# GST 101: Introduction to Geospatial Technology

## Lab 2 - Spatial Data Models

### Objective – Explore and Understand Spatial Data Models

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### 1. Introduction

In this lab, students will explore and manage geospatial data using two modules of the FOSS4G software QGIS: QGIS Browser and QGIS Desktop. QGIS Browser is an application designed to preview and manage geospatial data. It is analogous to Windows Explorer, but works specifically with geospatial datasets. QGIS Desktop is the companion application used to perform spatial analyses and make maps.

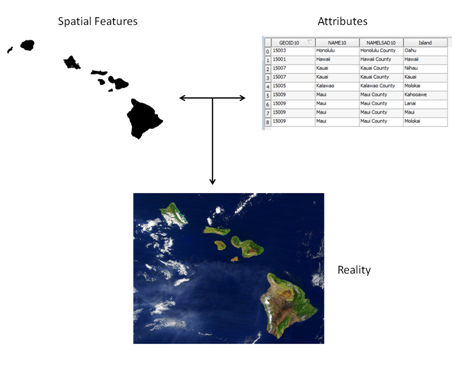
This lab will also introduce students to the QGIS interface, which is used throughout the course. It is important to learn the concepts in this lab as future labs will require the skills covered in this lab.

This lab includes the following tasks:

* Task 1 – Learn to work with QGIS Browser.
* Task 2 – Become familiar with geospatial data models.
* Task 3 – Viewing geospatial data in QGIS Desktop.

### 2. Objective: Explore and Understand Geospatial Data Models

Geographic Information Systems model the real world with representations of objects such as lakes, roads and towns. Geospatial data models are the means used to represent these features. They are composed to two parts: spatial features and attributes that when combined create a model of reality.



Two parts of the geospatial data model

There are two main geospatial data models: vector and raster.

Vector Data Model – best for modeling discrete objects. Vector data comes in three forms: point, line and polygon.

Raster Data Model – this model is best for modeling continuous objects. A raster is composed of a matrix of contiguous cells, with each cell (pixel) holding a single numeric value.

### 3. How Best to Use Video Walk Through with this Lab

To aid in your completion of this lab, each lab task has an associated video that demonstrates how to complete the task. The intent of these videos is to help you move forward if you become stuck on a step in a task, or if you wish to see every step required to complete the tasks.

We recommend that you do not watch the videos before you attempt the tasks. The reasoning for this is that while you are learning the software and searching for buttons, menus, and other features…, you will better remember where these items are and, perhaps, discover other features along the way if you discover them on your own. With that being said, please use the videos in the way that will best facilitate your learning and successful completion of this lab.

### Task 1 Learn to work with QGIS Browser

In this task, you will become familiar with QGIS Browser. The first step in working on a project with geospatial datasets is to organize your workspace. It is important that we organize datasets logically on the computer and make them easy to find. In this task, you will obtain a copy of the lab data and explore how the data is organized using QGIS Browser.

1. The data for this lab is located at C:1012 on the lab machine. You may copy the entire GST 101 folder to a new working directory of your choosing.
2. To do this use Windows Explorer. Click Start -> All Programs -> Accessories -> Window Explorer.
3. Click on the Local Disk (C:) drive on the left hand file tree. NOTE: You may have to expand the Computer by clicking the arrow to the left.
4. Locate the GST 101 Folder. Right click on the GST101 folder and choose Copy from the context menu.
5. Choose your working directory.
6. Right click on your new working directory and choose Paste from the context menu.

Now open QGIS Browser

1. Click Start -> All Programs -> OSGeo4W -> QGIS Browser.

The interface to QGIS Browser is simple and clean (Figure below ). The File Tree is displayed on the left. (NOTE: your machine may have a different set and number of drives listed here. This is fine.) Below the drives are Database Connections. There are no connections to any databases at this point. The Display Window takes up the remainder of the window. There are Display Tabs above the Display Window that allow you to control the information you see.

[QGIS Browser ](figures/QGIS\_Browser.png " QGIS Browser ")

1. Look at the File Tree. Click the arrow to the left of the C: drive. You will now see all of the subfolders directly under the C: folder.
2. Expand C:1012in the File Tree by clicking the arrows to the left of each folder. You will now see the contents of the Data folder for the lab (Figure below).

[Lab Data in QGIS Browser ](figures/Lab\_Data\_in\_QGIS\_Browser.png " Lab Data in QGIS Browser ")

1. Take a moment to read the names of the files. There are two folders and several files listed with different icons. The icon indicates that the dataset is a vector layer. The is used to represent raster data but is also used for other files such as the XML files you see here.

### Task 2 Become familiar with geospatial data models

Now that you’re familiar with the basic layout of QGIS Browser we will explore some geospatial data.

1. Let’s take a closer look at these data.
2. Select the Hawaii\_Counties.shp layer in the File Tree. The Display Window automatically switches to the Metadata tab. This gives you some basic information about the dataset. You’ll notice that the Storage type is ESRI shapefile. The Display Window also tells you that it has a Geometry type of polygon and it has 9 features (Figure below).

[Metadata in QGIS Browser ](figures/Metadata\_in\_QGIS\_Browser.png " Metadata in QGIS Browser")

In addition to data models (vector and raster) we have to understand file formats. Some file formats are designed to store vector and others raster data. Shapefiles are vector file format. In fact they are probably the most common vector file format. A particular shapefile can only contain one geometry type (polygon, line or point). A shapefile is actually a collection of files on the computer with a common name, but different extensions.

1. Now select PubSchools.shp. You’ll see that this is also an ESRI Shapefile but that it is a point dataset with 287 features.
2. Select SDOT\_StateRoutes.shp. This is an ESRI Shapefile with line geometry and 122 features.
3. Select Hawaii\_Counties.shp again and click on the Preview tab. This shows you the spatial features of this GIS dataset (Figure below )

[Preview in QGIS Browser ](figures/Preview\_in\_QGIS\_Browser.png " Preview in QGIS Browser ")

1. Click on the Attributes tab. This shows you the other component of the data model, the attributes. Each row corresponds to one polygon. The columns are things we know about the polygons such as island name (Figure below ).

[Attributes in QGIS Browser ](figures/Attributes\_in\_QGIS\_Browser.png " Attributes in QGIS Browser ")

1. Select the Oahu\_Landsat\_15m.jp2 dataset. Click on the Preview tab. This is an example of a raster dataset. Like a photograph, it is composed of cells. This raster is a satellite image of the island of Oahu, Hawaii (Figure below).

[Raster data Preview ](figures/Raster\_data\_Preview.png " Raster data Preview ")

Let’s look at the file formats in more detail.

1. Select the lab Data folder in the File Tree. The Param tab is all that is available when a folder is selected (Figure below).
2. Now the Display Window is showing you what you would see in Windows Explorer.

[Folder contents ](figures/Folder\_contents.png " Folder contents ")

Focus on the Hawaii Counties files. Notice that the File Tree shows that Shapefile just as Hawaii\_Counties.shp whereas the Display Window is showing seven files named Hawaii\_Counties. These are all the component files of this particular shapefile. The File Tree simplifies the view of your data showing you only the *.shp and* .xml files. For more information on ESRI shapefiles refer to this link

<http://en.wikipedia.org/wiki/Shapefile>

### Task 3 Viewing geospatial data in QGIS Desktop

Now that you know how geospatial datasets are stored on your computer, let’s see what the data they contain look like. This next section will introduce you to QGIS Desktop.

1. Click Start -> All Programs -> OSGeo4W -> QGIS Desktop.
2. QGIS Desktop is the application you will use for setting up and making maps, and doing GIS analyses. It is has two main sections: the Table of Contents and the Map Window.

[ QGIS Desktop ](figures/QGIS\_Desktop.png " QGIS Desktop ")

Let’s add some data. QGIS has Add Data buttons for each major geospatial data model (vector and raster).

1. Click the Add Vector Layer [ Add Vector Layer Button ](figures/Add\_Vector\_Layer\_Button.png " Add Vector Layer Button ") button. It’s located on the toolbar along the left hand side of the Table of Contents.
2. This opens the Add vector layer window. Add one of the ESRI shapefiles which is a file based dataset. Keep the Source type "File" which is the default. Then click the Browse button.

[ Add Vector Layer ](figures/Add\_Vector\_Layer1.png " Add Vector Layer ")

1. The Open an OGR Supported Vector Layer window opens. (NOTE: OGR is a FOSS4G project that sole purpose is to read and write geospatial vector data files.) The window defaults to ESRI Shapefiles which is perfect. From exploring the lab data in QGIS Browser you know there are several shapefiles. Take a moment to see what other options are there. Click the down arrow to the right of ESRI Shapefiles [OGR]… (Figure below).

[ OGR Supported Vector Formats ](figures/OGR\_Supported\_Vector\_Formats.png " OGR Supported Vector Formats ")

1. Once you’re finished exploring make sure it is still set to ESRI Shapefiles. This filters what you can see in the lab folder so that you only see the shapefiles.
2. Select Hawaii\_Counties.shp and click Open (Figure below).

[ Open an OGR Supported Vector Layer ](figures/Open\_an\_OGR\_Supported\_Vector\_Layer.png " Open an OGR Supported Vector Layer ")

1. Now back at the Add vector layer window and click Open to add the data to QGIS Desktop (Figure below).

[ Add vector layer – Hawaii Counties ](figures/Add\_vector\_layer-Hawaii\_Counties.png " Add vector layer – Hawaii Counties ")

1. You will now see Hawaii\_Counties in the Table of Contents and the map features displayed in the map window. Vector GIS layers will come in with random colors. You’ll learn how to change layer styling in a future lab.
2. Let’s examine the attributes. Right click on the Hawaii Counties layer in the Table of Contents. This opens a context menu. Select Open Attribute Table (Figure below).

[ Layer Context Menu ](figures/Layer\_Context\_Menu.png " Layer Context Menu ")

1. The table opens. If you recall from exploring this dataset with QGIS Browser, it has 9 features (9 polygons). The attribute table has 9 corresponding records. There are columns with the County name and with the island name. Close the Attribute Table by clicking the X in the upper right hand corner.

[ Attribute Table ](figures/Attribute\_Table.png " Attribute Table ")

1. Another way to interact with both the spatial features and the attributes is the Identify button .
2. Click the Identify button [ Identify Button ](figures/Identify\_Button.png " Identify Button ")
3. Click on one of the features on the map. The Identify results window (Figure below) shows you the attributes for the feature you clicked on.

[ Identify Results ](figures/Identify\_Results.png " Identify Results ")

Now you will learn how to add Raster data to QGIS Desktop.

1. Click the Add Raster Layer button [ Add Raster Layer button ](figures/Add\_Raster\_Layer\_button.png " Add Raster Layer button ")
2. The Open a GDAL Supported Raster Data Source window opens (Figure below). This is a very similar workflow to adding vector data.

[ Open a GDAL Supported Raster Data Source ](figures/Open\_a\_GDAL\_Supported\_Raster\_Data\_Source.png " Open a GDAL Supported Raster Data Source ")

1. Whereas QGIS used OGR to open vector data files, here it uses another FOSS4G project called GDAL. GDAL is another software library that QGIS uses. It is software for reading and writing raster datasets.
2. The window’s raster data filter is set to [GDAL] All Files by default, so you see the entire contents of the folder (Figure below).

[ [GDAL] All Files ](figures/[GDAL]\_All\_Files.png " [GDAL] All Files ")

1. Set the filter to [GDAL] ERDAS JPEG200 (third option from the top). Also, note how many formats it will read! In GIS there are many more raster file types than vector. Once you’ve set the filter you’ll see the one dataset: Oahu\_Landsat\_15m.jp2 (Figure below).

[ [GDAL] ERDAS JPEG 2000 ](figures/[GDAL]\_ERDAS\_JPEG\_2000.png " [GDAL] ERDAS JPEG 2000 ")

1. Select the raster dataset and click Open.
2. This dataset only covers a portion of Hawaii, just the island of Oahu. Right click on the Oahu Landsat 15m dataset in the Table of Contents and choose Zoom to Layer Extent to zoom to the spatial extent of this raster (Figure below).

[ Zoom to Layer Extent ](figures/Zoom\_to\_Layer\_Extent.png " Zoom to Layer Extent ")

You may notice two folders in the lab data folder that we have not discussed yet. One is named hlloah and the other info. Together these combine to make another geospatial dataset called a GRID. The info folder holds the attributes and always has the name "info". The other folder is the layer name and contains the spatial data.

1. Click the Add Raster Layer button again.
2. Set the filter to [GDAL] Arc/Info Binary Grid. It’s about a dozen items from the top of the list. Double click the hilloah folder to enter it. Select the hdr.adf file and click Open to add the raster to QGIS (Figure below).

[ Adding a GRID to QGIS ](figures/Adding\_a\_GRID\_to\_QGIS.png " Adding a GRID to QGIS ")

1. This raster is a hillshade image of Oahu and it represents the terrain.

QGIS Desktop also has a browser window.

1. Right click on the blank space to the right of the Help menu. This opens a context menu showing all the toolbars and windows that you can add to the QGIS interface. Check the box next to Browser (Figure below). A Browser window is added as a tab to the Table of Contents.

[ Toolbars and Windows Context Menu ](figures/Toolbars\_and\_Windows\_Context\_Menu.png " Toolbars and Windows Context Menu ")

1. Click on the Browser Tab.
2. Note that there is a Favourites item. You identify workplaces as being Favourites in order for them to appear here.

Data is often stored deep inside a series of folders. It is often tedious and time consuming to navigate deep inside the folders to gain access to the data. Favourites provide a way to create a shortcut directly to any folder so that you have one-click access to any folder.

1. Navigate to the lab data folder. Right click on it and choose Add as a Favourite (Figure below). NOTE: Currently this functionality is reserved only for the Browser tab in QGIS Desktop. However, once it is set it will show up as a Favourite in QGIS Browser as well.

[ Add as a Favourite ](figures/Add as a Favourite.png " Add as a Favourite ")

1. Now expand Favourites and you’ll see your lab folder listed there. You can remove a Favourite anytime by right clicking on it and choosing Remove favourite.
2. Expand the lab folder under Favourites to expose the contents. Select SDOT\_StateRoutes.shp and drag it onto the map. This is a quick way to add data to your map.

NOTE: You can drag data from the QGIS Browser application to QGIS Desktop as well.

### 5 Conclusion

In this lab you have explored datasets that use the two common geospatial data models: vector and raster. You have also used the QGIS Browser to preview datasets. QGIS Desktop also allows users to make maps and perform analyses.

### 6 Discussion Questions

1. What are the 14 possible file extensions for files that compose a shapefile?
2. How can Browser favourites make your workflow more efficient?
3. What are the two main parts of a GIS data model?
4. Name three ways of seeing feature attributes for a vector GIS layer.