GeoBTAA Tutorials

None

Big Ten Academic Alliance Geospatial Information Network

2022

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1. Home

This is a test site! See https://sites.google.com/umn.edu/btaa-gdp/tutorials for current tutorials

The BTAA Geospatial Information Network has created a series of tutorials to showcase the practicality of the BTAA Geoportal for teaching and learning about maps, geospatial data, and GIS techniques. These tutorials cover a wide range of activities designed to meet the needs of instructors and students in a wide range of disciplines and levels of competency in geospatial data retrieval, use, and analysis.

2. Georeference

This tutorial is part of an educational series produced by members of the Big Ten Academic Alliance Geospatial Information Network.

Prepared by: Wenjie Wang, GIS Specialist, University of Illinois at Urbana-Champaign (wenjiew@illinois.edu).

2.1 Overview of Georeferencing

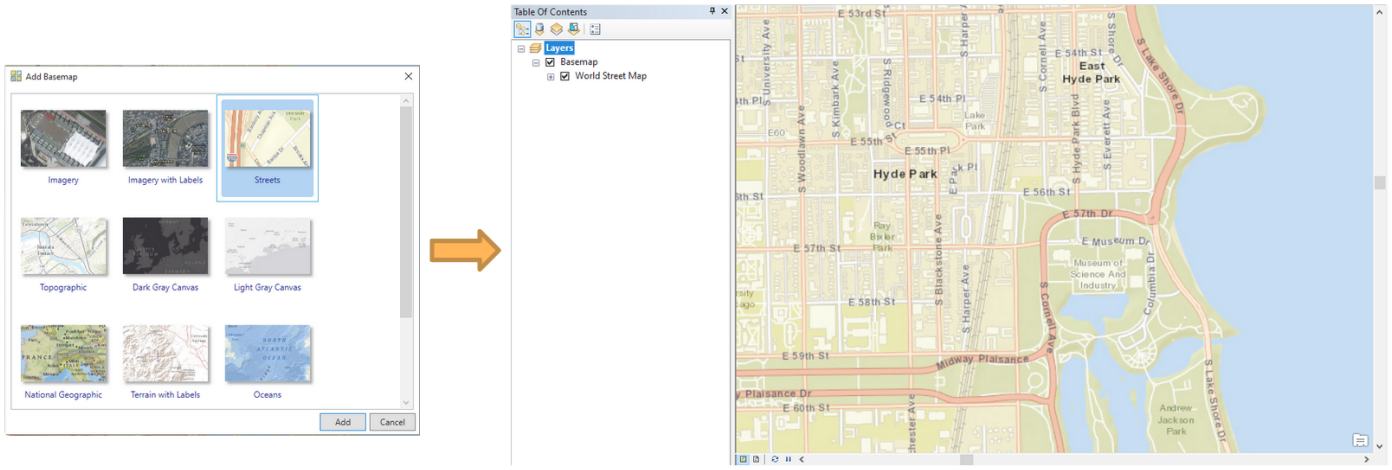
Georeferencing is a commonly used tool to accurately digitize data on a paper map. It uses a series of control points in the digital image to associate this image with spatial locations. The digital image could be an aerial photography, a scanned map, or a picture of a topographic map. The georeferenced map can be used for basic map analysis, such as calculating distances and areas. In this tutorial, you will learn how to georeference a historical map by using ArcMap.

2.2 Download Data

1. Open BTAA geoportal: https://geo.btaa.org/
2. Search term “Hyde Park Community”
3. Click Original Jpeg button to open the map
4. Right click the map and save image as “G4104-C6-2H9-1920z-U5.jpg”

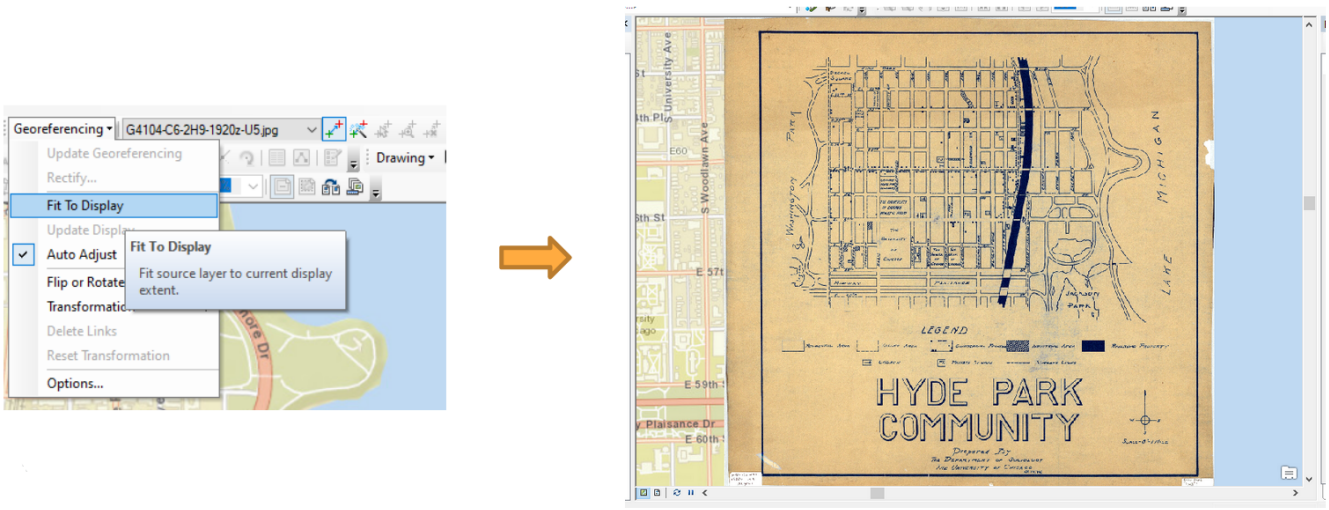
2.3 Data Processing

1. Open ArcMap
2. Click Add Basemap and choose Streets map
3. Zoom in to the study area: Hyde Park, Chicago, Illinois



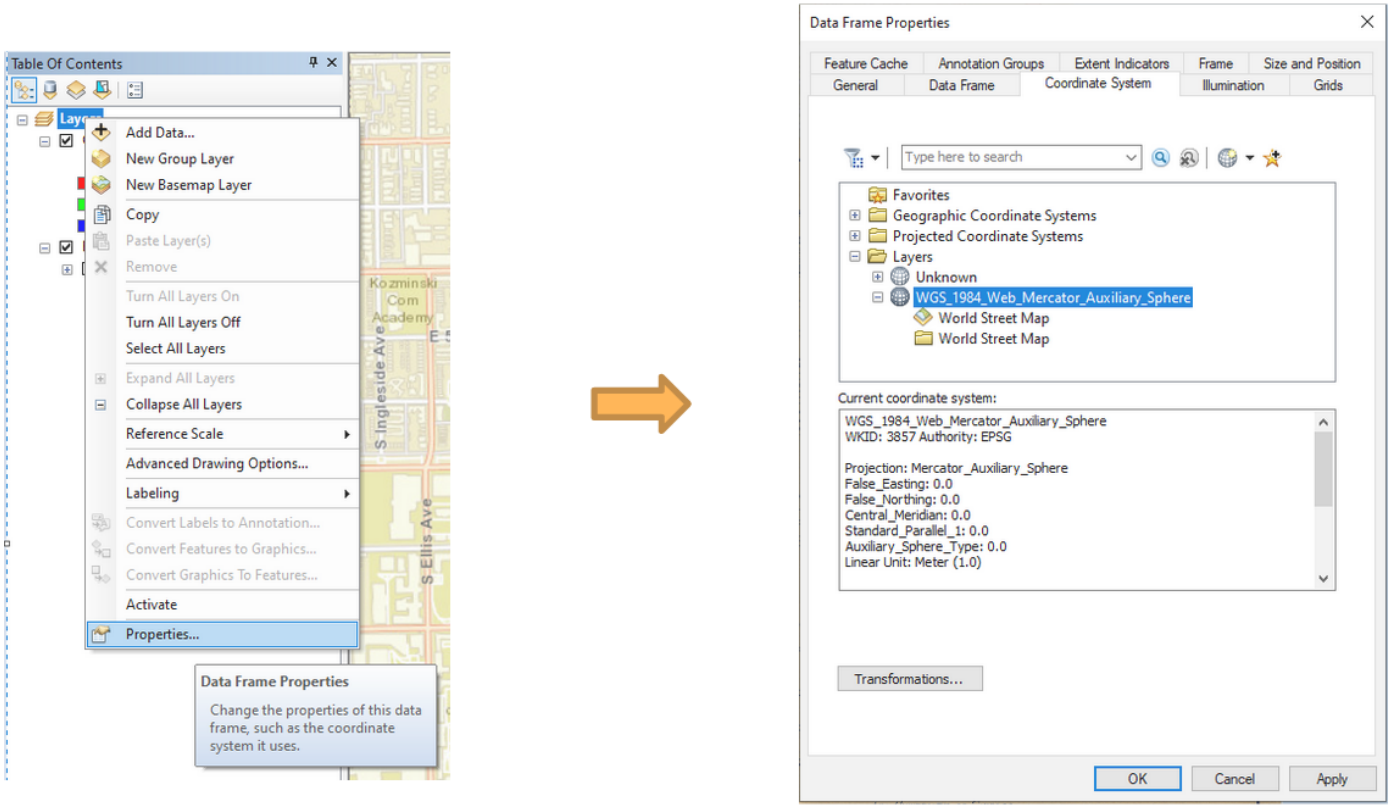
Add Basemap and Zoom to Hyde Park

1. Click Add data and choose the image “G4104-C6-2H9-1920z-U5.jpg”
2. Click Customize -> Toolbar -> Georeferencing to add georeferenced tool
3. Click Fit To Display to show the image in the study area.



Fit Scanned Map to Display

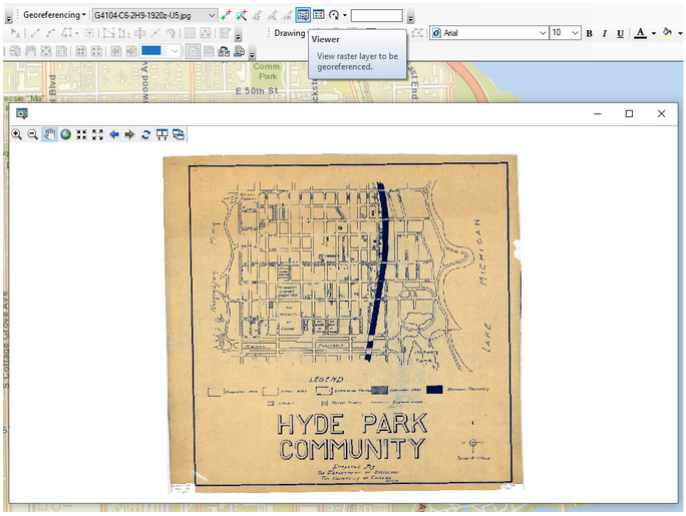
1. Right click Layers -> Properties and select WGS_1984_Web_Mercator_Auxiliary_Sphere as the coordinate system.

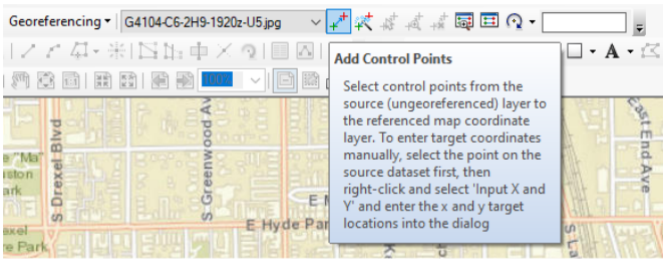


Set Coordinate System

1. Click Viewer to show the image in a new window.

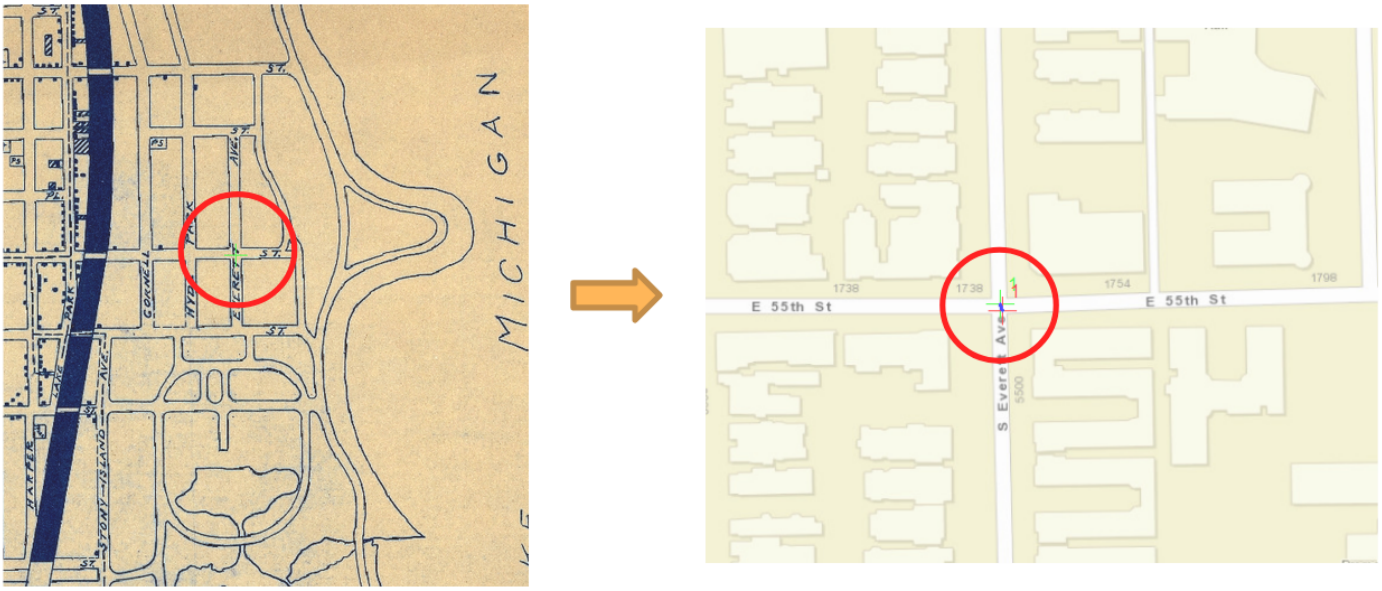
2. Click Add control Points to select control points. Select control points from the viewer window, and then choose the corresponding location in the street map.





Add Control Points

1. Select control points in the area close to the four corners of the map.
2. Select additional control points. The more points you assign the more accurate your georeferenced map will be.



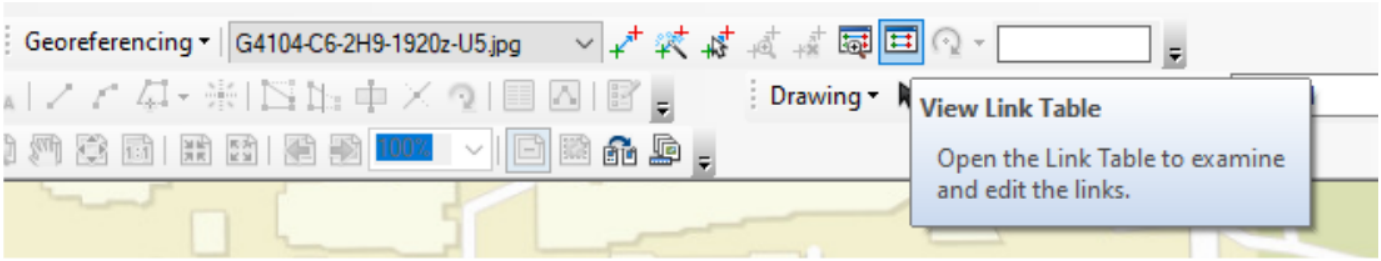
More Control Points

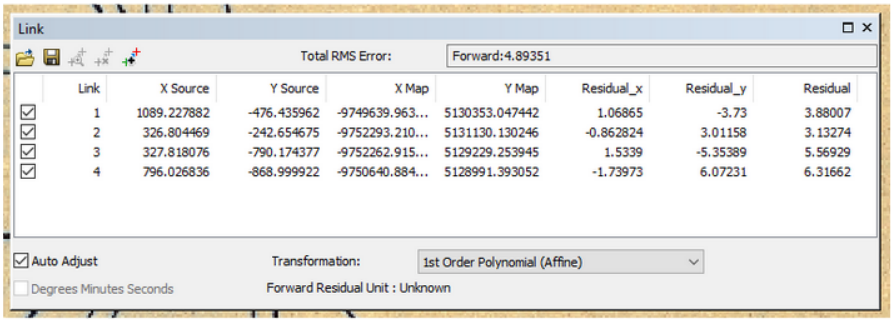
Tips

Here are some tips for choosing control points:

- The number of control points needed depends on the image being used. Normally, at least four control points are required for georeferencing.
- Choose road crossings or sidewalk intersections, because the edges of roads may change over time.
- The control points should be spread across the unreferenced image.

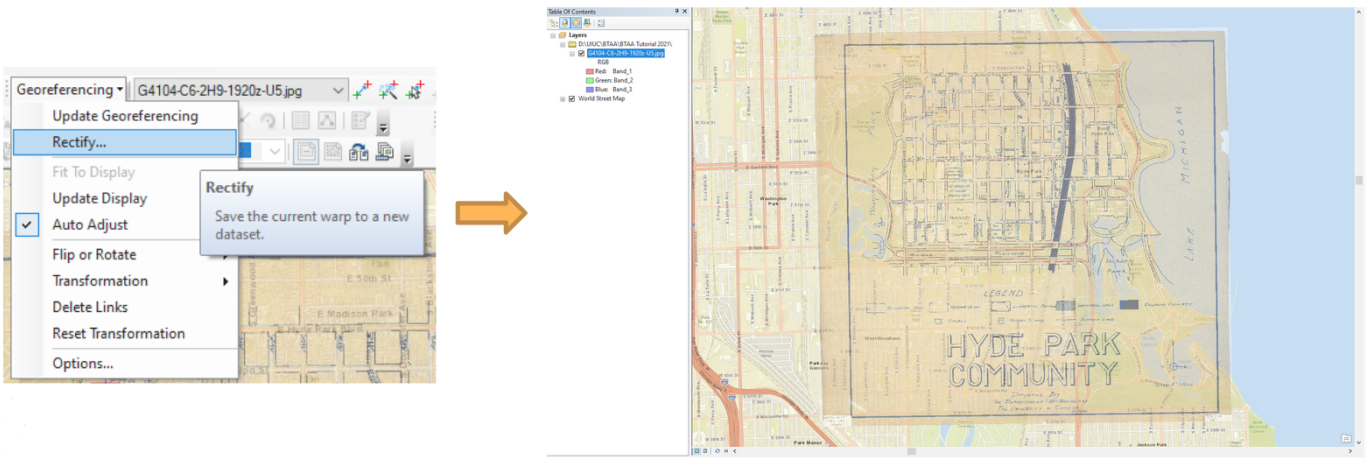
1. Click View Link Table. It is up to you to determine the acceptable residual values. If a link has a residual value much larger than others, the link should be deleted.





Residual Values

1. After georeferencing, click Rectify to save the result.
2. In the layer property, change transparency to 50%. It is an easy to compare the georeferenced map locations with the real world locations.



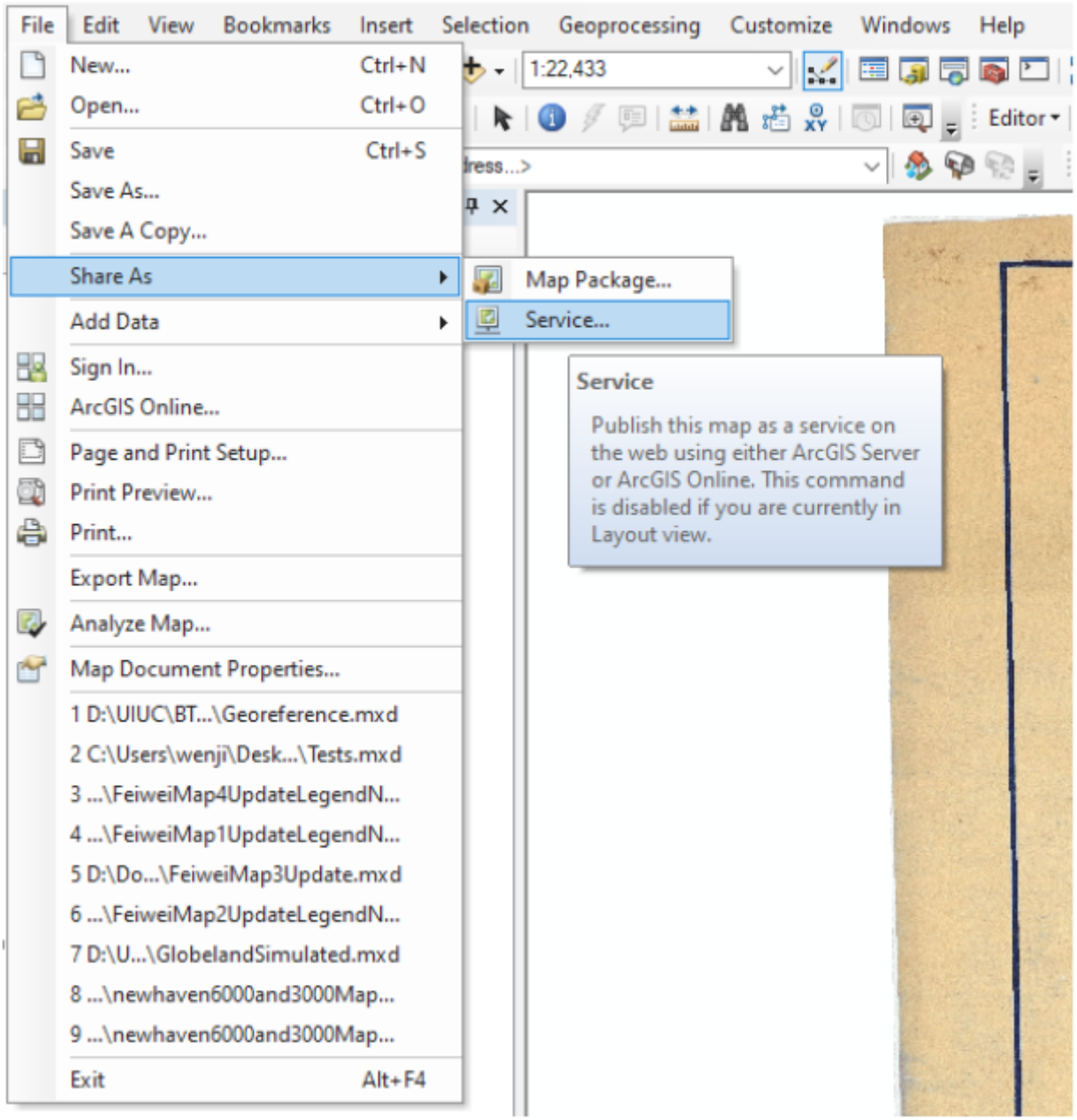
Make Map Overlay Semi-Transparent

2.4 Publish Map on ArcGIS Online

- This topic is optional. to publish a hosted layer, you will need publishing privileges in your ArcGIS organizational account.
- Publishing a tiled service to ArcGIS Online will consume credits, which are the currency used across ArcGIS. To estimate how many credits you will need to perform specific transactions or store data, you can refer to this website: https://doc.arcgis.com/en/arcgis-online/administer/credits.htm
- Sign in with your university account.
- Remove Basemap
- Click File -> Share as -> Service

• Choose Public a service

• Choose a connection and enter service name

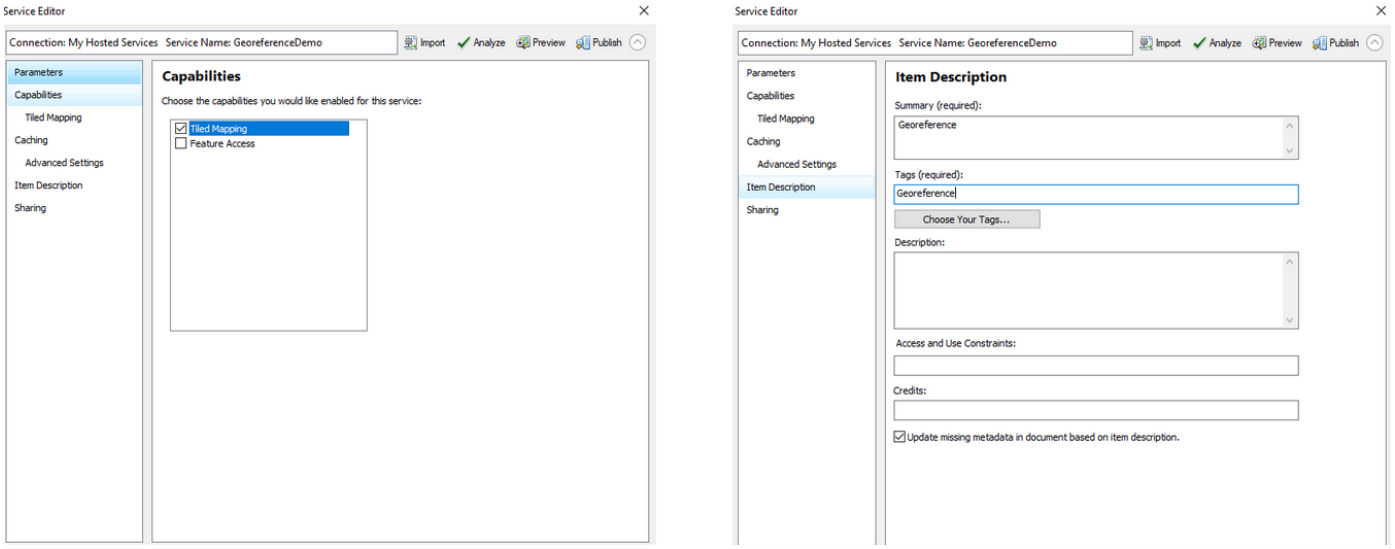


Share as a Service

1. Select Tiled Mapping

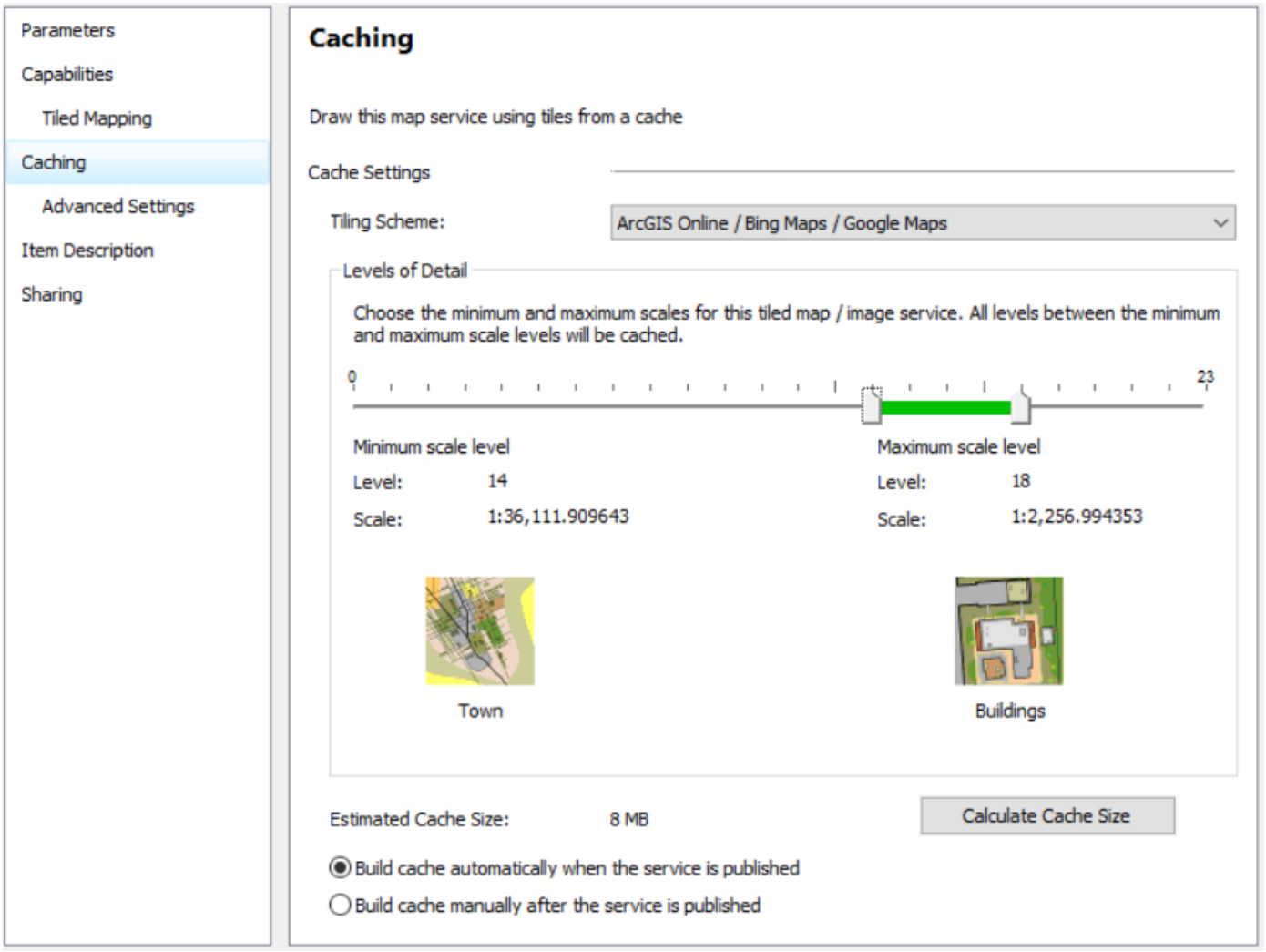
2. Enter information in Item Description

3. In the Sharing tab, you can choose to share your service with yourself (private), your organization, or everyone (public)



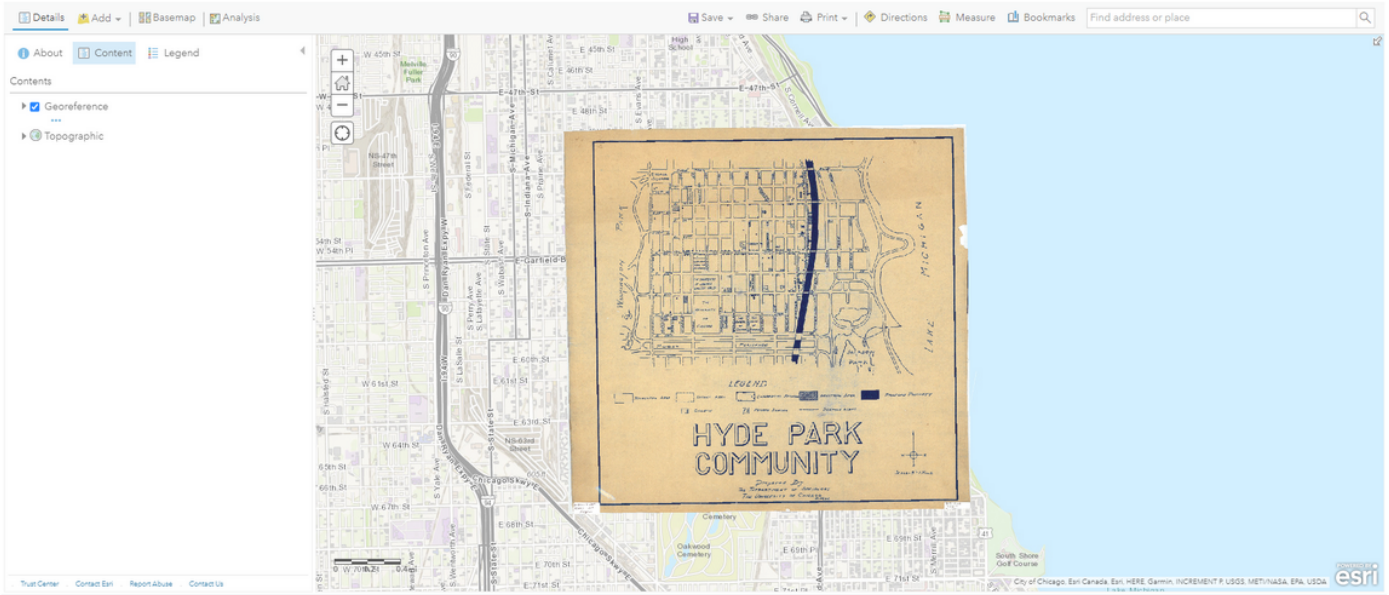
Enter Service Information

1. Select appropriate levels of detail. Do not choose extreme large cashe size, which may consume all your credits.
2. Click Publish button to publish this service.
3. Tile Packages can be used to save credits. You will not be charged for generating tiles. You will only be charged for tile storage. For more information, please refer to: https://www.esri.com/about/newsroom/arcuser/use-tile-packages-to-save-credits/



Define Scale Range for Tiles

1. Log in to ArcGIS Online and open the published map in your Content. The map can be digitized for further usage. For more information, please refer to the Digitizing tutorial, which was prepared by Nicole Kong.



Open in ArcGIS Online

3. Glossary

3.0.1 ArcGIS Dynamic Map Layer Service

An ArcGIS Dynamic Map Layer is based on vector data. (points, lines, and polygons). Map image layers are dynamically rendered image tiles.

3.0.2 ArcGIS Feature Layer Service

An ArcGIS Feature Layer Service displays vector data (points, lines, and polygons) as individual or collected features.

3.0.3 ArcGIS Image Map Layer Service

An ArcGIS Image Map Layer displays raster data (a grid of cells used to store imagery).

3.0.4 ArcGIS Tiled Map Layer Service

An ArcGIS Tiled Map Layer Service displays set of web-accessible tiles that reside on a server.

3.0.5 Index Maps

Index maps are a type of finding aid that allows a user to use a map to select a specific item within a set. Resources in the BTAA Geoportal that use index maps are multi-page items, such as atlases and sheet maps. To find items on an index map, click a green polygon or point in the map viewer. A preview of the item will appear beneath the map, and the user can click a link to be directed to the selected map page.

3.0.6 International Image Interoperability Framework (IIIF)

The International Image Interoperability Framework (IIIF) web service API displays an image from a server. This image can be panned and zoomed.

3.0.7 Web Mapping Service (WMS)

A Web Map Service renders a geospatial dataset as map images.

3.0.8 Web Feature Service (WFS)

A Web Feature Service serves queryable geographic features.

4. Linking Tabular Data to Geospatial Data

This tutorial is part of an educational series produced by members of the Big Ten Academic Alliance Geospatial Information Network.

Prepared by: Wenjie Wang, GIS Specialist, University of Illinois at Urbana-Champaign (wenjiew@illinois.edu).

4.1 Introduction

This tutorial gives an example to help students understand GIS technology allows people to connect data with geography. GIS can relate unrelated information by using location as the key index variable. Sometimes people don't fully understand their data until they see how it relates to other things in a geographic context. And GIS can help people understand what belongs where.

Through this tutorial, student can get familiar with how to link tabular data to geospatial data by using ArcGIS Online. Instructors can add more exercises based on students' need.

4.2 Download Data

Geospatial Data is the data about a object that has a geographic component.

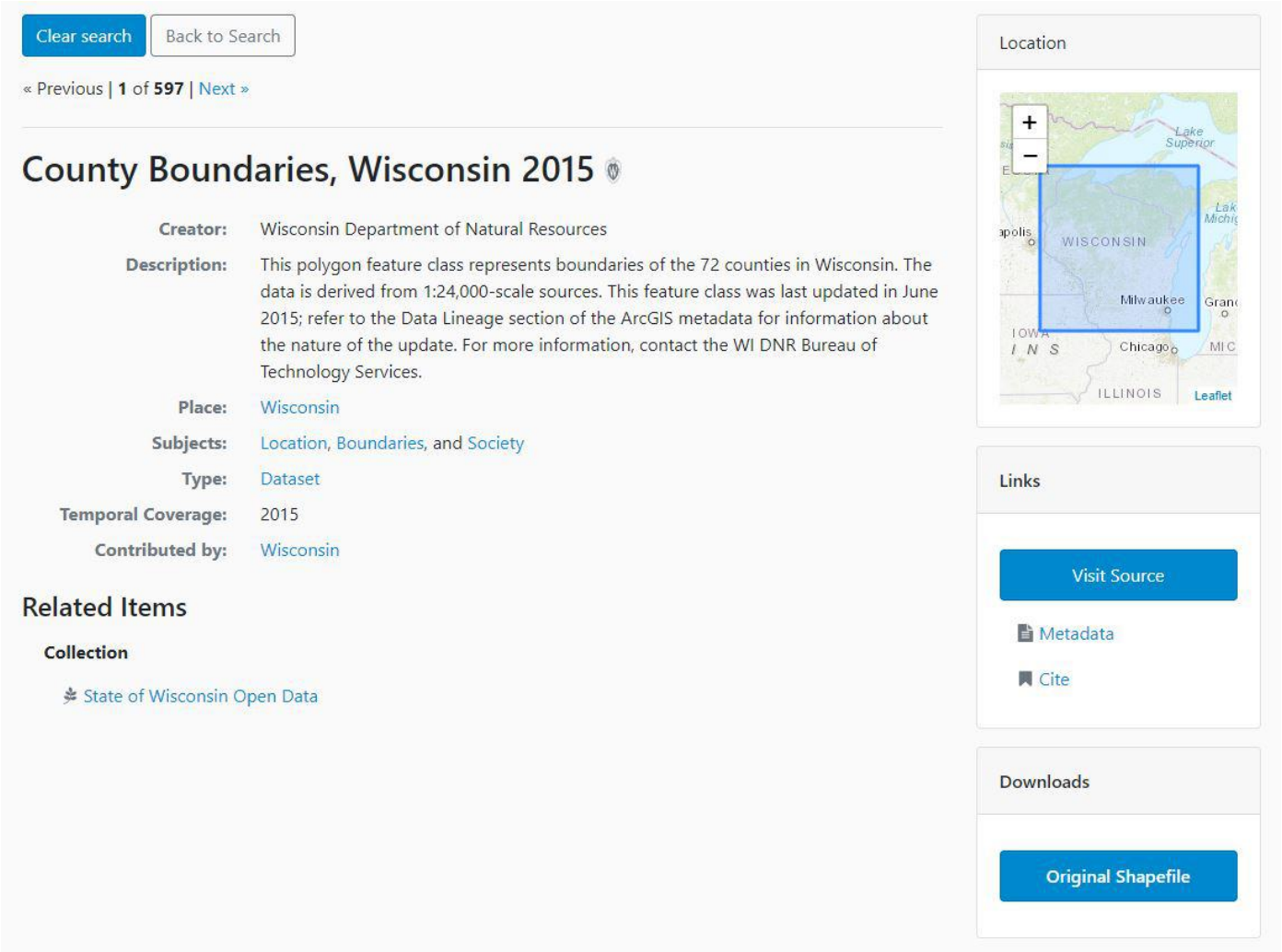
The Big Ten Academic Alliance Geoportal connects users to digital geospatial resources, including GIS datasets, web services, and digitized historical maps from multiple data clearinghouses and library catalogs. The site is solely a search tool and does not host any data.

Visit the Project Documentation page to find out more about our project's history, committees, working groups, conference presentations, and journal articles.

The following steps show how to find geospatial data from BTAA geoportal and tabular data from U.S. Census:

1. Search the keywords "county boundary of Wisconsin" through BTAA geoportal
2. Open the first result "County Boundaries, Wisconsin 2015"
3. Click the "Original Shapefile" button to download the data. Save as "WI_Counties_2015.zip"

This polygon feature class represents boundaries of the 72 counties in Wisconsin. The data is derived from 1:24,000-scale sources. This feature class was last updated in June 2015.



Polygon Feature Class for Wisconsin County Boundaries

1. Open U.S. Census website (https://www.census.gov/en.html) and search the keywords "wisconsin counties by population"
2. Open the first result "County Population Totals: 2010-2019" and click Wisconsin to download the table.

Tables

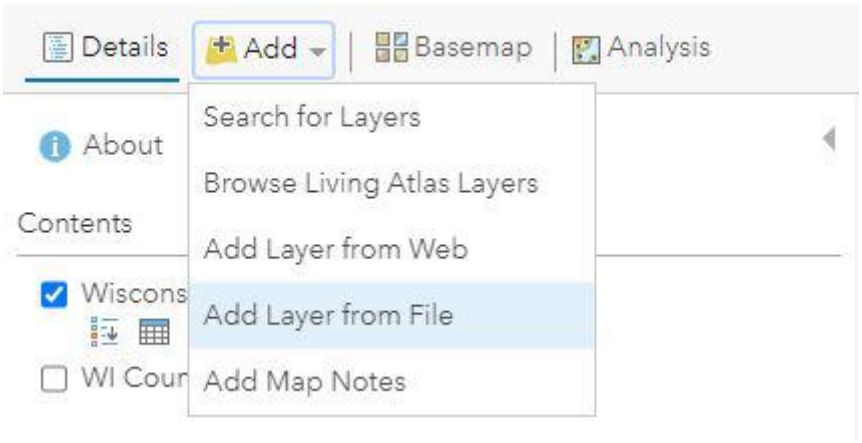
Annual Estimates of the Resident Population for Counties: April 1, 2010 to July 1, 2019

United States
Alabama
Alaska
Arizona
Arkansas
California
Colorado
Connecticut
Delaware
District of Columbia
Florida
Georgia
Hawaii
Idaho
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
Missouri
Montana
Nebraska
Nevada
New Hampshire
New Jersey
New Mexico
New York
North Carolina
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
Rhode Island
South Carolina
South Dakota
Tennessee
Texas
Utah
Vermont
Virginia
Washington
West Virginia
Wisconsin
Wyoming

Annual Estimates of the Resident Population for Counties in Wisconsin: April 1, 2010 to July 1, 2019 (CO-EST2019-ANNRES-55), U.S. Census Bureau, Population Division, March 2020

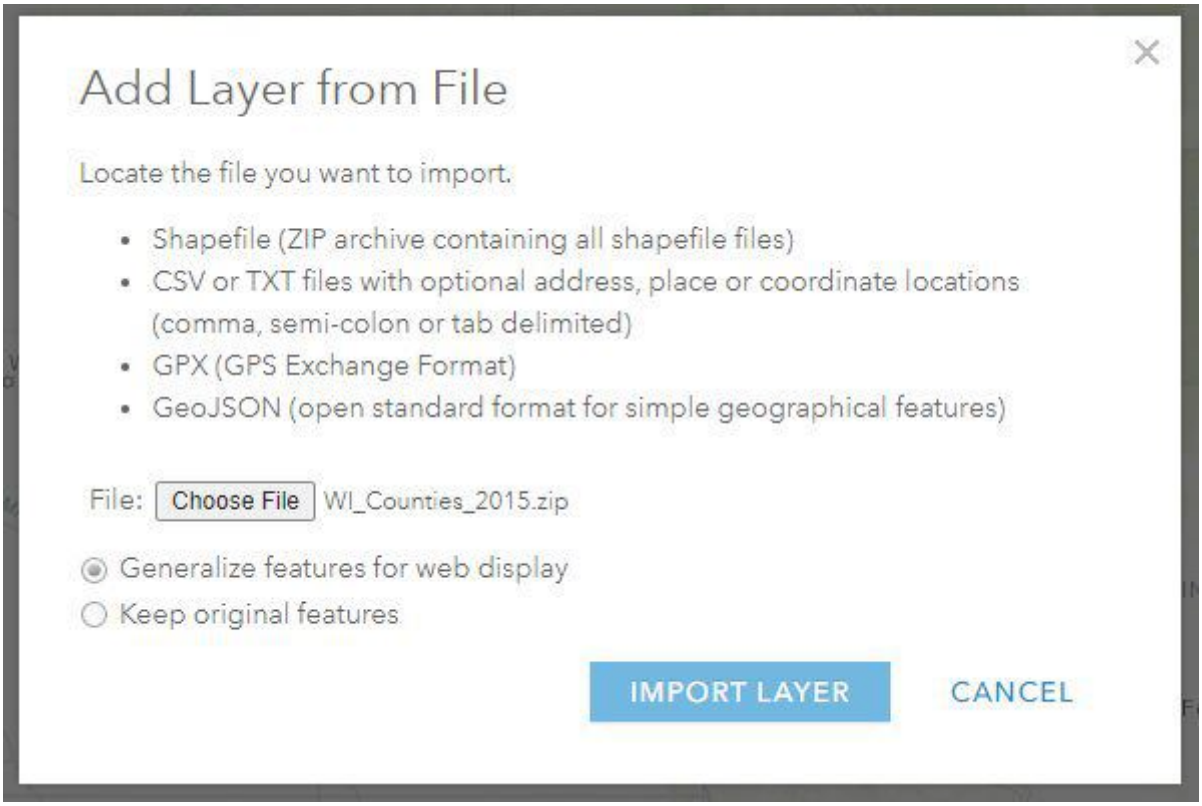
4.3 Prepare Data

1. Log into ArcGIS Online and create Web Map



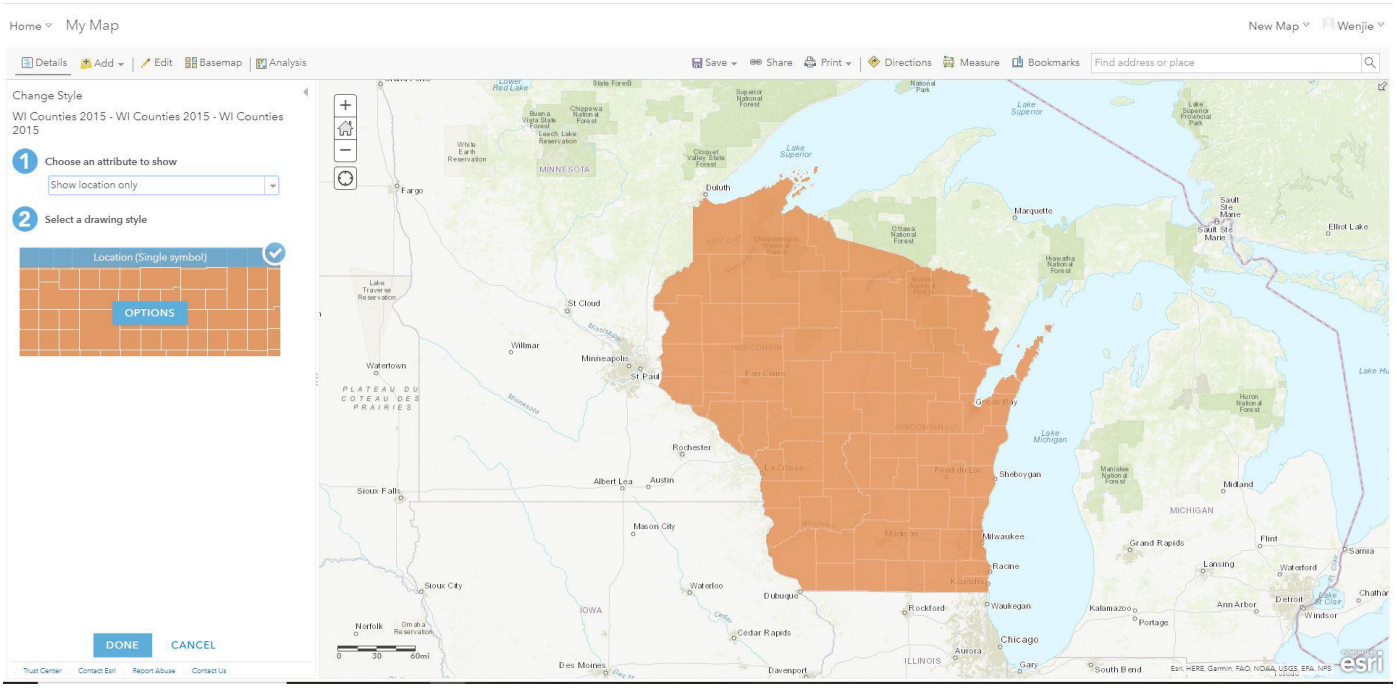
Adding a Layer in ArcGIS Online

1. Add WI_Counties_2015.zip as a new layer from File



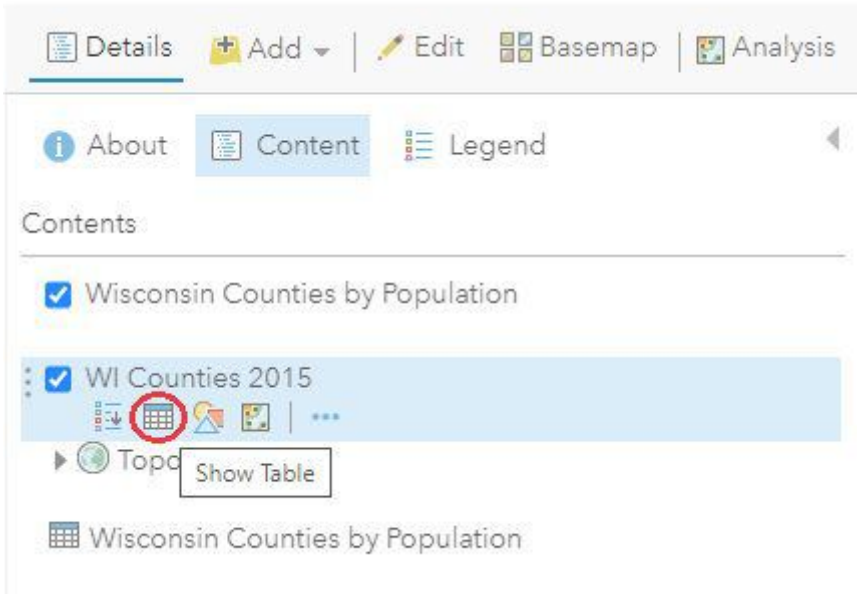
Choosing a File in ArcGIS Online

1. Choose an attribute to show. Here we use “show location only”

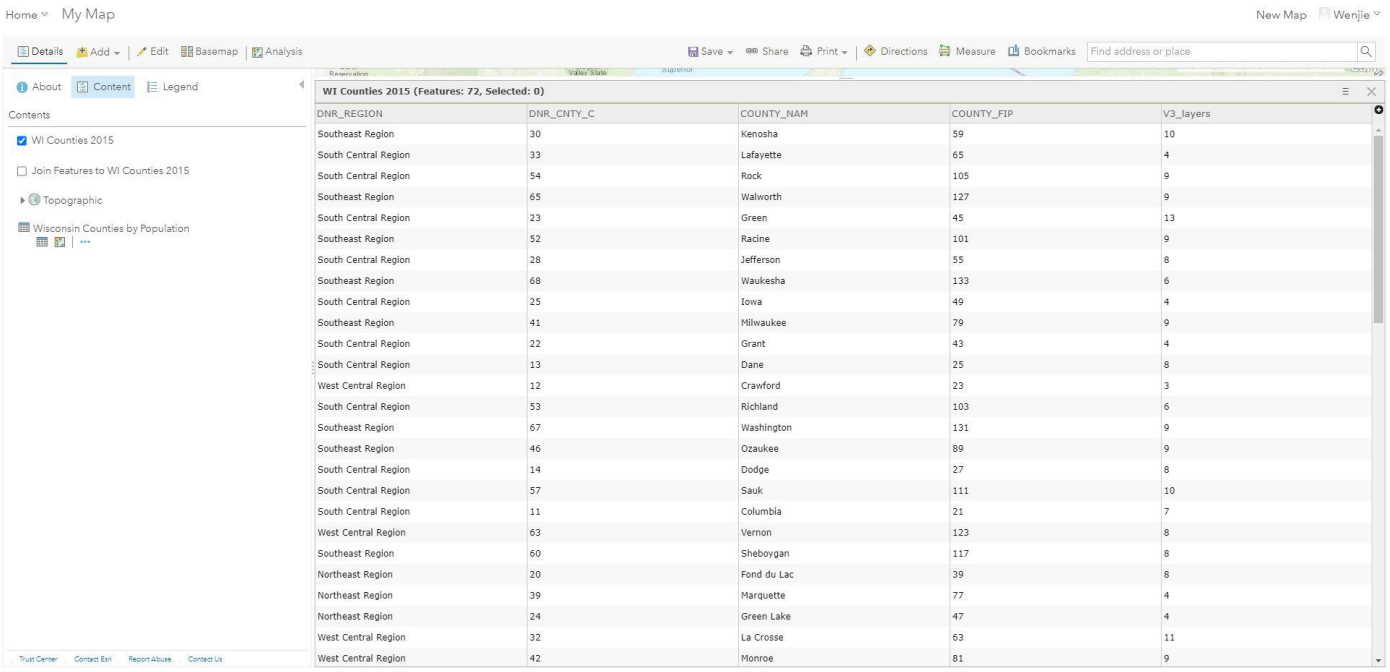


Choosing an Attribute to Show in ArcGIS Online

1. Click “show table” button to open attribute table and get to know what information was included in the geospatial dataset.



Show Table in ArcGIS Online

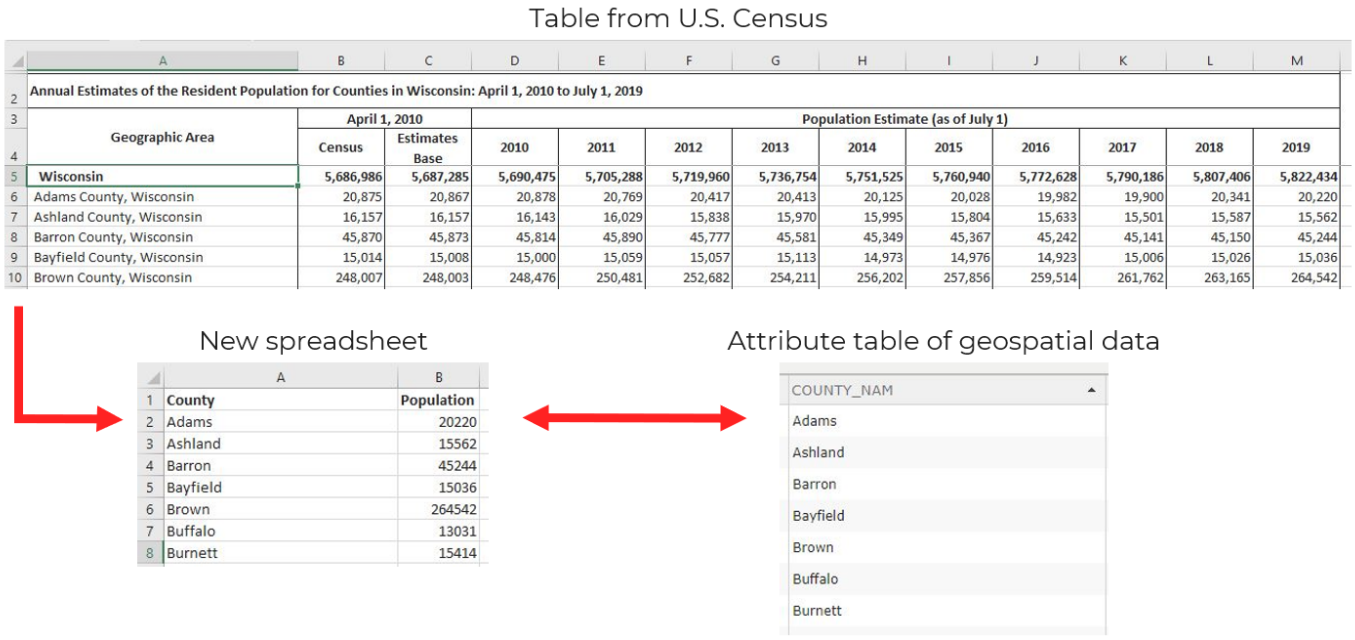


DNR_REGION	DNR_CNTY_C	COUNTY_NAM	COUNTY_FIP	V3_layers
Southeast Region	30	Kenosha	59	10
South Central Region	33	Lafayette	65	4
South Central Region	54	Rock	105	9
Southeast Region	65	Walworth	127	9
South Central Region	23	Green	45	13
Southeast Region	52	Racine	101	9
South Central Region	28	Jefferson	55	8
Southeast Region	68	Waukesha	133	6
South Central Region	25	Iowa	49	4
Southeast Region	41	Milwaukee	79	9
South Central Region	22	Grant	43	4
South Central Region	13	Dane	25	8
West Central Region	12	Crawford	23	3
South Central Region	53	Richland	103	6
Southeast Region	67	Washington	131	9
Southeast Region	46	Ozaukee	89	9
South Central Region	14	Dodge	27	8
South Central Region	57	Sauk	111	10
South Central Region	11	Columbia	21	7
West Central Region	63	Vernon	123	8
Southeast Region	60	Sheboygan	117	8
Northeast Region	20	Fond du Lac	39	8
Northeast Region	39	Marquette	77	4
Northeast Region	24	Green Lake	47	4
West Central Region	32	La Crosse	63	11
West Central Region	42	Monroe	81	9

Attribute Table in ArcGIS Online

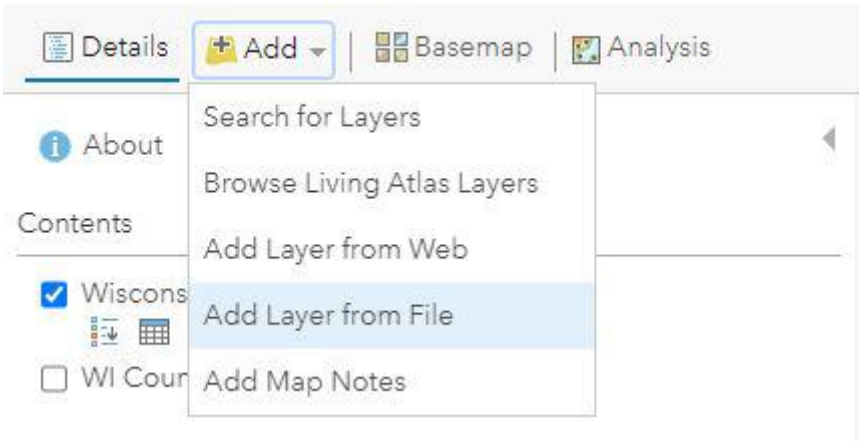
1. Create a new excel file and name it as "Wisconsin Counties by Population.csv". Copy and paste the county name column and population in 2019 column from U.S. Census spreadsheet into this new excel file. We need to use county name as the common field to link those two tables. Therefore, the name of counties in both table should be the same.

   Notice: paste the values only and revise the name of counties by using replace tool.

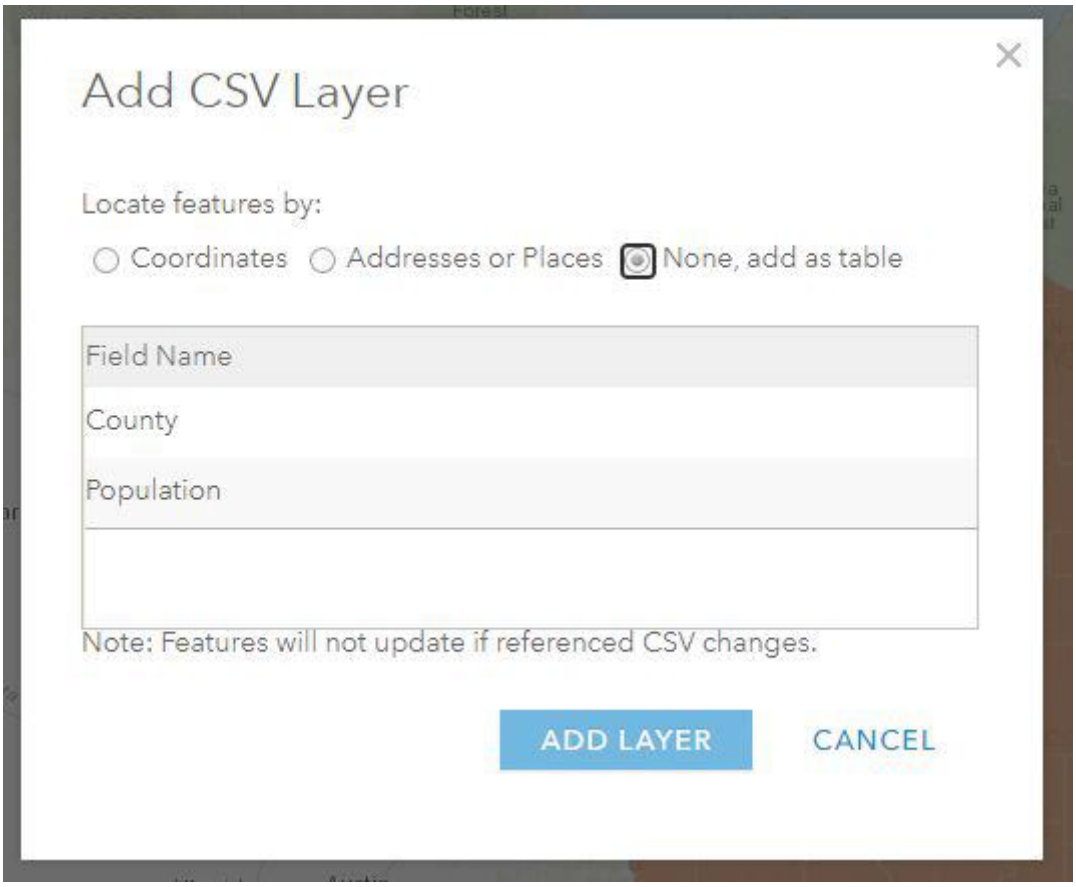


Shared Attribute Between Two Tables

1. Add the “Wisconsin Counties by Population.csv” as a new layer and choose “None, add as table”



Add Layer from File

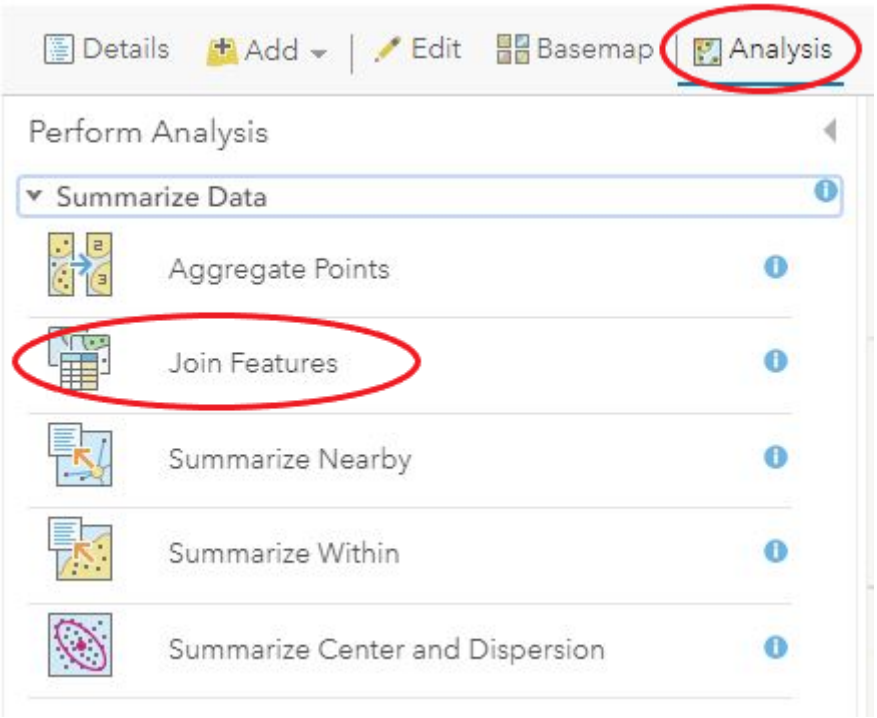


Add CSV

4.4 Data Process

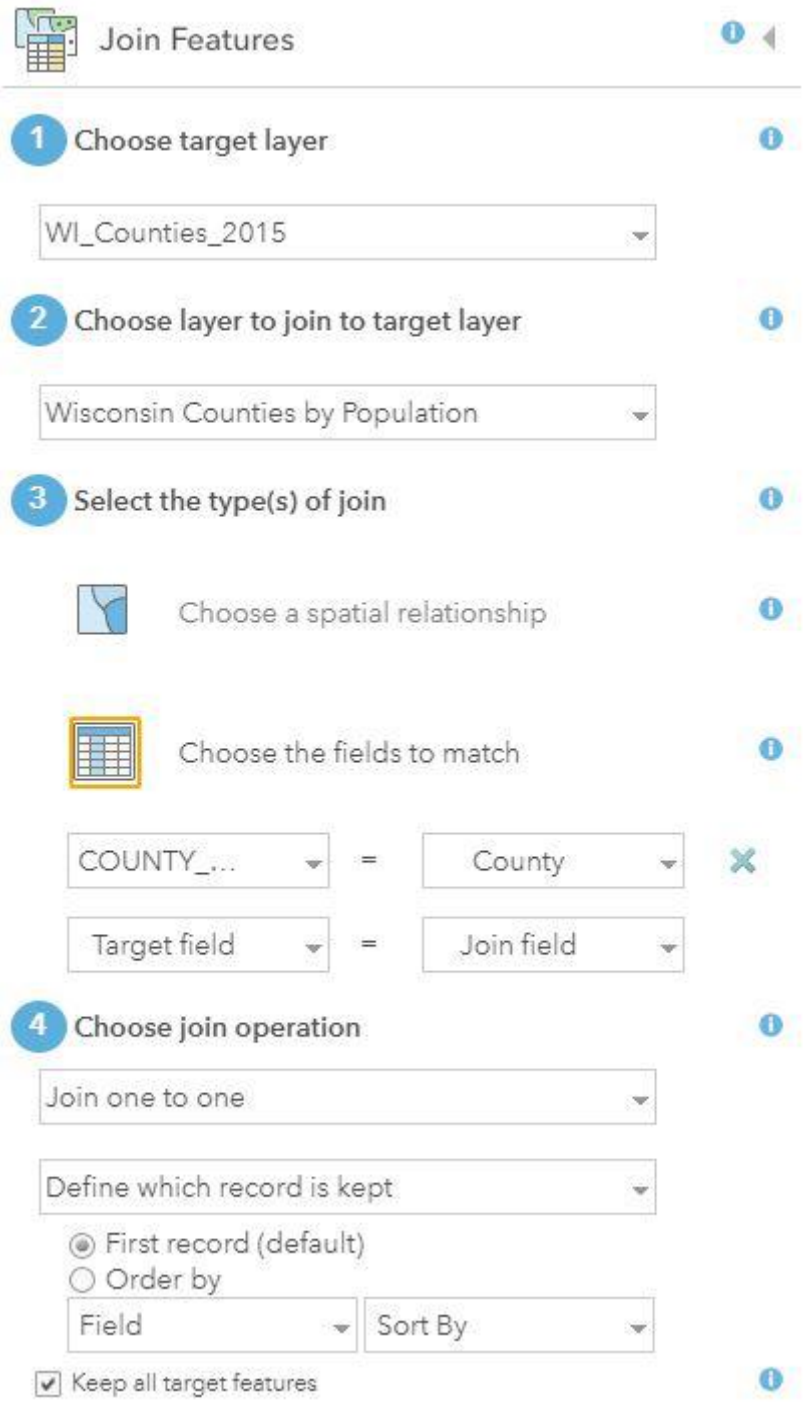
The following steps show how to link tabular data to the geospatial data:

1. Click Analysis and choose Join Features



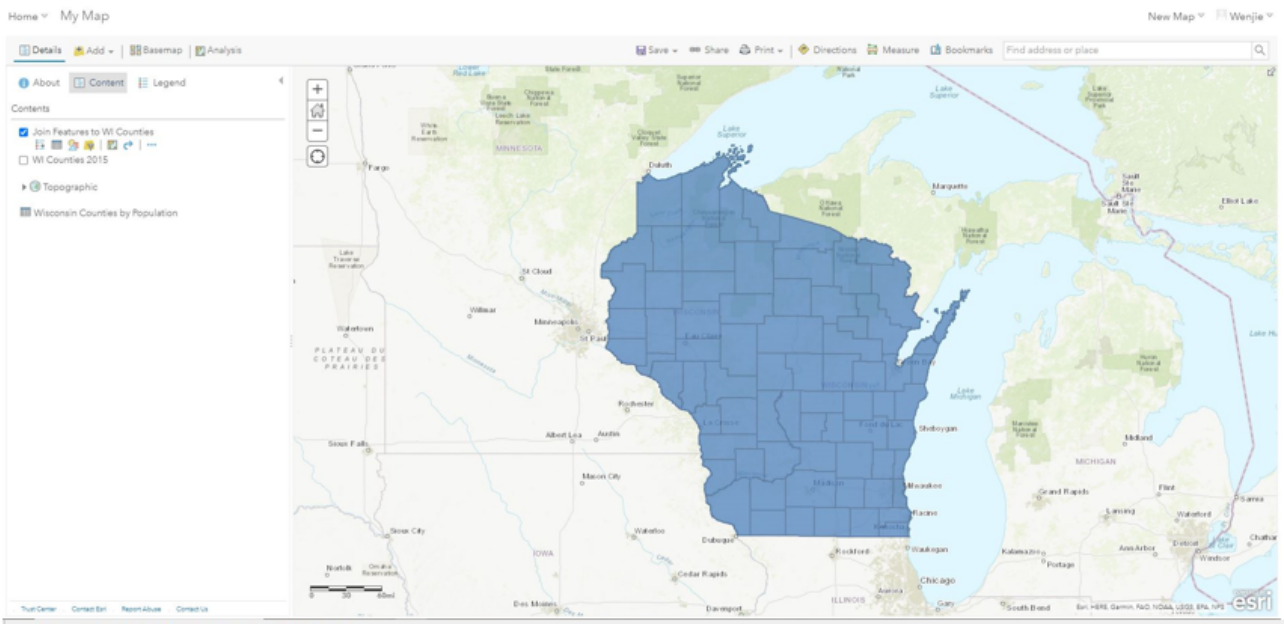
Joining Features

1. Choose WI_Counties_2015 as the “Target Layer” and Wisconsin Counties by Population as the “Layer to Join to the Target Layer”.
2. Choose the “COUNTY_Nam” and “County” as the fields to match.
3. Choose a one-to-one join operation and name the result layer as Wisconsin Counties by Population.



Join Features Input Form

1. Click the Run Analysis button, and a new layer based on population will be shown.

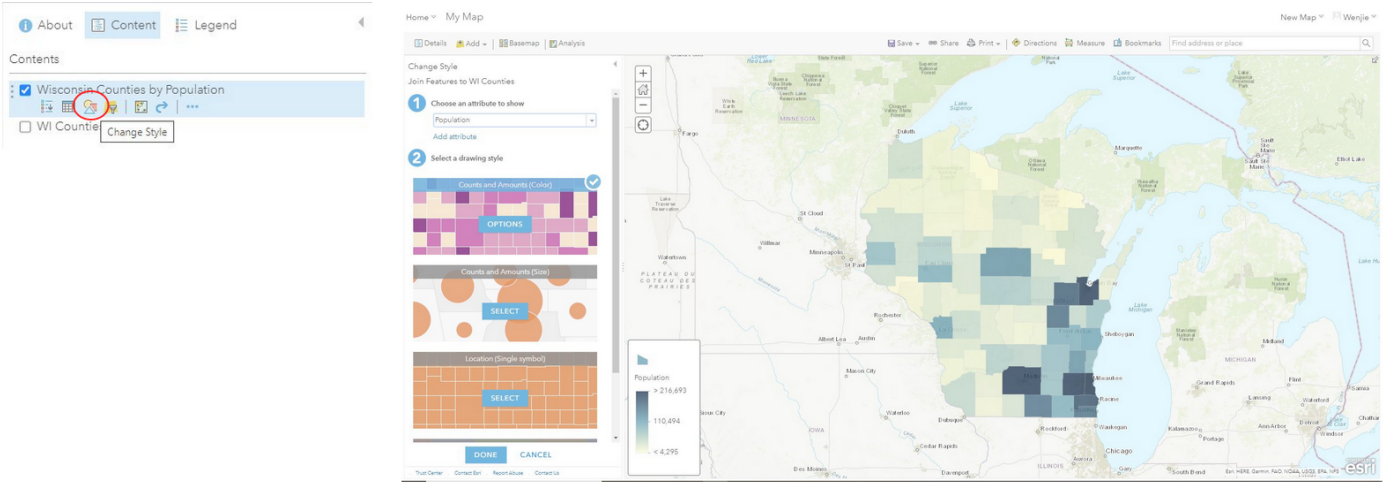


Population Test new (Features: 72, Selected: 0)

DNR_REGION	DNR_CNTY_C	COUNTY_NAM	COUNTY_FIP	V3_layers	Population
West Central Region	1	Adams	1	6	20,220
Northern Region	2	Ashland	3	10	15,562
Northern Region	3	Barron	5	4	45,244
Northern Region	4	Bayfield	7	10	15,036
Northeast Region	5	Brown	9	7	264,542

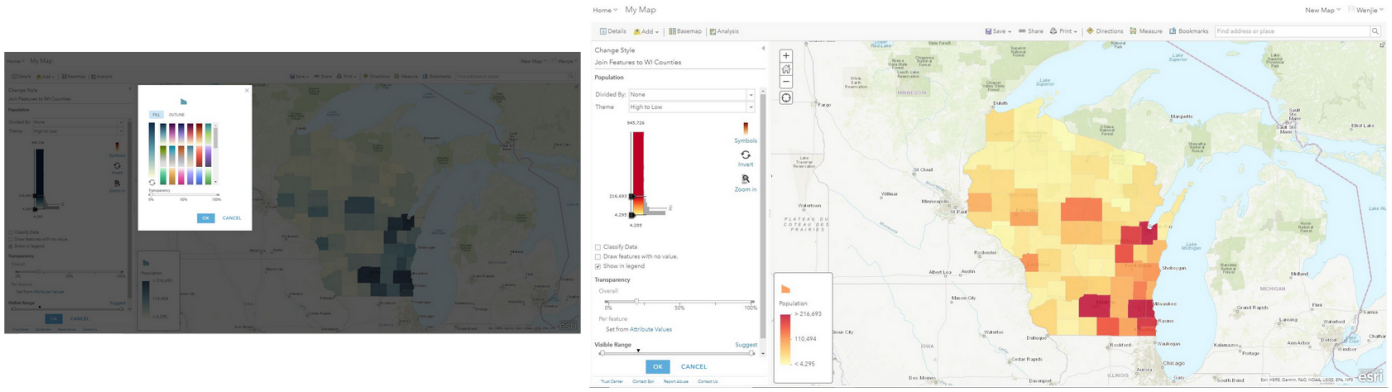
Join Output

1. Symbolize the Wisconsin Counties by Population layer by clicking “change style” button



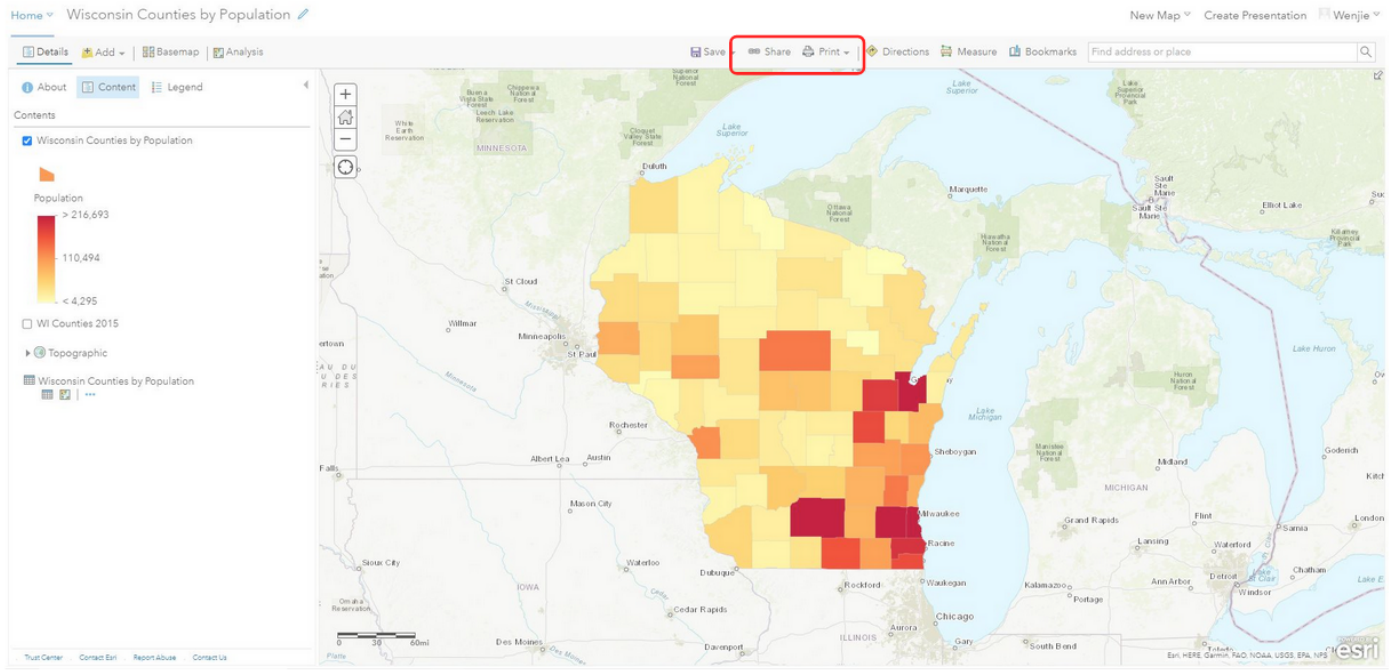
Change Layer Style

1. Choose the appropriate style to clearly show the population



Reset Choropleth Symbology

1. Share or Print the Wisconsin Counties by Population map
2. For copyright information, refer to the copyright tutorial



Share or Print

4.5 Exercise

Questions

1. What's the advantage of mapping tabular data?
2. Choose different basemap and use different symbol to create different thematic map.
3. Download a shapefile data related to students' research field and link their tabular data to it.

4.6 Wrapping Up

This tutorial is part of an educational series produced by members of the Big Ten Academic Alliance Geoportal. The BTAA Geoportal connects users to digital geospatial resources, including GIS datasets, web services, and digitized historical maps from multiple data clearinghouses and library catalogs. The site is solely a search tool and does not host any data.\ To access additional tutorials in this series that cover various other topics, visit: https://sites.google.com/umn.edu/btaa-gdp/tutorials.

5. Story Maps

This tutorial is part of an educational series produced by members of the Big Ten Academic Alliance Geospatial Information Network.

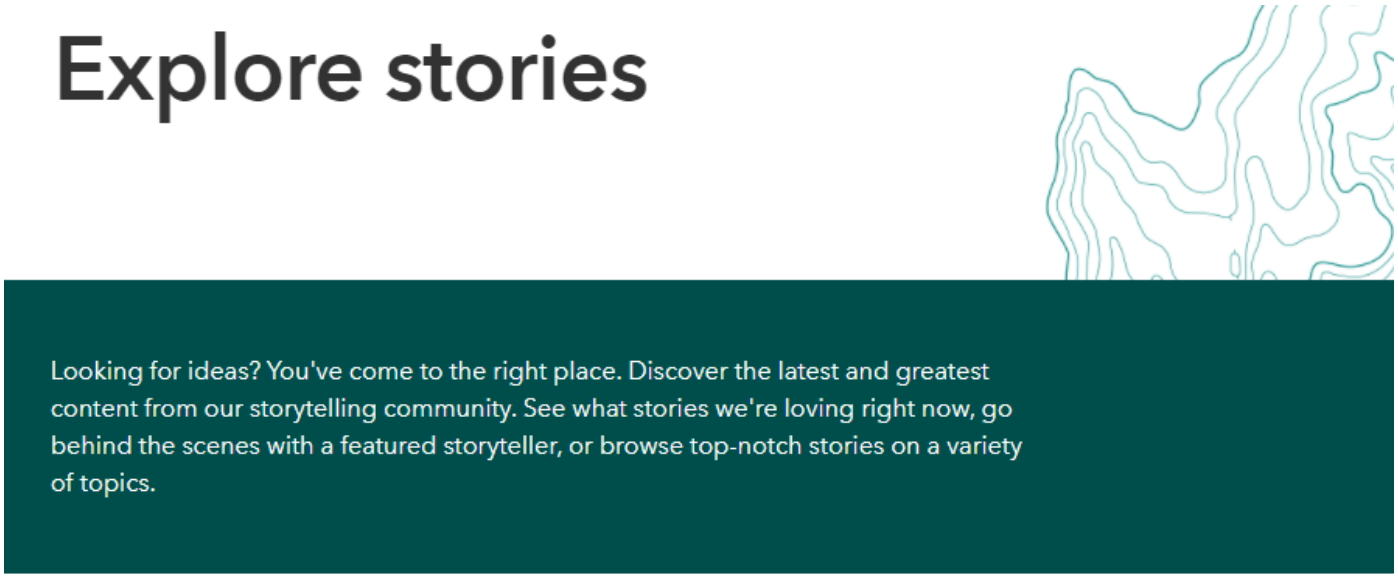
Prepared by: Ryan Mattke, Map and Geospatial Information Librarian, University of Minnesota (matt0089@umn.edu).

5.1 Introduction

Story Maps are an application within ArcGIS Online which allows you to integrate web maps with text, images, and other multimedia content.

Story Maps allow you to:

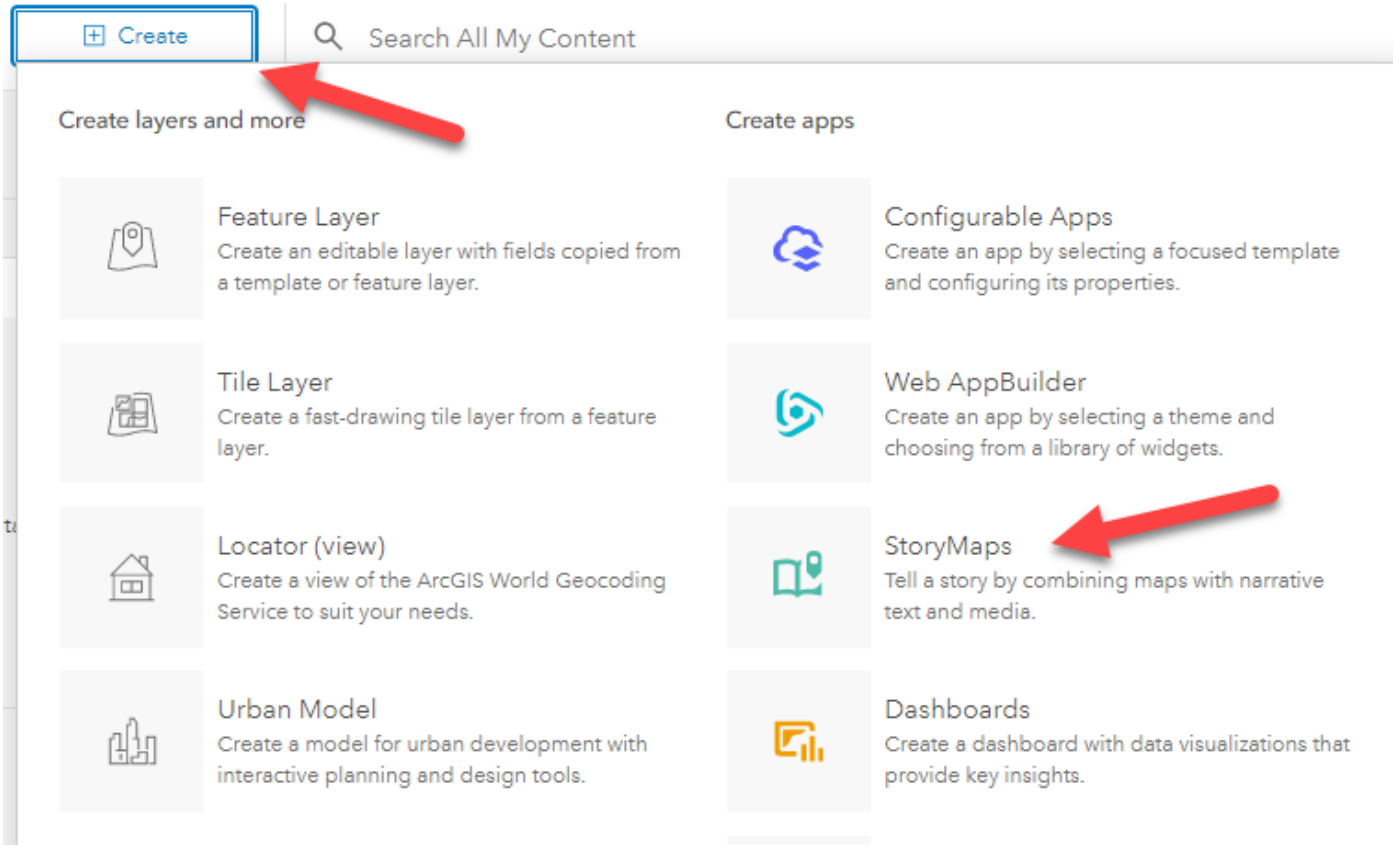
- Put your web maps in context
- Compare web maps and data sets
- Experiment!



Explore Stories

5.2 Basics

The first step is to log on to ArcGIS Online, go to your Content section, and click Create then Story Maps.

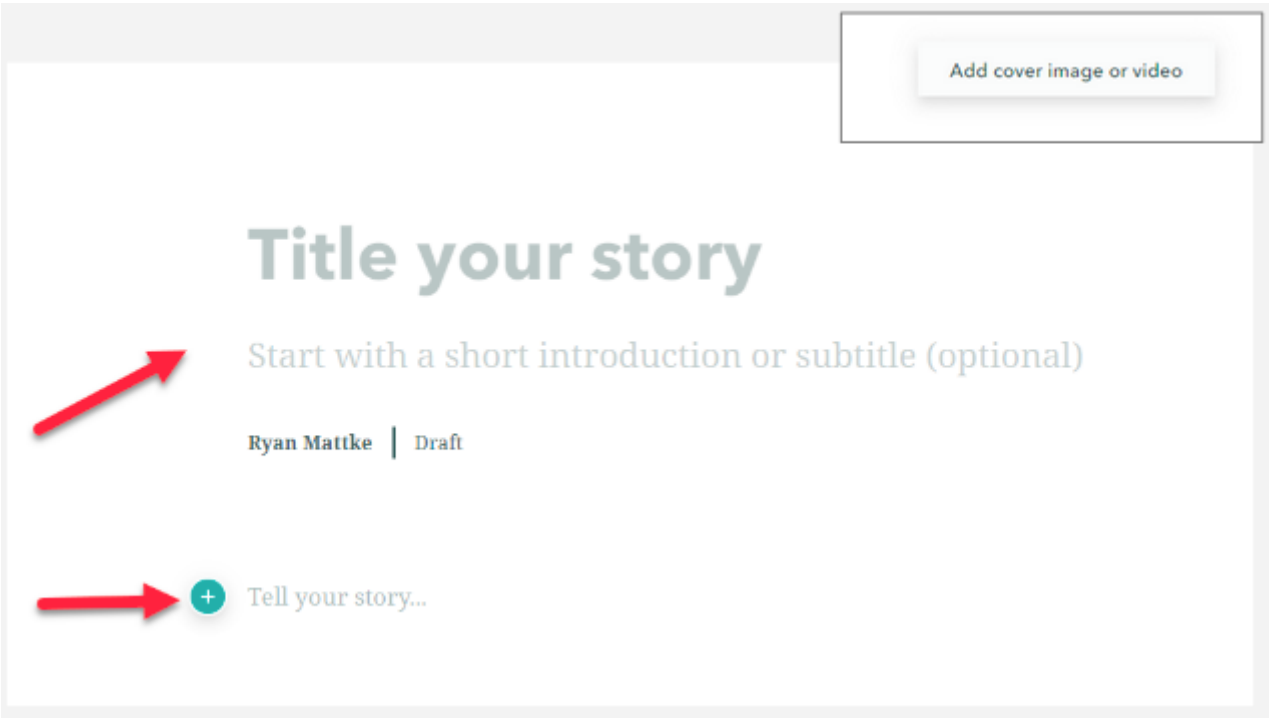


Create Story Map

Give you story a title and a subtitle and/or an introduction.

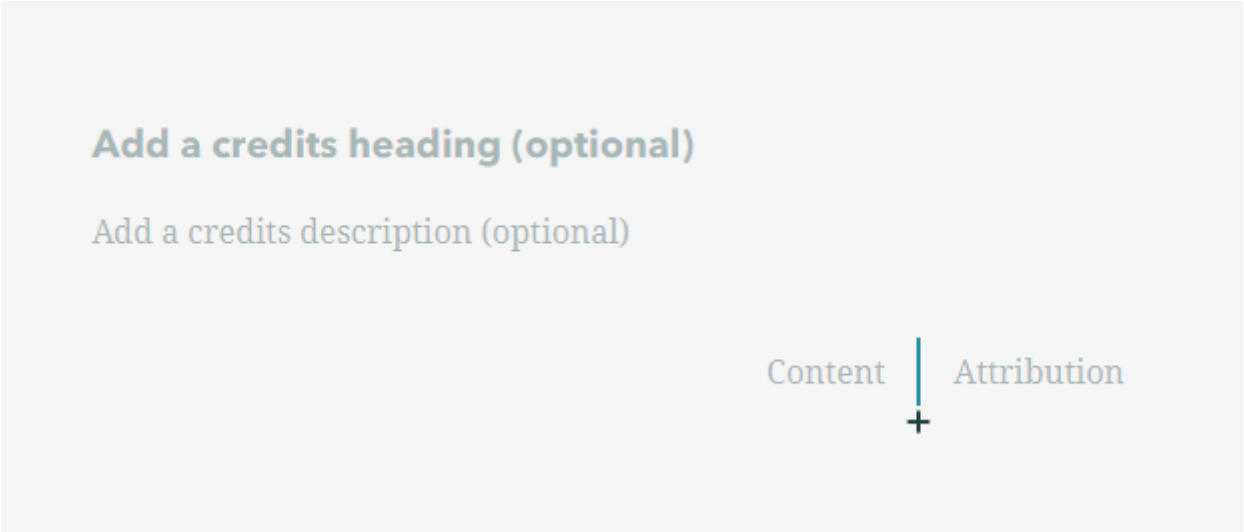
Add cover image or video (upper right).

Click the "+" symbol to add content to the story map.



Adding Title and Content

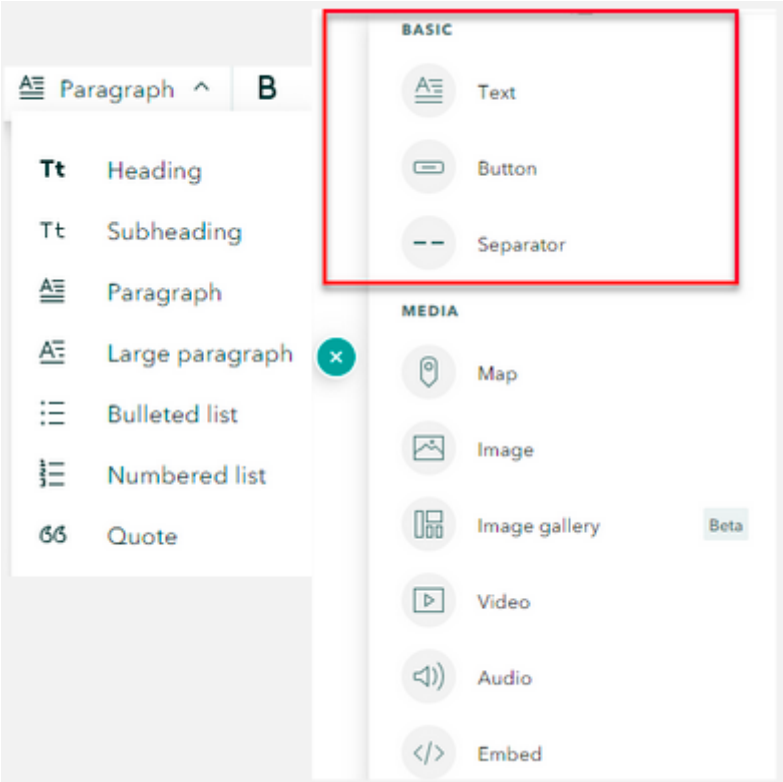
Be sure to take advantage of the options (at the bottom/end of the story map) to add credits and content attribution.



Adding Credits

Basic options for content:

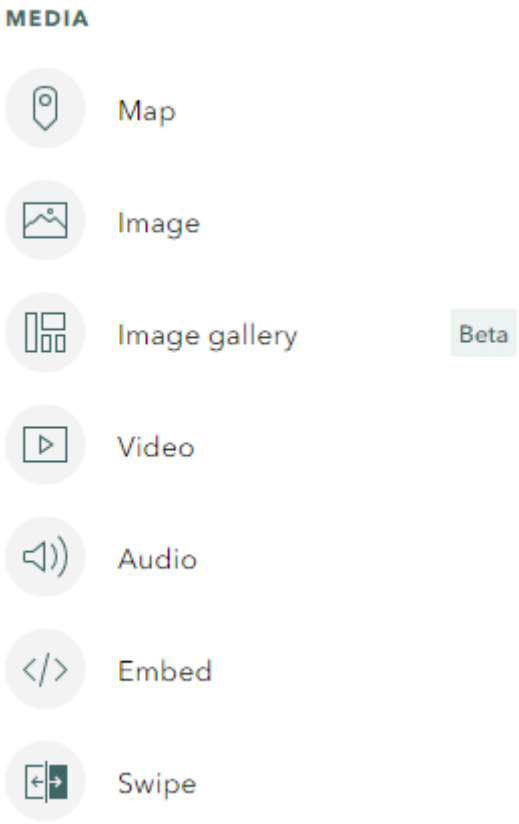
- Text – Options include heading, subheading, paragraph, , large paragraph, bulleted list, numbered list, and quote
- Button – To highlight a link with text
- Separator – Insert a horizontal line



Content Options

Media options for content:

- Map – Insert a web map or web app from ArcGIS Online
- Image – Upload or link to a jpg, png, gif, or svg file
- Image Gallery – Insert a gallery of up to 12 images
- Video – Upload or link to video content
- Audio – Upload or link to audio content
- Embed – Embed using iframe code or a web url; this could be a website, or even another story map
- Swipe – Compare two web maps or images



Media Options

Immersive options for content:

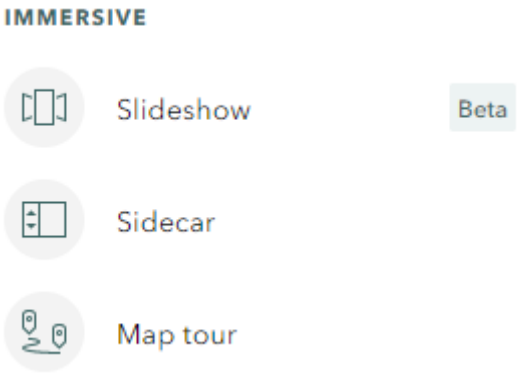
- Slideshow – Full screen, media-focused layout
- Sidecar – Stationary text/media panel with a scrolling narrative panel that can include web maps
- Map tour – Showcase a set of locations

5.3 Intermediate

Once you have the basics down, try something a little more fancy...

Immersive options for content:

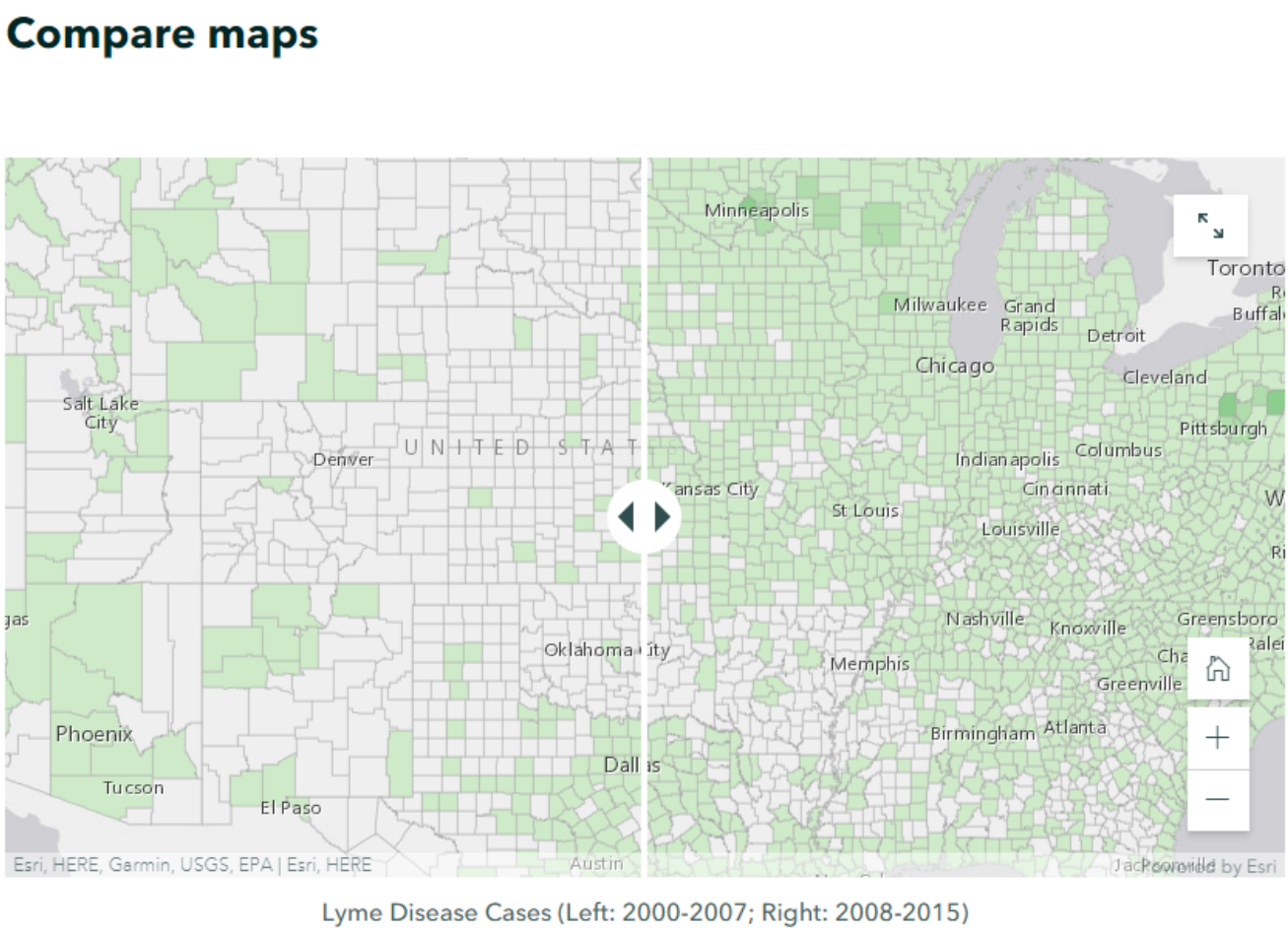
- Slideshow – Full screen, media-focused layout
- Sidecar – Stationary text/media panel with a scrolling narrative panel that can include web maps
- Map tour – Showcase a set of locations



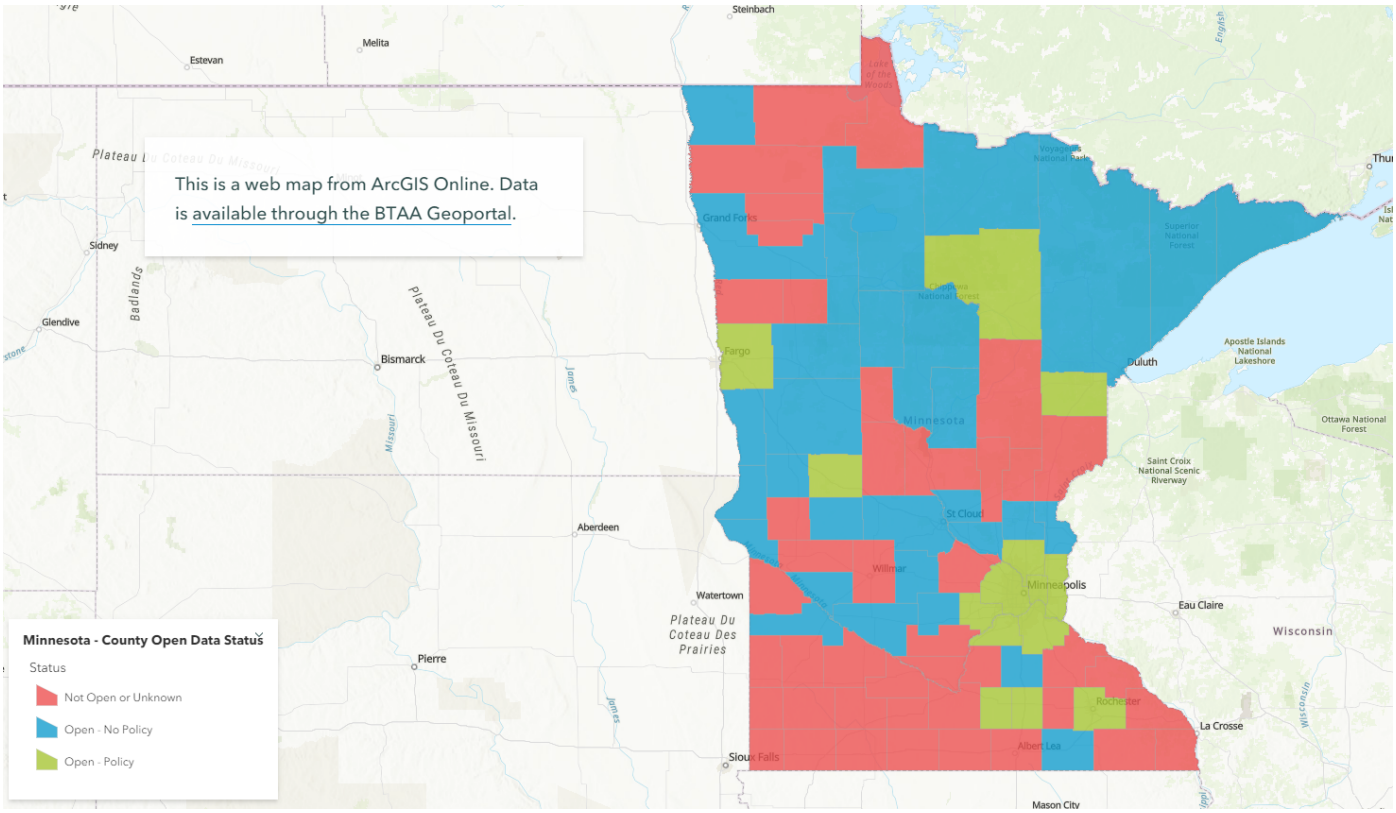
Immersive Options

5.4 Explore

Example Story Map from the Big Ten Academic Alliance Geospatial Data Project



Compare Maps



Open Data Status

Compare Images

5.5 Resources

- Instruction for Creating Dynamic Digital Narratives
- Nine steps to great storytelling
- Five Principles of Effective Storytelling
- Esri Resources Page
- Visual storytelling: Bring your narrative to life with an effective mix of photos
- How to make an awful story map

6. Find & Use GIS Web Services with the BTAA Geoportal

This tutorial is part of an educational series produced by members of the Big Ten Academic Alliance Geospatial Information Network.

Prepared by: Jay Bowen, GIS Specialist, University of Iowa (jay-bowen@uiowa.edu).

Note for Instructors

This tutorial is intended for GIS users with an established cursory understanding of how to use GIS software for visualizing spatial data and making maps, regardless of whether they are graduate, undergraduate, or faculty/staff users. These users may have encountered web services for GIS in formats like WMS, WMTS, or WFS, but are unsure of how to use them. This tutorial is meant to introduce users to these formats, demonstrate how to find them in the BTAA Geoportal, and show how to use them in QGIS, ArcGIS Desktop, ArcGIS Online, and ArcGIS Pro. For an extra challenge involving the use of ArcGIS Feature Services to create a web map with Leaflet, please follow the link to my tutorial on GitHub.

These slides walk through the steps of loading an ArcGIS Feature Service in several of the most commonly used GIS platforms. Please use the links provided on the Loading Web Services: Menu page to jump to the appropriate slides for your preferred software.

The tutorial was designed for in-person, hybrid, and online instructional contexts. The self-guided review activity can be assigned to be completed after class, or as a live activity where students can pose questions to the instructor and other students, in person or through a chat window, as they work through it.

6.1 Learning Objectives

Through completing this tutorial, students will:

1. Learn the basics of GIS web services - What are they? What kind of data do they host? What are the benefits and drawbacks?
2. Locate and load an ArcGIS Feature Service with the BTAA Geoportal and their preferred GIS software.
3. Find and load their own web service through the BTAA Geoportal and consider the utility of their data to different kinds of users.

6.2 Intro to Web Services

Several types of web services available to GIS users that serve geospatial data in different formats from web servers. As documented in the tutorial, Types of Geospatial Information by Nicole Kong, geospatial data for web services fall into four categories: vector, raster, tabular, and scanned maps. For this exercise, we will focus on the categories below:

Data Type	What is it?	Relevant Web Service
Vector	Discrete points, lines, or polygons	WFS/ArcGIS Feature Service
Raster	Continuous pixelated data with each pixel assigned a value	WMS/ArcGIS Map Service
Scanned Map	A scanned sheet map in image format	WMTS/ArcGIS Tiled Map Service

Effective use of all these services will likely save you a lot of time downloading, cleaning, processing, and managing your data.

6.2.1 Web Feature Service (WFS)

Features: Direct access to vector data curated by the organization hosting the data. You will not need to join tabular data from one source to shapefiles from another source, and you will often have a direct connection to consistently updated data.

Drawbacks: Updates to the tables are dependent upon the host. What happens if the server goes down or the data cease to be updated? For regularly updated data, it can be difficult to determine all possible values for classification purposes, if only a portion are used frequently, and the metadata are not very detailed.

6.2.2 Web Map Service (WMS)

Features: Renders geospatial data as map images. Similar benefits to WFS.

Drawbacks: Can be quite limiting if derived from data that were originally in vector format – loss of associated tabular data.

6.2.3 Web Map Tile Service (WMTS)

Features: Access to scanned maps that are already georeferenced. Saves a lot of time considering how painstakingly slow georeferencing can be!

Drawbacks: The georeferencing is not always great. You may find yourself redoing it anyway.

Question

Can you think of any drawbacks or reasons why it might be preferable to download, process, and manage your own data?

For additional information about these services, navigate to the glossary page.

6.3 Locating Services

For the purposes of this exercise, let's map leaking underground storage tanks in Iowa.

1. Navigate to the BTAA Geoportal. Search for "Iowa leaking tanks."
2. In the results, under "Limit your search," scroll down to "Resource Class" and click "Web Services." This will limit your results to web services (not needed here, but it will help if you have many search results).
3. Click the result entitled "Leaking Underground Storage Tanks: Iowa," hosted by the Iowa DNR.
4. In the upper right corner, under "Links," click "Web Services." Now you have access to a web service URL!

Tip

For a more thorough exploration of using the BTAA Geoportal, please see the tutorial entitled Finding Geospatial Data by Joshua Sadvari.

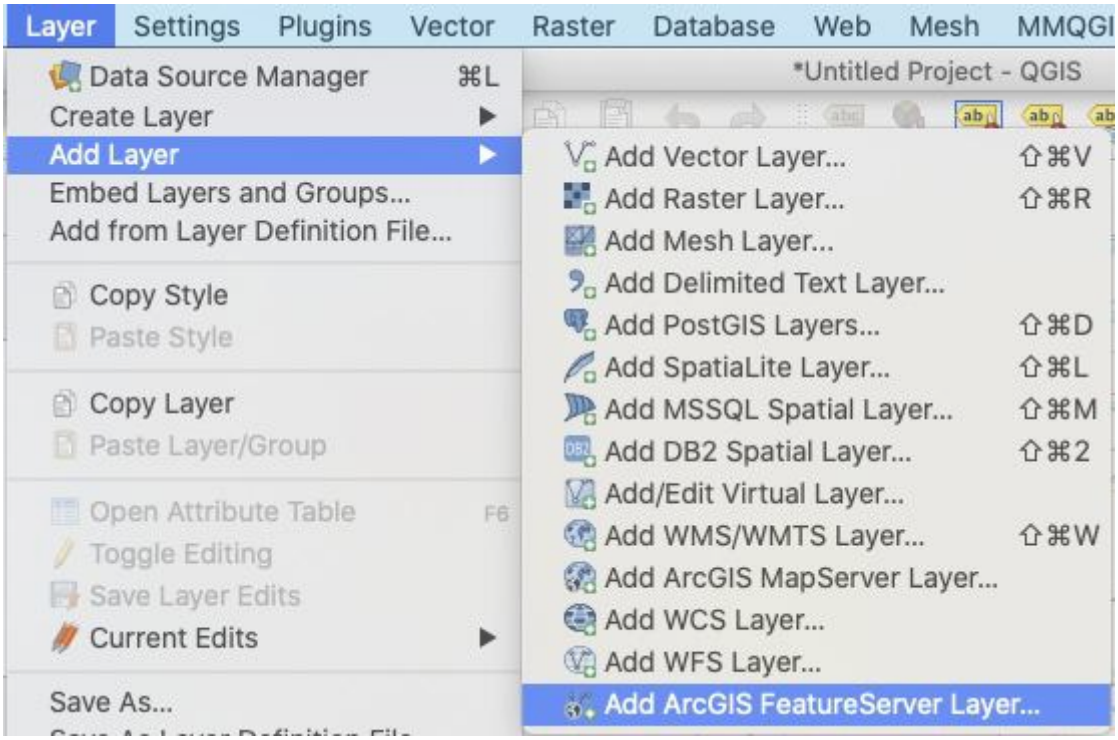
6.4 Loading Web Services

There are slightly different steps for loading web services depending upon which GIS platform you are using.

6.4.1 QGIS

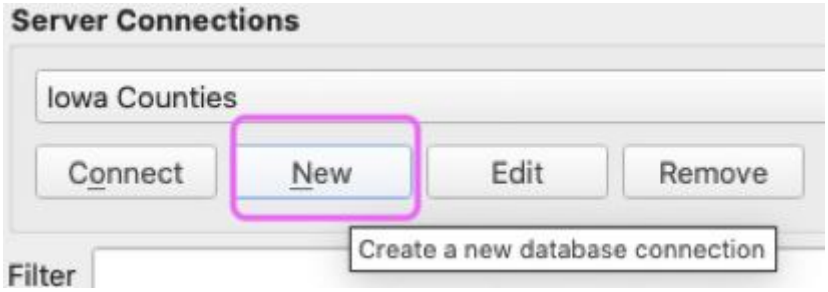
Now that you have access to a web service, you will want to know how to use it in your preferred GIS software. For this exercise, we will use QGIS.

1. Open QGIS and go to the Layer drop down menu. Click Add Layer > Add ArcGIS FeatureServer Layer.



Add an ArcGIS FeatureServer Layer in QGIS

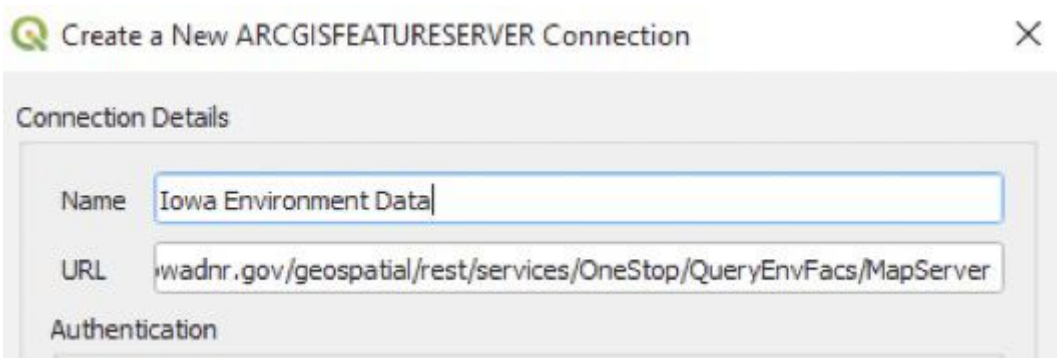
2. In the window that opens, click “New” to establish a new connection between QGIS and the web service.



New server connection in QGIS

3. Give your connection a meaningful name, like “Iowa Environment Data”

4. Paste the URL obtained from the geoportal into the empty box next to “URL” and click “OK.”

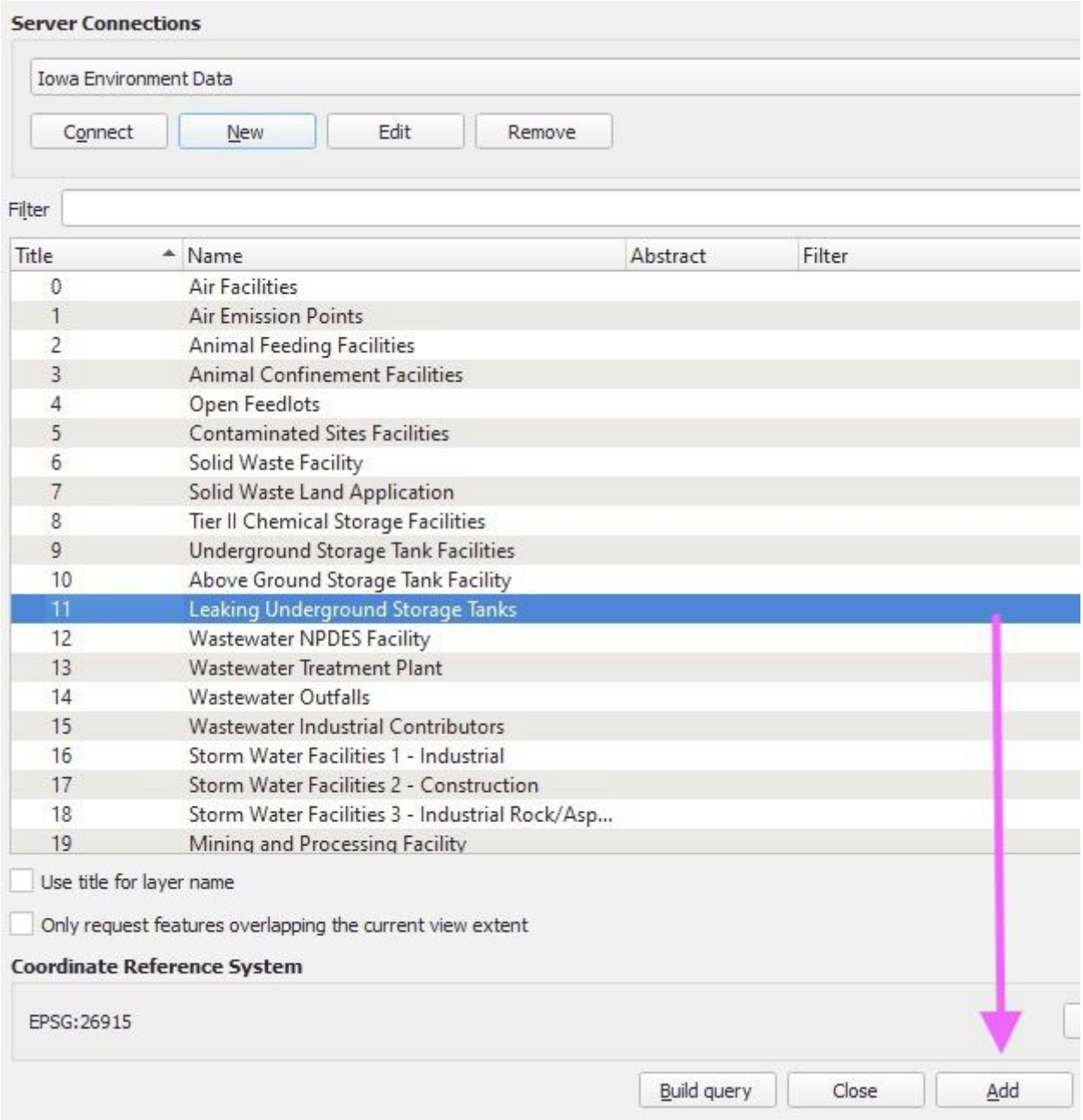


Name and enter your service URL

Warning

Make sure that you cut off everything in the address after “MapServer,” ex: https://programs.iowadnr.gov/geospatial/rest/services/OneStop/QueryEnvFacs/MapServer

5. The Server Connection window will appear. Highlight “Leaking Underground Storage Tanks” and click “Add” at the bottom of the window.

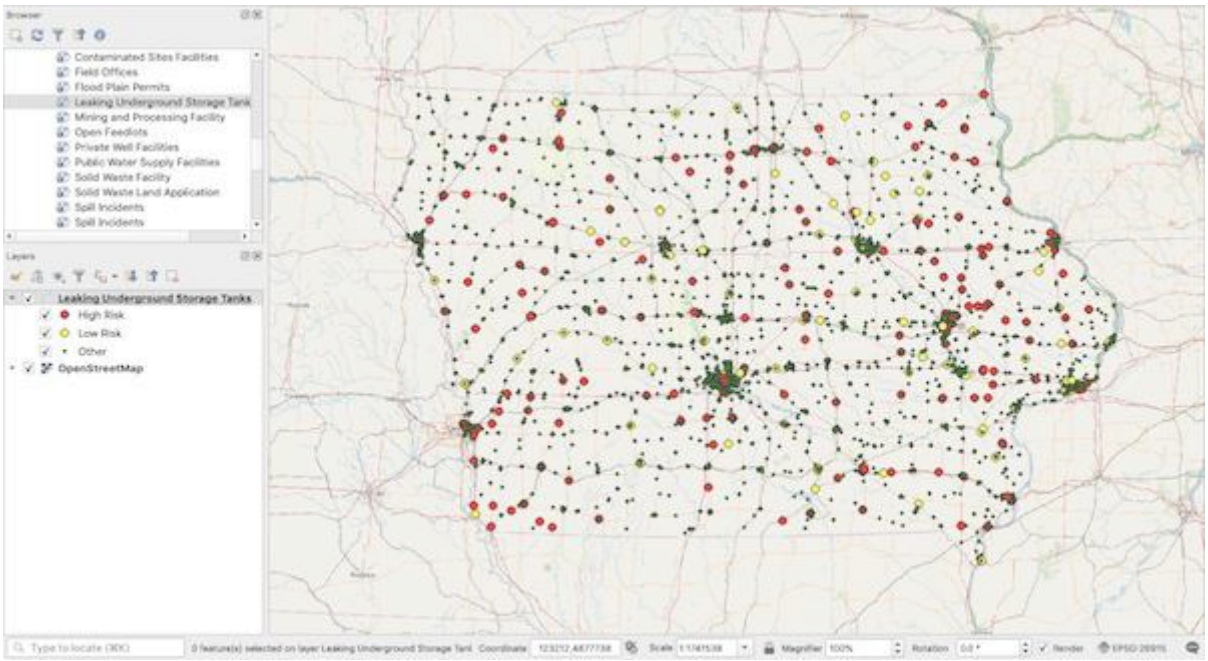


QGIS Server Connection Window

6. “Leaking Underground Storage Tanks” will appear in your Table of Contents. If you have not added a base map, do so now. As you can see, the map window is crowded with many symbols, but you now have data from a web service in your map window!

Iowa Leaking Underground Storage Tanks web service

7. Look at the attribute table and play around with editing the symbology based on one of the fields. There is a lot of interesting info!



Iowa Leaking Underground Storage Tanks web service with layer styling

6.4.2 ArcGIS Pro

Now that you have access to a web service, you will want to know how to use it in your preferred GIS software. For this exercise, we will use ArcGIS Pro. Open ArcGIS Pro, go to the Insert tab, and click “Connections.” In these options, you will also notice options for other types of web services. You can experiment with adding these later. Click “New ArcGIS Server.”

Paste the URL obtained from the geoportal into the empty box next to Server URL and click “OK.”

In the Catalog window, open “Project,” expand “Servers,” and expand the service you just connected.

Notice that you are connected to all the services the Iowa DNR offers.

Expand “OneStop” and “QueryEnvFacs.”

Use “Leaking Underground Storage Tanks” and select “Add To Current Map.”

You may need to zoom into your map in order to see the data, as it is scale-dependent upon loading in Pro. You will also notice that the map window is crowded with many symbols, but you now have data from a web service in your map window!

Look at the attribute table and play around with editing the symbology based on one of the fields. There is a lot of interesting info!

6.4.3 ArcGIS Online

Now that you have access to a web service, you will want to know how to use it in your preferred GIS software. For this exercise, we will use ArcGIS Online. Make sure to select “An ArcGIS Server Web Service” for this data. You will also notice options for other types of web services. You can experiment with adding these later. Open ArcGIS Online, go to the Add tab, and click “Add Layer from Web.” Copy and paste the web service URL in the empty box next to “URL” and click “Add Layer.”

ArcGIS Online will automatically add the data to your map window. You will notice that there is a high density of similar symbols, but you now have data from a web service in your map window!

Look at the attribute table and play around with editing the symbology based on one of the fields. There is a lot of interesting info!

6.4.4 ArcGIS Desktop

Now that you have access to a web service, you will want to know how to use it in your preferred GIS software. For this exercise, we will use ArcGIS Desktop. Open ArcGIS Pro, open the Catalog window, maximize “GIS Servers,” click “Add ArcGIS Server.” Paste the web service URL into the box next to “Server URL” and click “Finish.” Choose “Use GIS Services” and click “Next.”

In the Catalog window, expand the service you just connected. Expand “OneStop.”

Drag and drop “QueryEnvFacs” into your map window. Add a basemap if you have not done so.

In the Table of Contents, maximize “OneStop/QueryEnvFacs, find “Leaking Underground Storage Tanks” and tick the box next to it.

It is likely that you will not be able to see the symbols on the map. Zoom into a city or region and they will appear.

You will notice that there is a high density of similar symbols, but you now have data from a web service in your map window!

6.4.5

Self-Guided Activity Using the skills learned here, use the BTAA Geoportal to:

1. Find a web service of your choice
2. Connect to it in QGIS or ArcGIS
3. Load the data in your map window
4. Take a screenshot of your data in the map window, add it to a Google doc, and write a paragraph explaining how this service might be useful to different kinds of users (general public, students, researchers, professionals, etc.).

7. Types of Geospatial Information

This tutorial is part of an educational series produced by members of the Big Ten Academic Alliance Geospatial Information Network.

Prepared by: Nicole Kong, Associate Professor, GIS Specialist, Purdue University (kongn@purdue.edu).

7.1 Introduction

- There are many types of data that can be brought into GIS.
- The “type” introduced in this tutorial refers to the different data models that can usually be discovered from a geodata portal or other data portal sites. Or, the data models that GIS professionals usually use to collect and share information.
- It doesn’t refer to the topic, content, or the purpose of the information, the information source, or any other aspects.
- BTAA Geoportal Project Glossary of Terms https://sites.google.com/umn.edu/btaa-gdp/about/project-documents/glossary

7.2 Geospatial Information Types

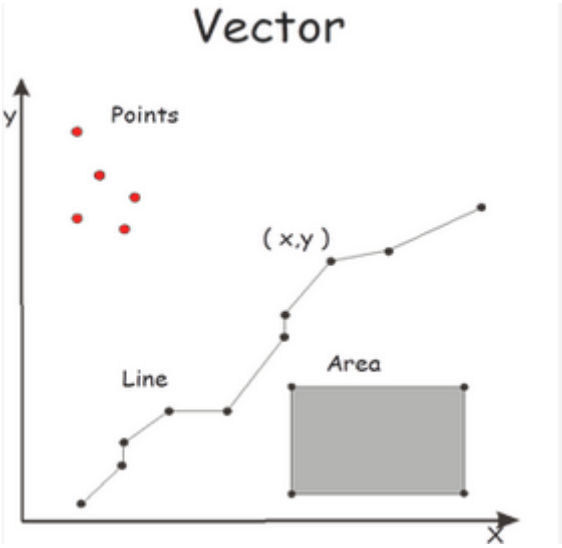
- GIS data are usually stored in one of the following data models
- Vector
- Raster
- Tabular
- Geospatial information can be found from scanned maps
- GIS data can be hosted online using web services

Vector	Web Services
Raster	
Tabular	
Scanned Map	

7.2.1 Vector Data

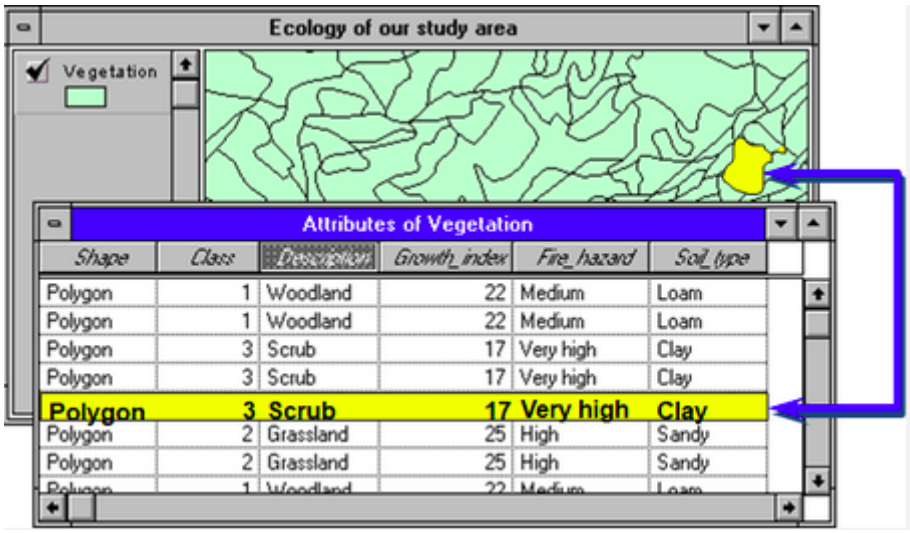
Vector	Web Services
Raster	
Tabular	
Scanned Map	

- Vector data are comprised of vertices and lines (or arcs), represented explicitly in the form of XY coordinates.
- The 3 basic geometry types for vector data are:
- Points - XY coordinates
- Example: cities, schools, incident locations
- Lines - connecting the points in a set order
- Example: roads, streams
- Polygons - a set of points in a particular order and close it (the 1st and last point are the same)
- Example: a state, county, or census block
- Most GIS applications do not allow mixed geometry type In a single layer



*Vector Data Types *Used by permission of Paul Bolstad, GIS Fundamentals*

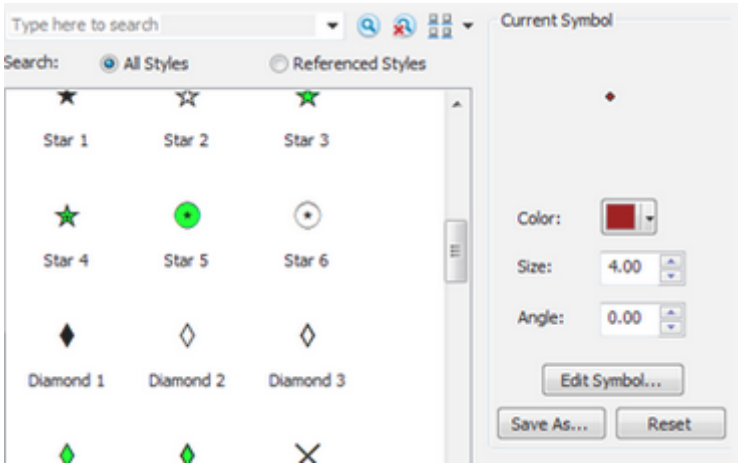
- Each vector feature has attribute data that describe it.



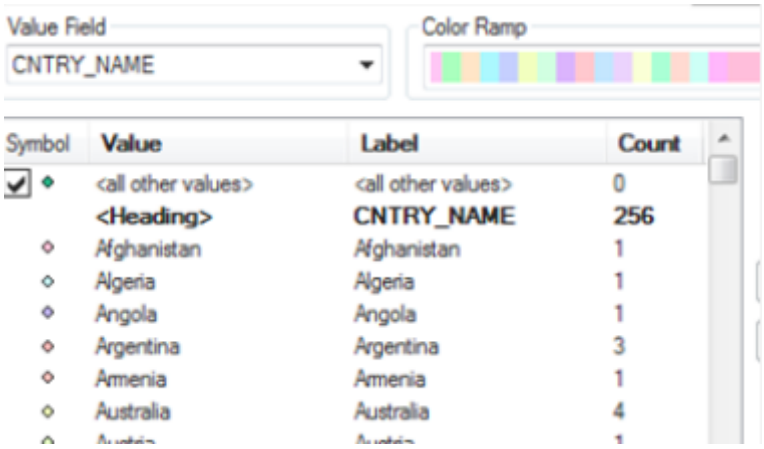
Attribute Data

• Vector data are usually saved as a shapefile or a feature class in a geodatabase (In Arc/Info (1980-1999), it can also be saved in coverage format).

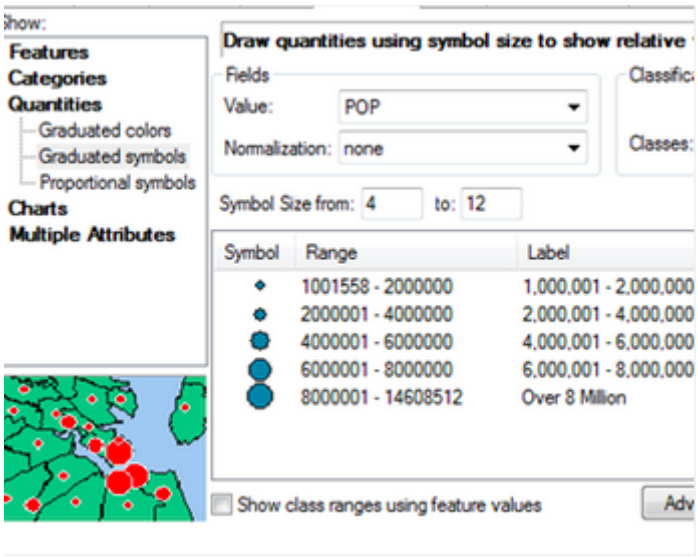
• Vector symbology:



Single Symbol



Categorical Symbol



Quantitative Symbol

7.2.2 Raster Data

Vector	Web Services
Raster	
Tabular	
Scanned Map	

• Raster data is made up of pixels with each pixel has its own Value.

• Raster data is usually used to represent surfaces.

• Raster data model is commonly used for digital elevation models (DEM), aerial and satellite imagery, and land use land cover maps.

• Raster data resolution: cell dimension, or the size of pixels.

• Raster images can consume a large amount of storage space.

Raster Data Types

*Raster Data Types *Used by permission of Paul Bolstad, GIS Fundamentals*

• Two types of raster data: **continuous** and **discrete**

• **Discrete** rasters have distinct themes or categories. Each class can be discretely defined, usually ba integer values. Example, land cover/use map.

• **Continuous** rasters are grid cells with gradual changing data such as elevation and temperature.

Raster Two Types

*Continuous and Categorical Data *Used by permission of Paul Bolstad, GIS Fundamentals*

• Raster data are usually saved in the format of raster dataset, GeoTIFF, or many other formats.

7.2.3 Vector vs. Raster

	Vector	Raster
Positional Precision	Can be precise	Defined by cell size
Attribute Precision	Poor for continuous data	Good for continuous data
Output Quality	Very good, map like	Fair to poor, depending on resolution
Data Structure	Often complex	Often quite simple
Storage Requirement	Relatively small	Often quite large
Spatial Analysis	Good topology relationship	Good for modeling

7.2.4 Tabular Data

Vector	Web Services
Raster	
Tabular	
Scanned Map	

- Tables with geospatial information can be used for mapping purpose in GIS.
- Tables with information that can be joined with an existing map Reference: Tutorial about table join
- Tables with XY coordinate information
- Tables with address information
- Geocoding

7.2.5 Scanned Maps

Vector	Web Services
Raster	
Tabular	
Scanned Map	

- A scanned map stored as an image file.
- Georeferenced scanned map: has a linked file that stores spatial information so that it can be overlayed with other digital maps in GIS. Usually stored as GeoTIFF.
- Un-georeferenced scanned map: The presence of coordinates in the record's metadata does not make the map georeferenced. Can be saved as TIFF or JPG, etc.

Scanned Map

A Scanned Map

7.2.6 Web Services - GIS

Vector	**Web Services**
Raster	
Tabular	
Scanned Map	

- A streaming GIS layer that can be viewed and queried in a browser or GIS application.
- Types of GIS web services - they are often provided using either Esri format or open standard defined by Open Geospatial Consortium (OGC)

Esri	ArcGIS Dynamic Map Layer Service	Vector data. Map image layers are dynamically rendered.
	ArcGIS Feature Layer Service	Displays vector data as individual or collected features.
	ArcGIS Image Map Layer Service	Displays raster data (a grid of cells used to store imagery).
	ArcGIS Tiled Map Layer Service	Displays set of web-accessible tiles that reside on a server.
OGC	Web Mapping Service (WMS)	Renders a geospatial dataset as map images.
	Web Feature Service (WFS)	Serves queryable geographic features.
IIIF	International Image Interoperability Framework (IIIF)	Displays an image from a server. This image can be panned and zoomed.

7.3 How to Find These Data in the BTAA Geoportal

The Big Ten Academic Alliance Geoportal connects users to digital geospatial resources, including **GIS datasets**, **web services**, and **digitized historical maps** from multiple data clearinghouses and library catalogs. The site is solely a search tool and does not host any data.

7.3.1 Search by Resource Class

Once you are at the search results page of BTAA Geoportal, you have filter options on the left of the screen. You can filter your search by **Resource Class**.

- **Datasets:** vector or raster data
- **Maps:** scanned maps and photographs
- **Web Services:** for items with a web service, such as an ArcGIS REST service, an OGC web service, or IIIF.
- **Imagery** Aerial photography and satellite imagery
- **Collections:** describe a group of records, typically as a description of and website link to the group's original geoportal or library.
- **Websites:** interactive web resource, such as dashboard.

7.4 Related Resources

- BTAA Geoportal Project Glossary of Terms
- Finding Geospatial Data (Tutorial)
- Linking tabular data to geospatial data (Tutorial)
- Using GIS web services (Tutorial)

7.5 Exercise

- Find an example for each of following type of data from BTAA geoportal. Discuss the use cases of each data type, as well as pros/cons of the particular data type.

- Vector data
- Raster data
- Scanned map
- Web service

7.6 Wrapping Up

This tutorial is part of an educational series produced by members of the Big Ten Academic Alliance Geoportal. The BTAA Geoportal connects users to digital geospatial resources, including GIS datasets, web services, and digitized historical maps from multiple data clearinghouses and library catalogs. The site is solely a search tool and does not host any data.

To access additional tutorials in this series that cover various other topics, visit: https://sites.google.com/umn.edu/btaa-gdp/tutorials.