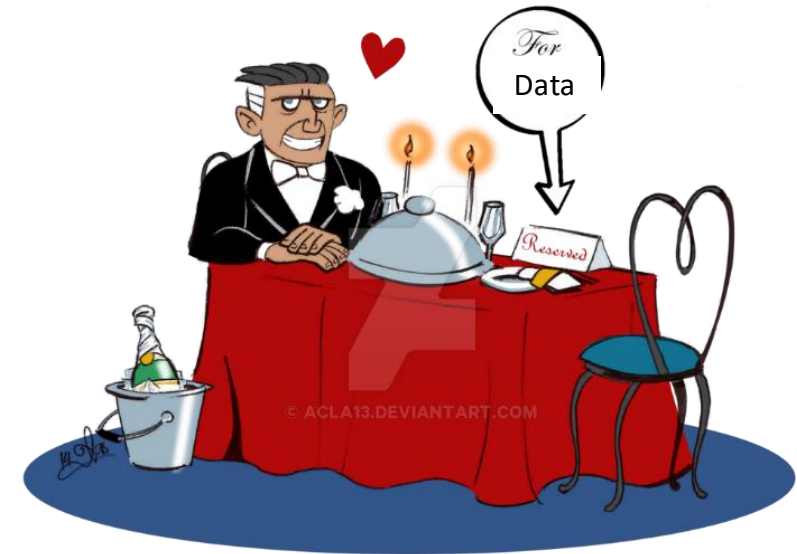
Dig a little

$w_{ij} \begin{cases} 1 & \text{centroid is one of nearest; is within specified distance; shares a common boundary; 1}^{\text{st}} \text{ order, 2}^{\text{nd}} \text{ order neighbour} \\ 0 & \text{otherwise} \end{cases}$

Tip ESDA: Try 2-3 methods, compare results

Tips

- ESDA
- Use HELP
- Community of practice/vendor support
- Get to know your data intimately
 - Open your attribute (tabular non spatial files) files
 - Use the  button, a lot

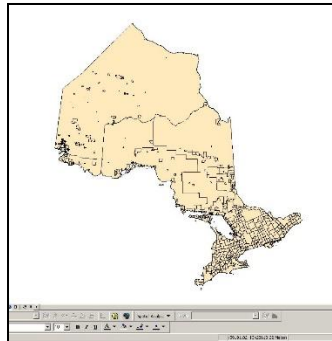
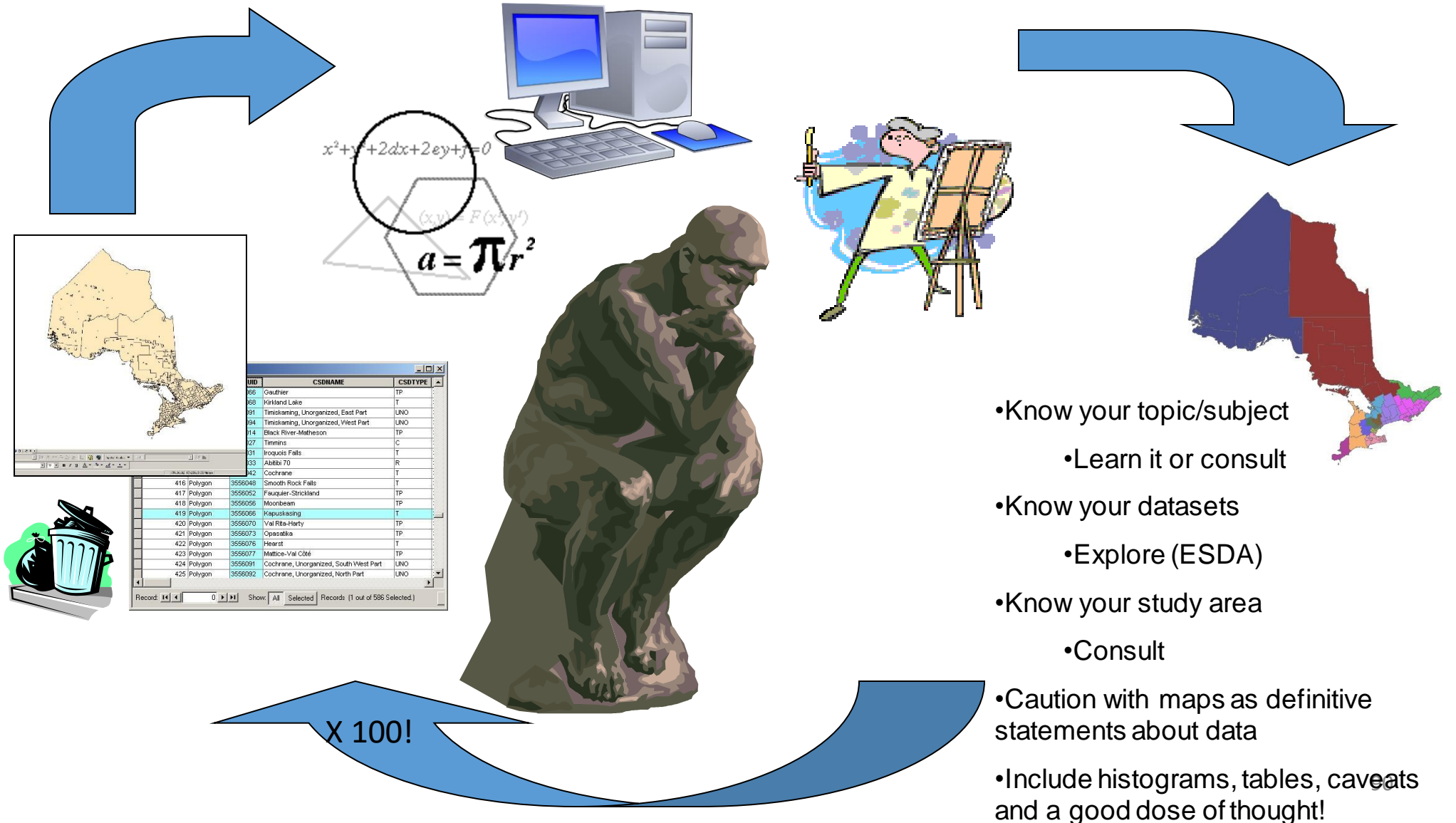


Conclusion



GIGO The wrong user

Good GIS/Good Cartography are Science and Art but anyone can do it



UID	CSDNAME	CSDTYPE
858	Gaudrier	TP
868	Kirkland Lake	T
891	Timiskaming, Unorganized, East Part	UNO
894	Timiskaming, Unorganized, West Part	UNO
914	Black River-Matheson	TP
927	Timmins	C
931	Inopuk Falls	T
933	Abitibi 70	R
942	Cochrane	T
415	Polygon 3556049	Smooth Rock Falls
417	Polygon 3556052	Fauguer-Strickland
418	Polygon 3556056	Moonbeam
419	Polygon 3556066	Kapuskasing
420	Polygon 3556070	Vai Rta-Harty
421	Polygon 3556073	Opasatika
422	Polygon 3556076	Hewlett
423	Polygon 3556077	Mattice-Vai Cité
424	Polygon 3556091	Cochrane, Unorganized, South West Part
425	Polygon 3556092	Cochrane, Unorganized, North Part

