GeoBTAA Tutorials

None

Big Ten Academic Alliance Geospatial Information Network

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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. 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.

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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.

2.1 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.

2.2 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.

2.2.1 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.

2.2.2 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.

2.2.3 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.

2.3 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.

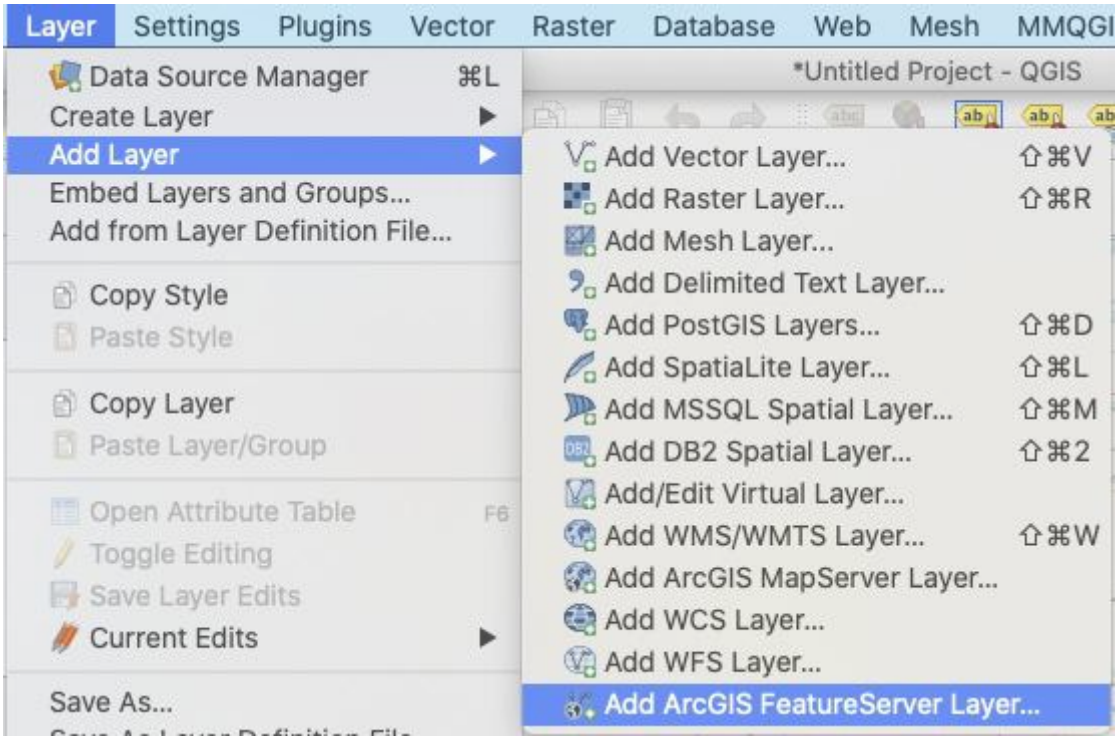
2.4 Loading Web Services

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

2.4.1 QGIS

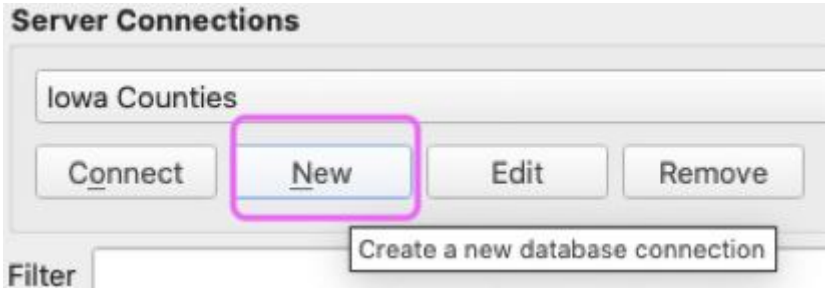
Now that you have access to a web service, you will want to know how to use it in your preferred GIS software. For this exercise, we will use QGIS.

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

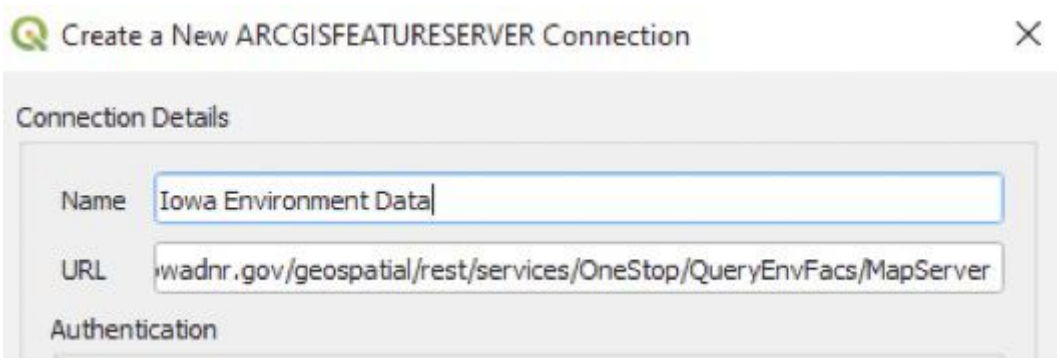
2. In the window that opens, click “New” to establish a new connection between QGIS and the web service.



New server connection in QGIS

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

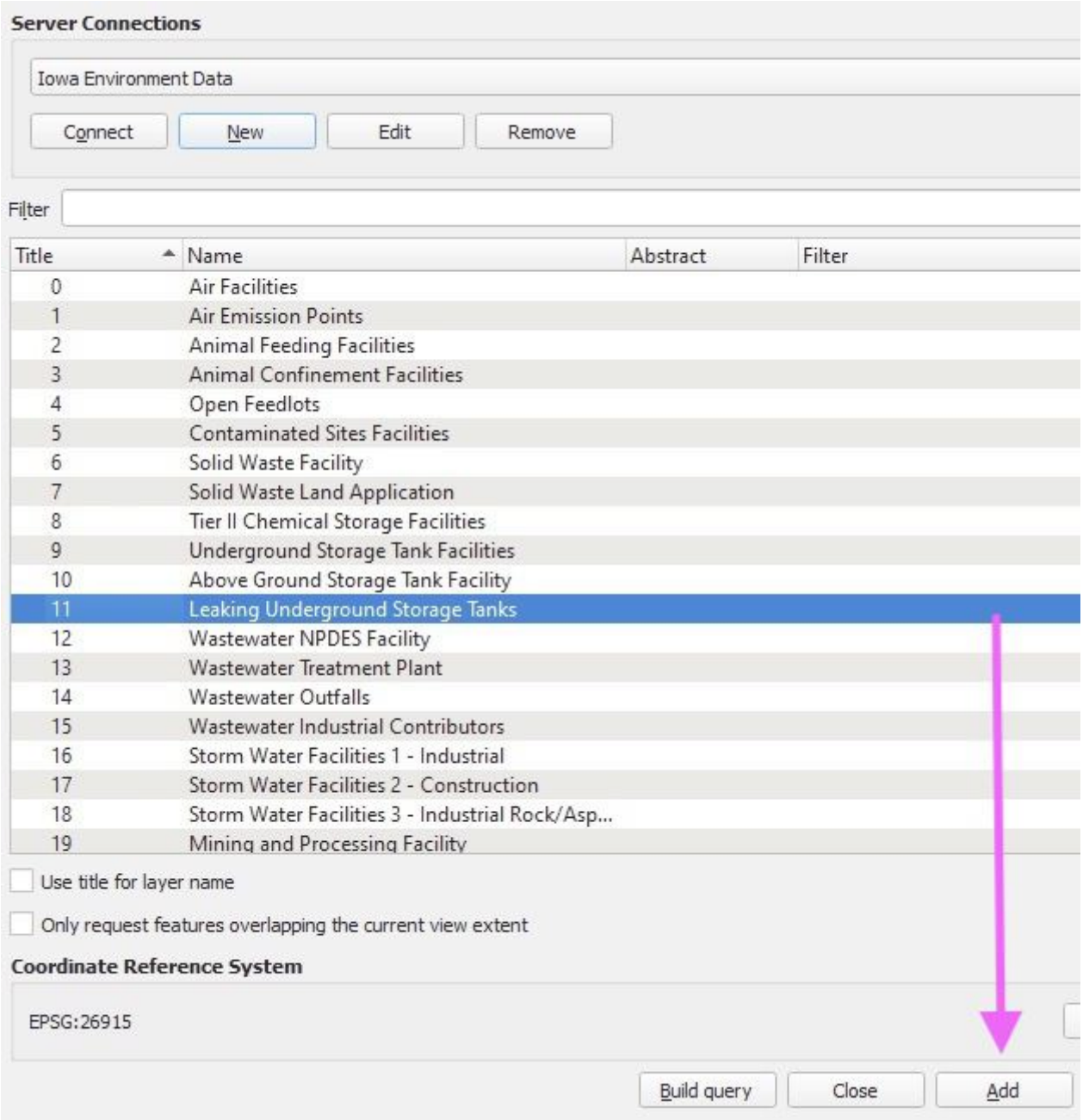
4. Paste the URL obtained from the geoportal into the empty box next to “URL” and click “OK.”



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.

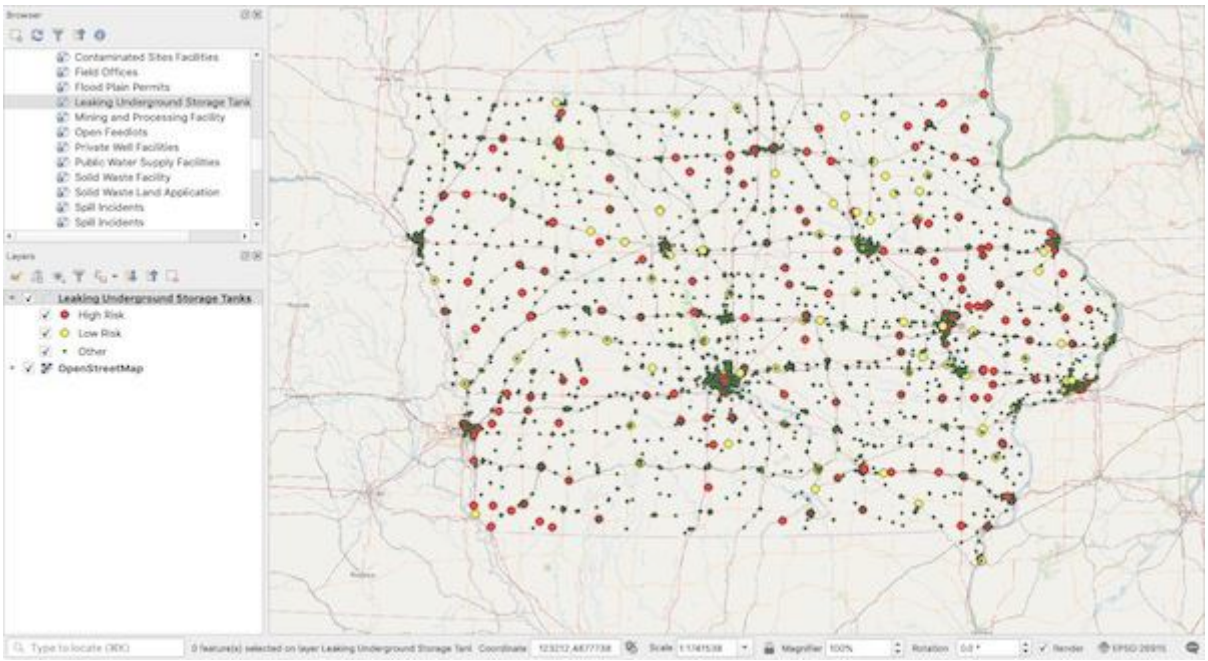


QGIS Server Connection Window

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

2.4.2 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!

2.4.3 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!

2.4.4 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!

2.4.5

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.).

3. Types of Geospatial Information

3.1 Contents

3.2 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

3.3 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	

3.3.1 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

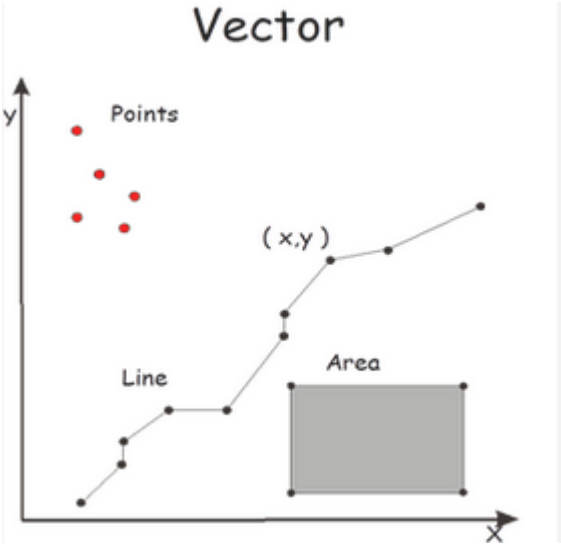


Figure 01. Vector Data Types *Used by permission of Paul Bolstad, GIS Fundamentals

- Each vector feature has attribute data that describe it.

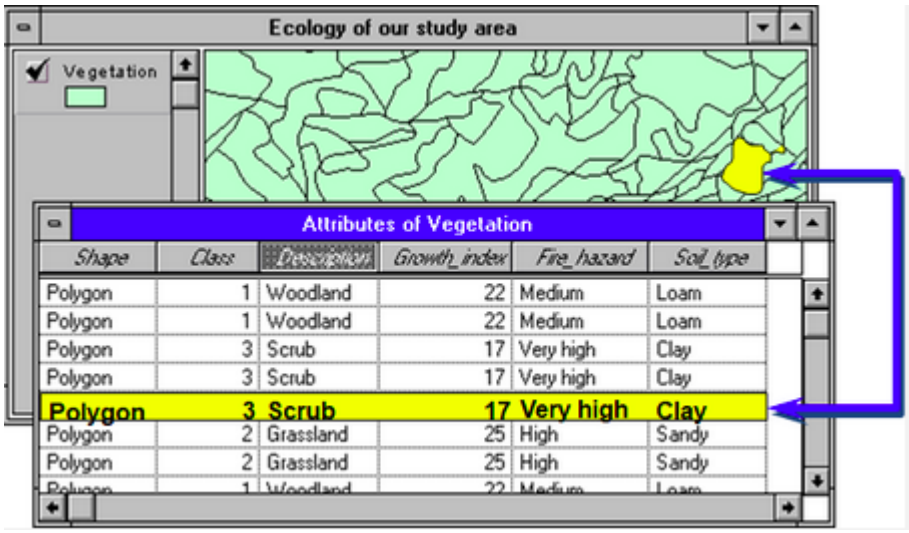


Figure 02. Attribute Data

- 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:

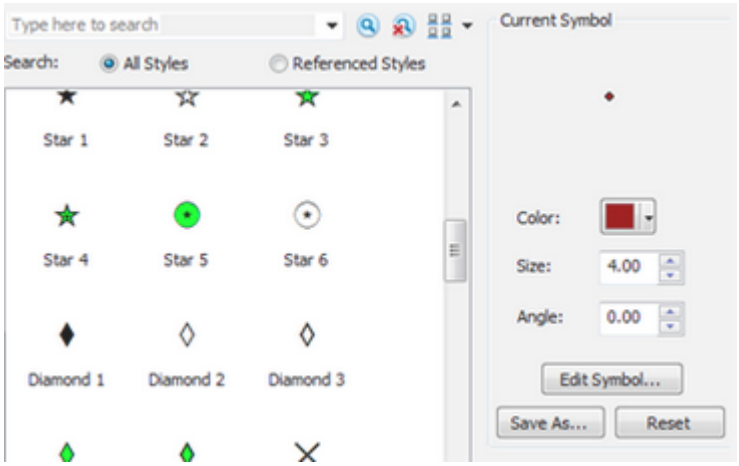


Figure 03. Single Symbol

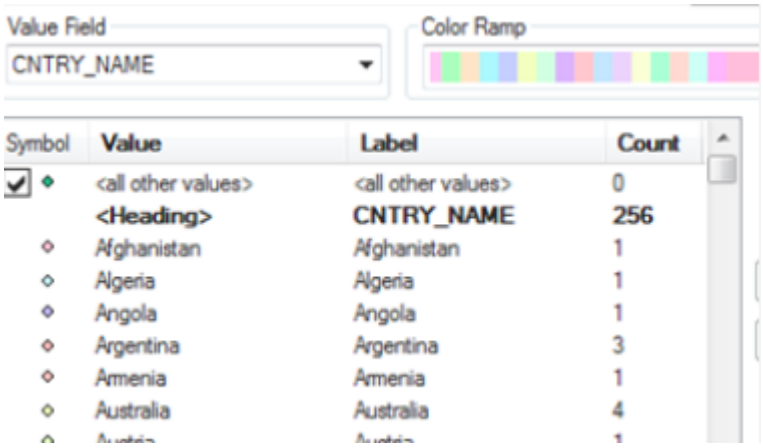


Figure 04. Categorical Symbol

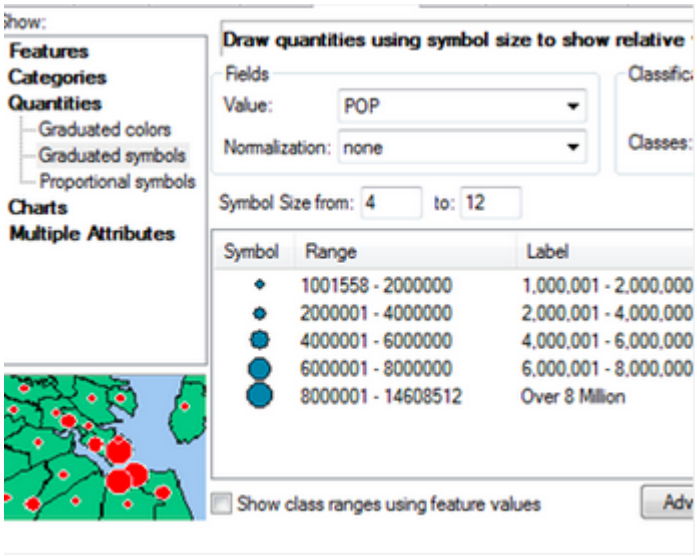


Figure 05. Quantitative Symbol

3.3.2 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

Figure 06. 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

Figure 07. 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.

3.3.3 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

3.3.4 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

3.3.5 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

Figure 08. A Scanned Map

3.3.6 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.

3.4 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.

3.4.1 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.

3.5 Related Resources

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

3.6 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

3.7 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.

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