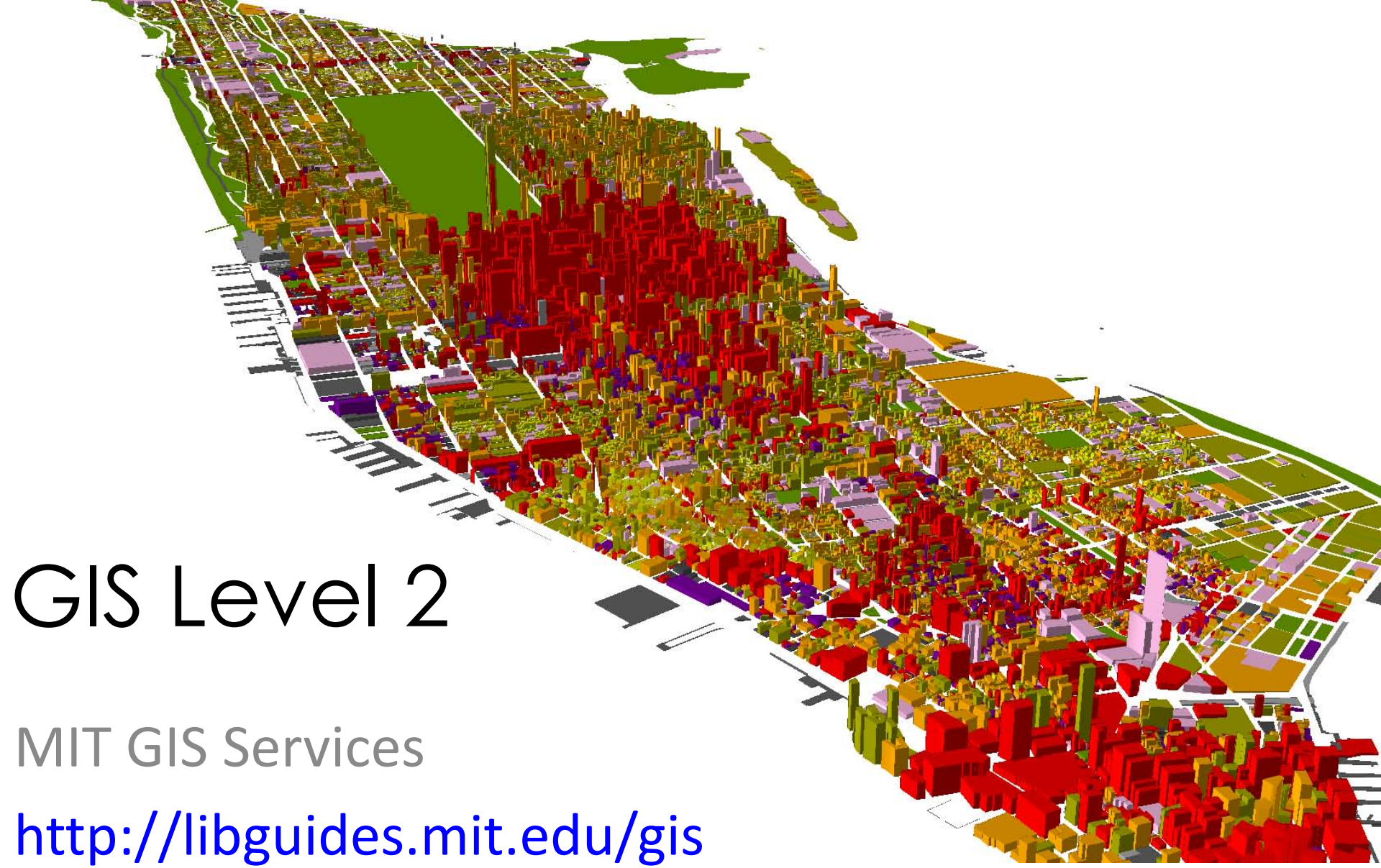


GIS Level 2

MIT GIS Services

http://libguides.mit.edu/gis

What will you learn today?

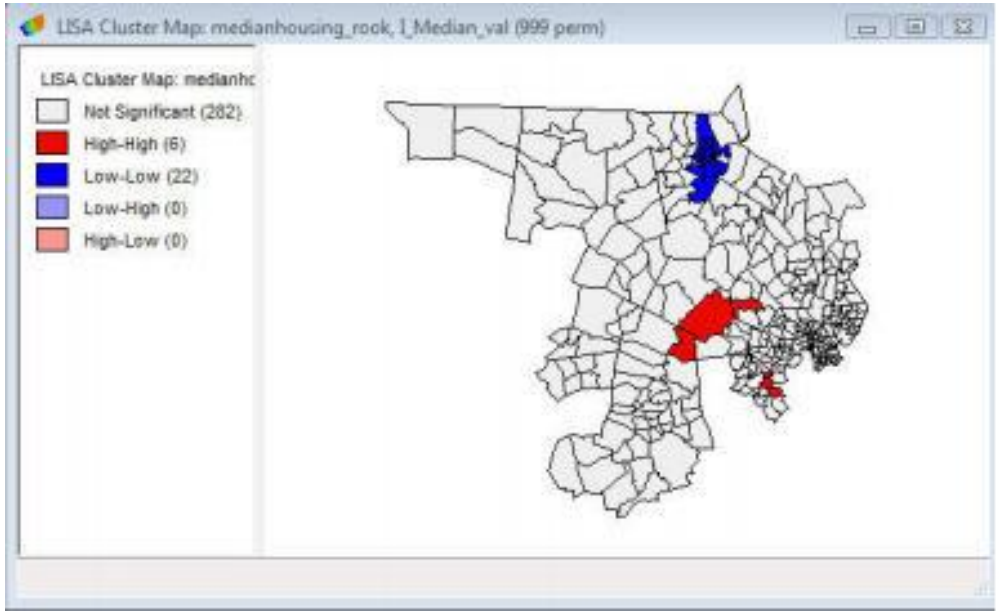
- How to use metadata and map projections to understand and transform geographic data
- How do use processing tools in ArcGIS and QGIS to perform a multi-step analysis
- How to automate this analysis using a model

What is analysis in a GIS?

- Using tools within a GIS to examine the attributes and location of spatial data and reveal relationships that you might not be able to see otherwise.

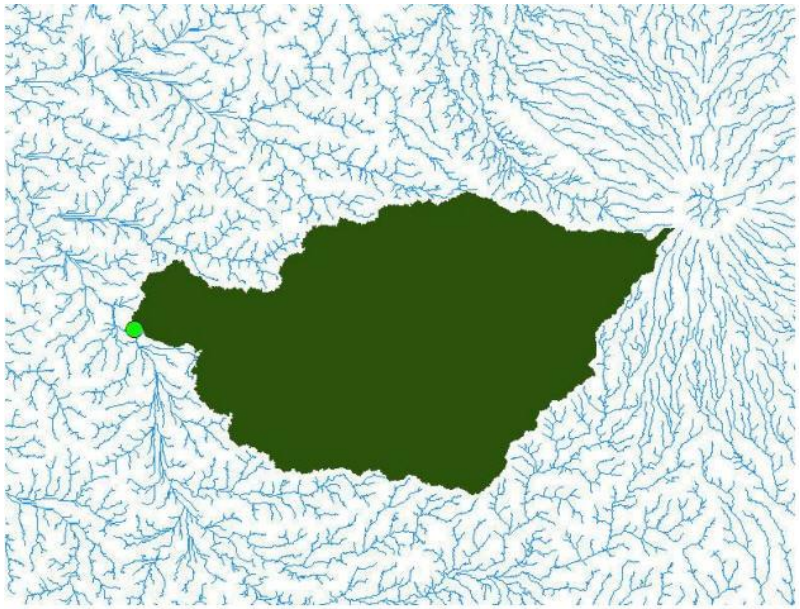
Examples of GIS Analyses

- Determine clusters of high and low values using spatial statistical tools, such as where there is a statistically significant cluster of high median home values.



Examples of GIS Analyses

- Extract elevation values from a Digital Elevation Model to determine where rivers will form, flow direction, and watersheds.



MAP PROJECTIONS IN ANALYSIS

Map Projections

There are many types of map projections. Each projection has certain strengths and also introduces one or more of the following types of distortion:

- Shape
- Area
- Distance
- Direction

More information on the GIS Services Website in Resources by Topic:
http://libguides.mit.edu/content.php?pid=347508&sid=2844938

Map Projections

Geographic Coordinate Systems

- Use a 3D spherical surface to define locations
- Units are in degrees

Projected Coordinate Systems

- Use a flat, 2D surface
- Constant lengths, angles and areas across the two dimensions
- Units in feet, meters, miles, etc.
- The exact map projection determines how the data are distorted when transformed from 3D to 2D.

Map Projections

- Part of your analysis model may involve a map projection transformation.
- Some analysis tools that involve distance or area calculations will require your data to be in a projected coordinate system.
- Although not required, you should transform your data into the same coordinate system for the most accurate results when performing an analysis.

Map Projections

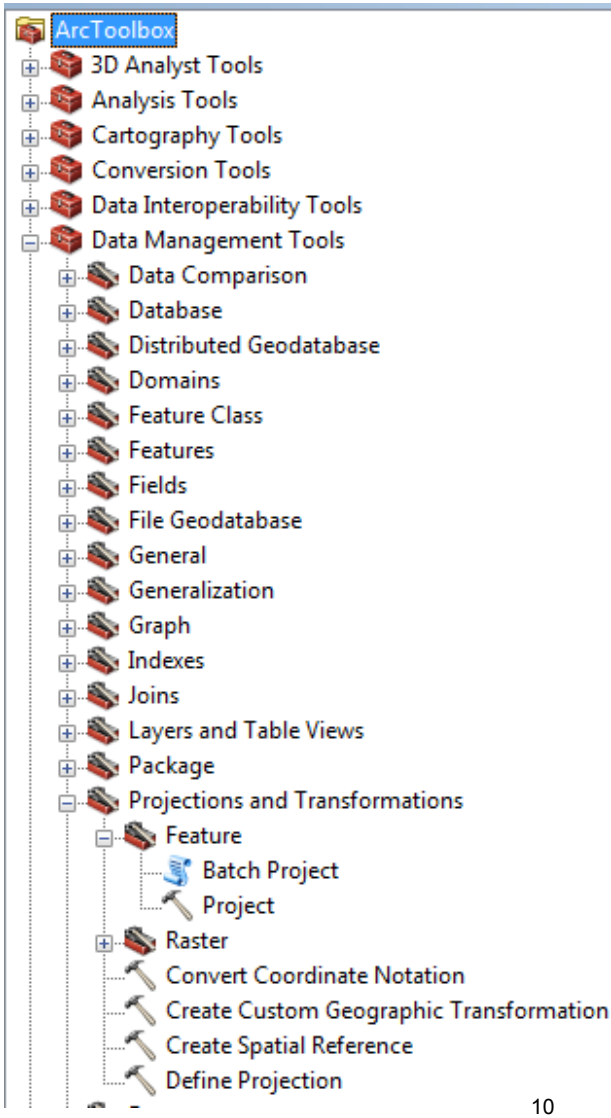
Define the projection of a data layer

- If the software doesn't understand what the projection is then it will not be able to overlay it in the correct location. A data layer must be defined as what it is according to the metadata. Defined shapefiles will have a .**prj** file.

Project a data layer into a new projection

- This is commonly done to match the projection of other files you are working with or to select an appropriate projection for the location and type of analysis you plan to do. The projection of the data layer must be properly defined before it can be projected.

Choose a projection to display your overall map in by adjusting the properties of your **data frame (ArcGIS) or project (QGIS)**. ArcGIS and QGIS can do "projection on the fly", so data layers in your project do not all have be in the same projection.



Map Projections

Changing and Defining Projections in ArcGIS:

- http://blogs.esri.com/esri/supportcenter/2013/08/23/when-to-use-the-define-projection-tool-and-the-project-tool-2/

Changing and Defining Projections in QGIS:

- https://docs.qgis.org/2.2/en/docs/user_manual/working_with_projections/working_with_projections.html

How do you know if your data has a defined map projection? How do you know what it is?

- Look for a .prj file as part of the shapefile.
- Open the file in QGIS or ArcGIS and examine the data layer information.
- Read the metadata.

Metadata

- Information about the data layer
- Read the metadata to determine who created the data, when it was created, what the codes in the table mean, if there are constraints on how it can be used, etc.
- You can find metadata:
  - Downloaded with your data layers
  - On the website where you got your data
  - Sometimes you may need to contact the data provider to get metadata
- Metadata is most commonly in html/xml format, text files, or in a table format, such as excel or csv.

Metadata

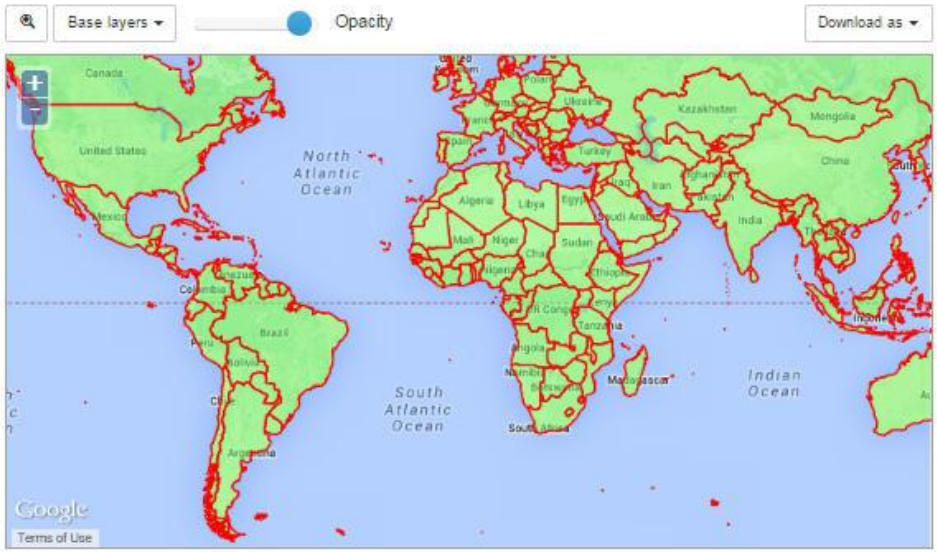
World (Countries, 2005)

Institution
MIT

Data Type
Polygon

Theme Keywords
polygon countries international boundaries coastlines area international codes status population boundaries society

Place Keywords
World



Download FGDC Metadata

- Identification Information
- Metadata Reference Information
- Spatial Data Organization Information
- Spatial Reference Information
- Entity and Attribute Information
- Distribution Information

In GeoWeb, expand each category to read the metadata.

Metadata

Spatial Reference Information

Horizontal Coordinate System Definition

Geographic Coordinate Units	Decimal degrees
Latitude Resolution	0.000000
Longitude Resolution	0.000000
Horizontal Datum Name	D_WGS_1984
Ellipsoid Name	WGS_1984
Semi-major Axis	6378137.000000
Denominator of Flattening Ratio	298.257224

Geographic Coordinate System in WGS84

Entity and Attribute Information

Distribution Information

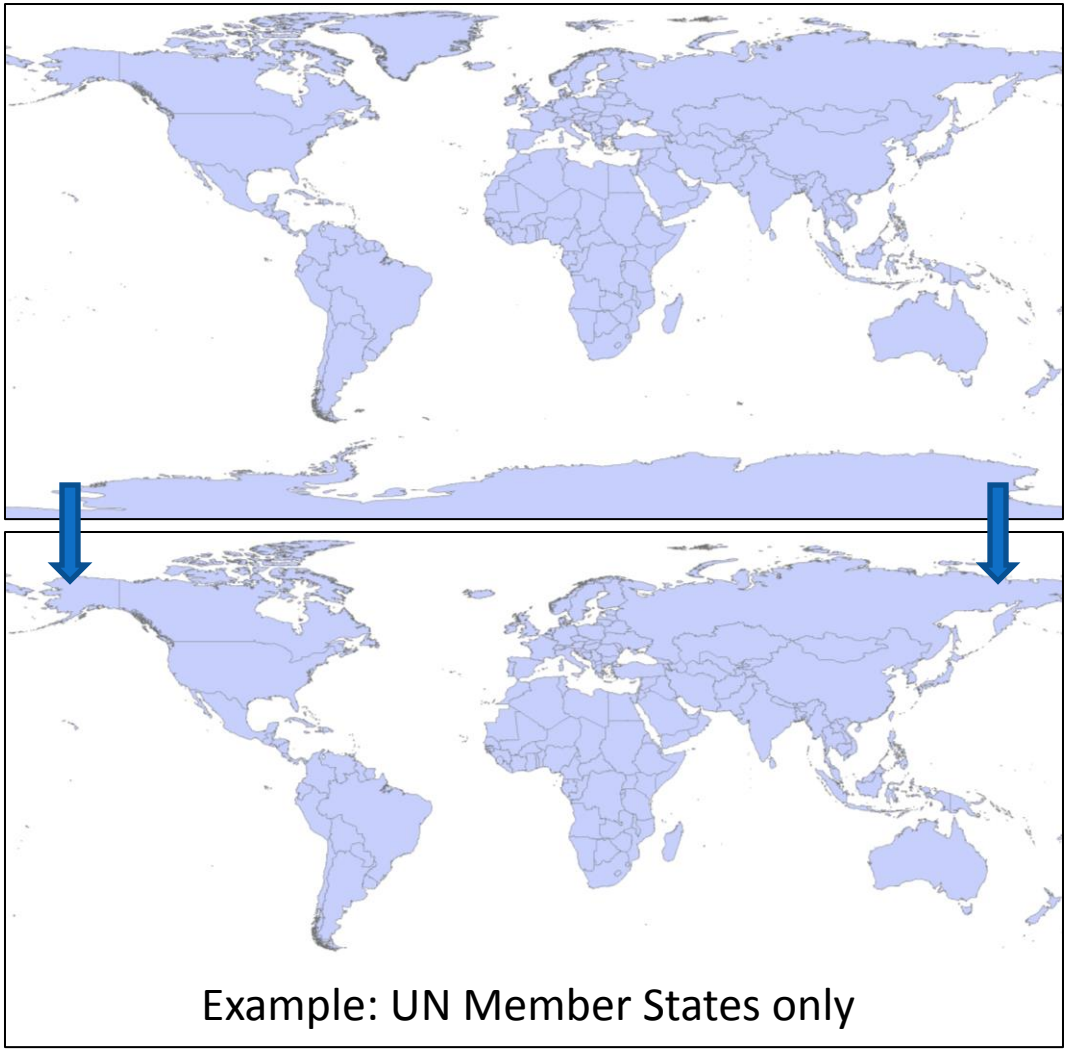
PROCESSING TOOLS

We will use processing tools in this workshop to:

- Narrow down a larger dataset
- Aggregate and analyze demographic data
- Pinpoint areas for development
- Identify suitable locations

Definition Query

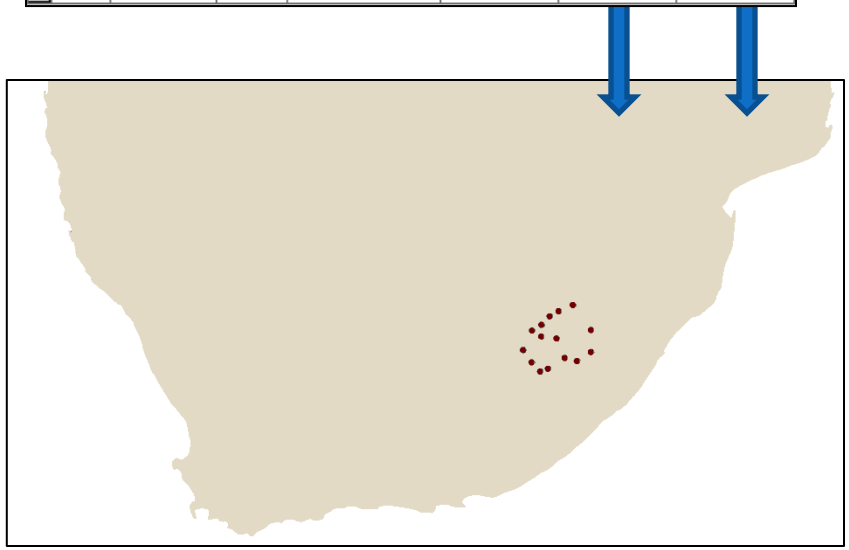
- Define what you want to be (and not to be) displayed on your map
- Also applies to any analysis performed afterward



Example: UN Member States only

Adding XY Data

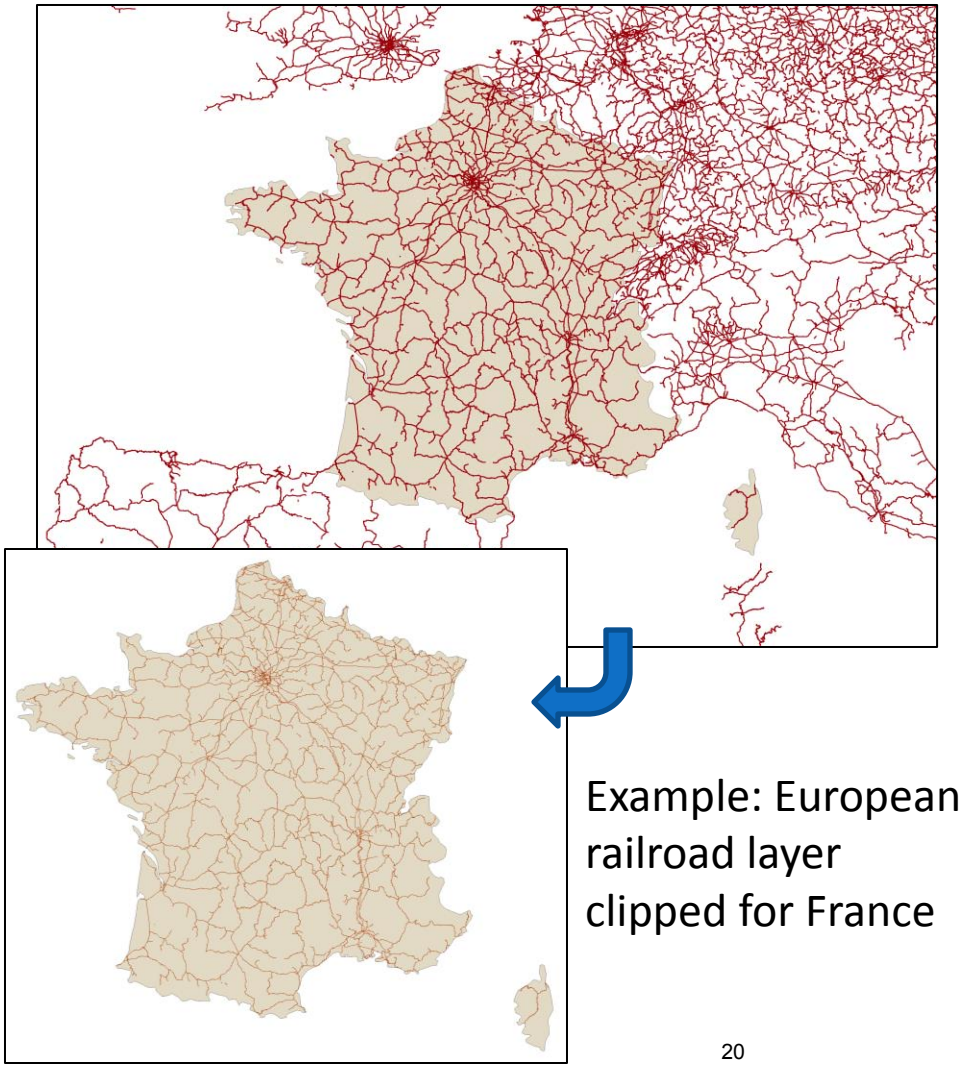
	FID	Shape *	TOWN	NAME	OBJECTID	X	Y
	0	Point	1	Qacha's Nek	1	28.367451	-30.04631
	1	Point	2	Tsoelike	2	28.702419	-30.125959
	2	Point	3	Mohale's Hoek	3	27.480089	-30.158529
	3	Point	4	Mount Moorosi	4	27.92717	-30.33884
	4	Point	5	Quthing	5	27.716221	-30.4114
	5	Point	6	Butha-Bothe	6	28.585939	-28.6283
	6	Point	7	Hlotse	7	28.210193	-28.792794
	7	Point	8	Maputsoe	8	27.968411	-28.92481
	8	Point	9	Teyateyaneng	9	27.75289	-29.152849
	9	Point	10	Mokhotlong	10	29.0781	-29.290779
	10	Point	11	Maseru	11	27.4916	-29.308319
	11	Point	12	Roma	12	27.74052	-29.46339
	12	Point	13	Thaba-Tseka	13	28.15136	-29.5235
	13	Point	14	Mafeteng	14	27.2521	-29.83139
	14	Point	15	Sehlabathebe	15	29.075661	-29.88435



- A table with columns of X and Y coordinates can be converted into points
- You must know the coordinate system beforehand
- Example: Towns in Lesotho Africa

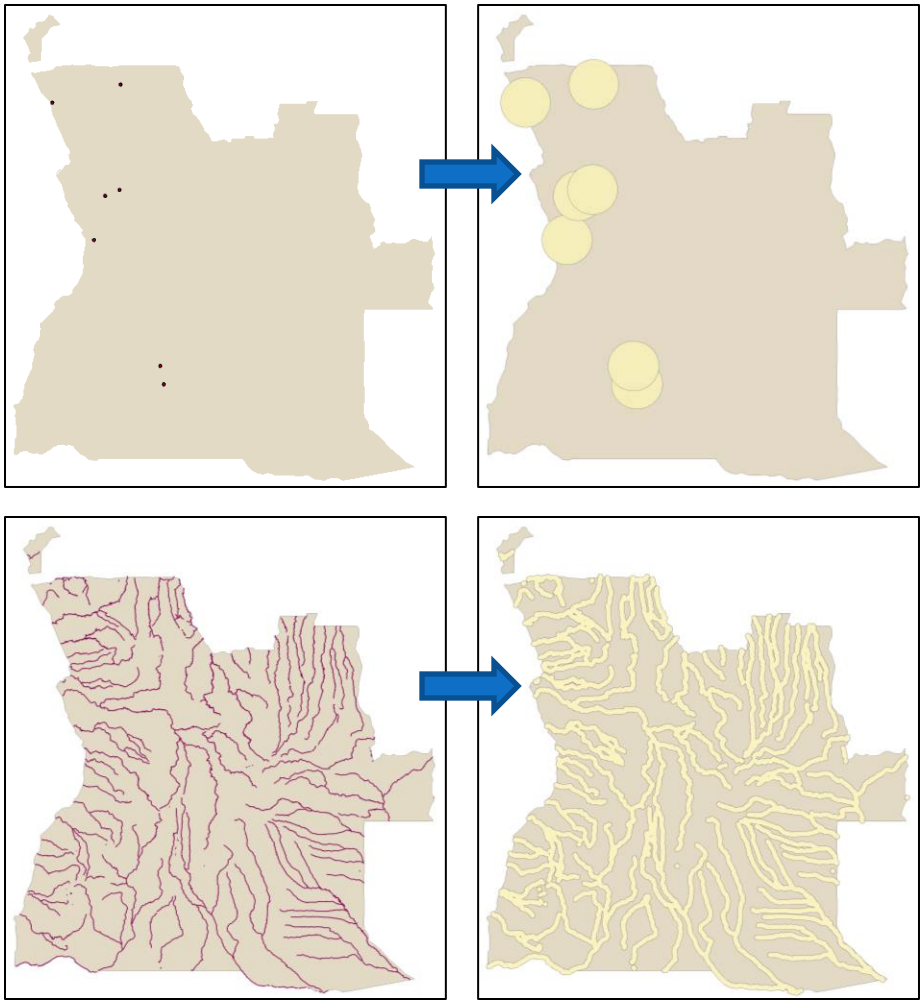
Clip

- Only features and parts of features within a boundary layer are retained
- The input layer can be a point, line, or polygon, but the clip layer must be a polygon



Example: European railroad layer clipped for France

Buffer

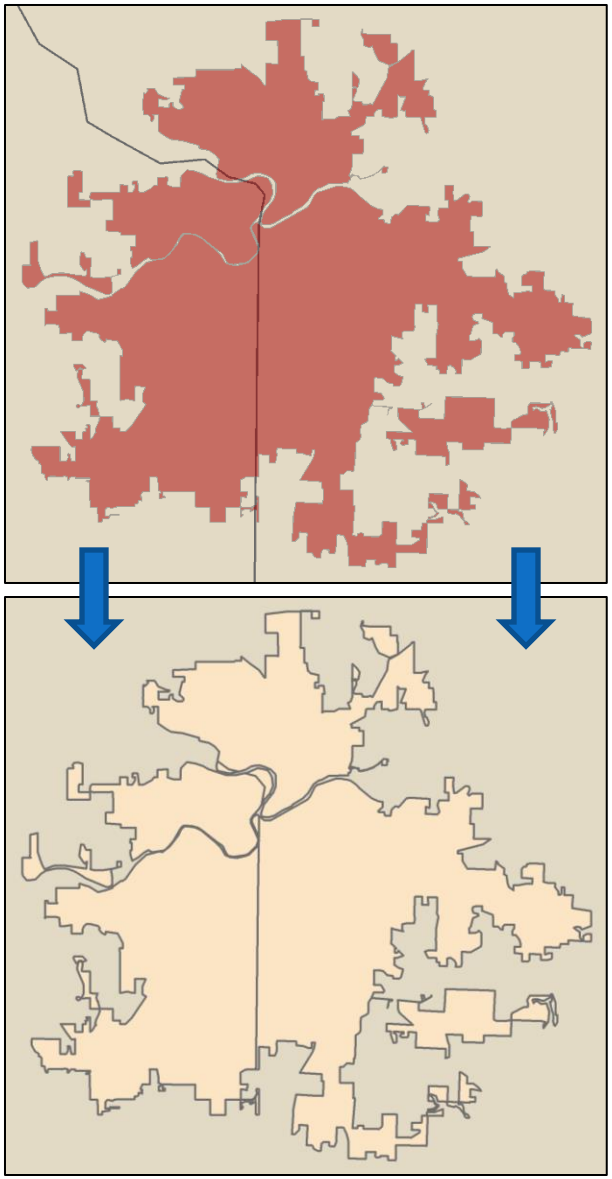


- Creates a polygon surrounding a feature at a given distance
- Can be around a point, line, or polygon
- Dissolve or create separate features

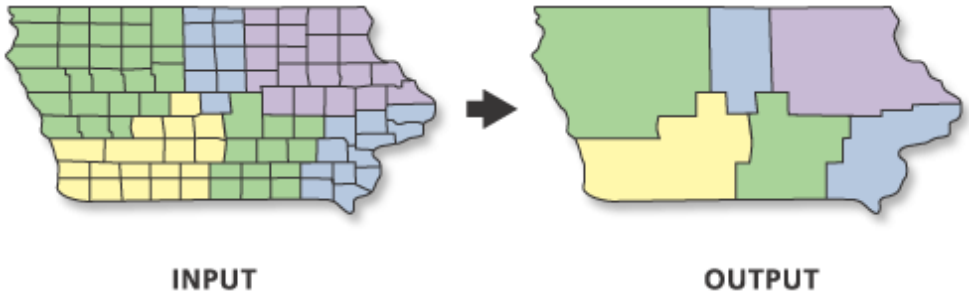
- Examples: 50 miles around mines and 5 miles around rivers in Angola

Intersect

- Takes two layers and combines them in a geometric intersection, retaining only space common to both layers
- Example: Kansas City urbanized area (one feature) and states (Kansas and Missouri) result in two features for urbanized area in each state



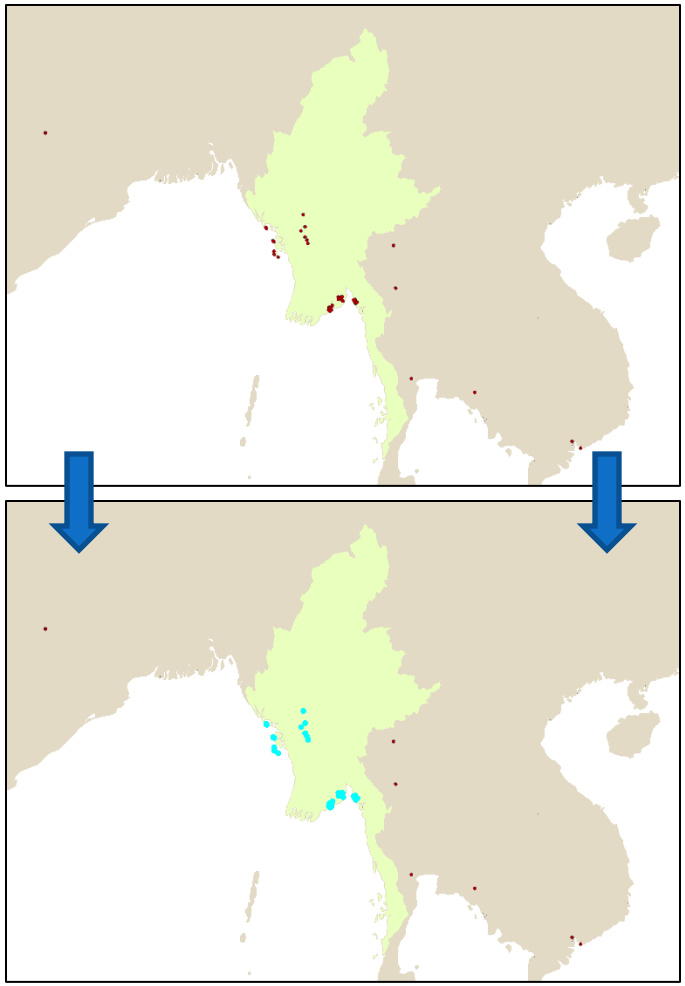
Dissolve



Example: Counties dissolved into regions based on a field in the attribute table

- Aggregates features based on specified attributes
- Choose a field to create new features
- Choose whether multipart features should be created (i.e. non-adjacent features should be combined)

Select by Location

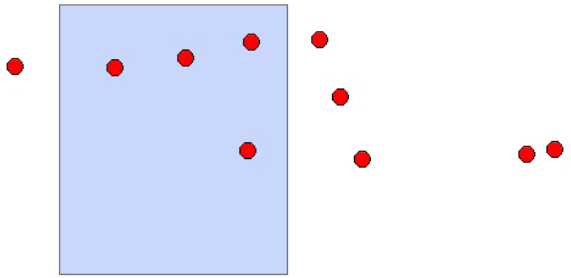


- Creates a selection in one layer based on some spatial relationship between that layer and another
- Example: Storage facilities in Myanmar (Burma) are selected

Spatial Join

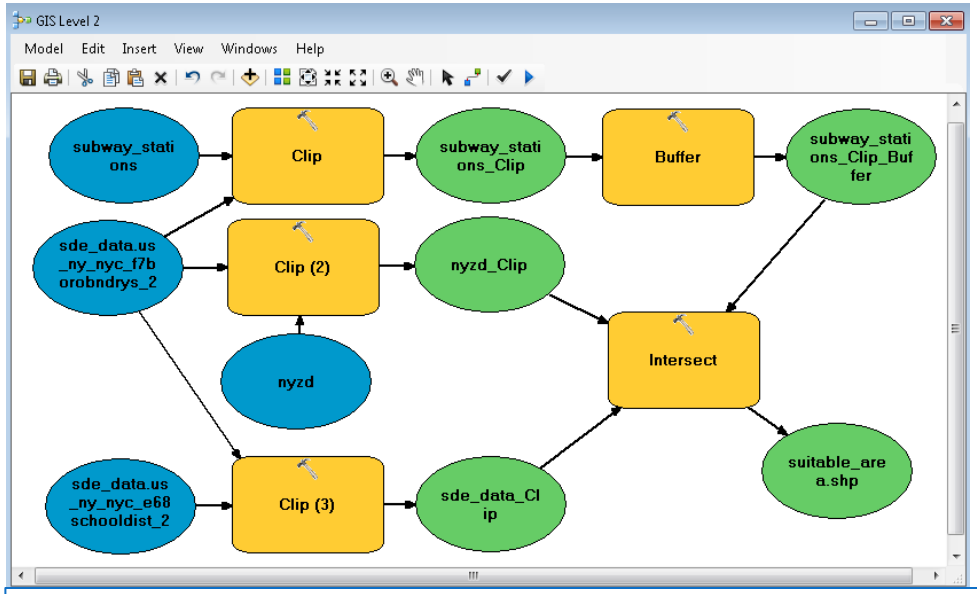
- Join the table information from two files, based on their spatial relationship.

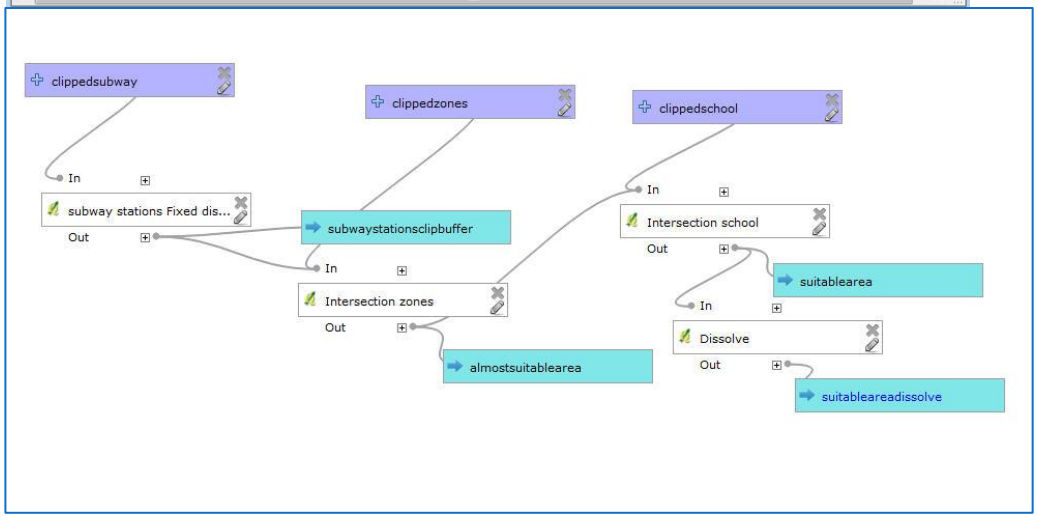
- Relationship options: Intersect, contains, closest, within



Example: Associate census tract numbers with business data to explore demographics and potential customers of a neighborhood.

Models

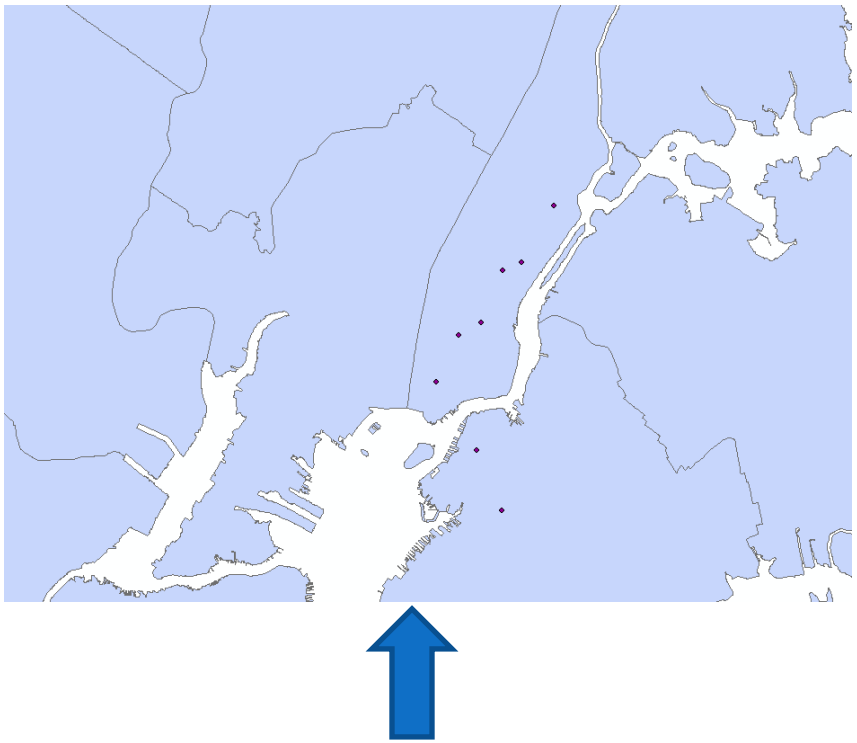




- Enables users to develop a workflow of their methodology
- A process consisting of multiple steps can be collapsed into one tool.
- A model can be edited as a python script to run multiple iterations.
- A model can be saved and shared on different machines and with other users.
- An image of a model is commonly used for documenting a process – in a thesis for example.

Geocoding

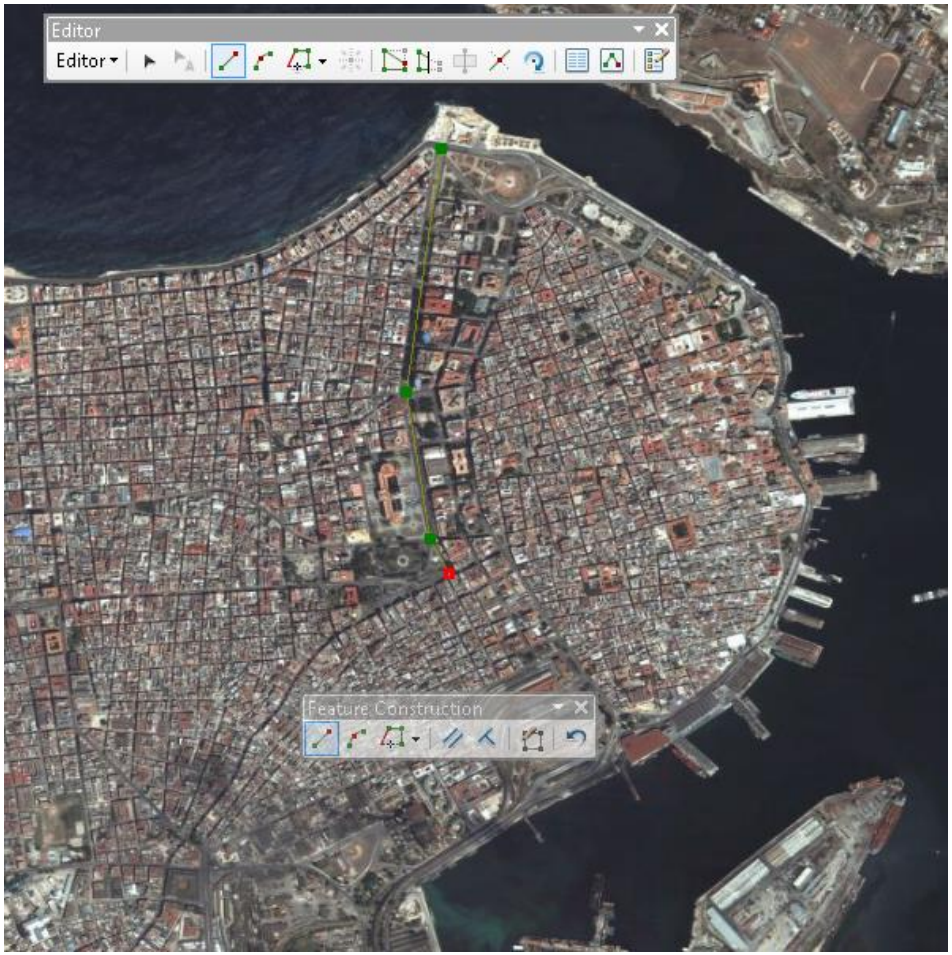
- Automatically plot address lists on a map
- Download **Address locators** from the IS&T ArcGIS download page or create your own. They are also on machines in the GIS lab.
- QGIS offers online geocoding tools using OpenStreetMap or Google.



OID	ID	NAME	STREET	CITY	STATE	ZIP
0	1	Pumpkin Manor	97 Warren St	New York	NY	10007
1	2	Apple Estates	369 Americas	New York	NY	10011
2	3	Orange Apartments	33 E 17th St	New York	NY	10003
3	4	Mulberry House	106 Court St	New York	NY	11201
4	5	Pear Flats	555 5th Ave	New York	NY	10017
5	6	Guava Building	160 E 54th St	New York	NY	10022
6	7	Tangerine Apts	267 7th Ave	Brooklyn	NY	11215
7	8	Grape Meadows	150 E 86th St	New York	NY	10028

Create and Edit Features

- New shapefiles can be created from scratch
- Features can be edited or created using the editor toolbar



Example: creating a major road layer for Havana, Cuba based on an aerial image base map

SOFTWARE

QGIS and ArcGIS

- ArcGIS (commercial/proprietary) and QGIS (open source) are the most popular GIS software programs.
- The interfaces look very similar and many of the same analysis tools can be found in each program.
- You may find some analyses are easier in QGIS and some in ArcGIS.

Today's Workshop Exercise

- Where are the most suitable sites for a new, large apartment complex in Manhattan?
- This exercise will take into account the following factors:
  - Parcel vacancy
  - Distance to subway station
  - School district
  - Zoned land use

RES.STR-001 Geographic Information System (GIS)Tutorial

January IAP 2016