

# A short introduction to Quantum GIS\*

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\*<http://www.qgis.org/>

*Note: This tutorial has an accompanying dataset for examples illustrated and for exercises. Please make sure you locate the dataset for purposes of using this tutorial.*

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## 1 Introduction

This tutorial is made for academic use for understanding the basics of GIS and use of the desktop application Quantum GIS.

### 1.1 Keywords

Following are the keywords which will be used frequently in the tutorial.

- **GIS:** A geographic information system is a system designed to store, represent and manipulate geographical data. A GIS stores spatial data ( $\langle x, y \rangle$  coordinates) and optionally a function value or data associated with each spatial data item, e.g., the elevation information for a district map.
- **QGIS:** Quantum GIS, QGIS is a free and open source geographic information system (GIS) application that provides data viewing, editing and analysis capabilities.
- **GIS layer:** A GIS layer is a view of a spatial area with information elements, e.g., a layer of roads, or a layer of village boundaries etc. Each layer has geographical context and hence multiple layers can be super-imposed to view aggregate details of a region, e.g., a road layer and a village layer when viewed together can help understand road connectivity details.
- **PostGIS:** PostGIS is an open source software program that adds support for geographic objects to the PostgreSQL database.
- **Metadata:** Data describing data, e.g., what do columns represent.
- **Geographic co-ordinate system:** A geographic coordinate system is a coordinate system used to locate every position on Earth. Common coordinate systems are the cartesian system, the polar coordinate system and the cylindrical or spherical coordinate system.
- **Projection system:** Since all view planes are in two-dimensions, projection systems are required to project three dimensional spaces onto two-dimensional planes.  
The projection system used by the GIS defines the measuring units.
- **CRS:** Co-ordinate reference system.

e.g., WGS 84:

A projection system, World Geodetic System, from the U.S. Military in 1984. This system is mostly used in our examples. The World Geodetic System is a standard for use in cartography, geodesy, and navigation. It comprises a standard coordinate frame for the Earth, a standard spheroidal reference surface (the datum or reference ellipsoid) for raw altitude data, and a gravitational equipotential surface (the geoid) that defines the nominal sea level.

- **Raster data:** Raster data is based on a (usually rectangular, square-based) tessellation of the 2D plane into cells/pixels. Each pixel/cell represents a small portion of the spatial area and has an associated value for some attribute, e.g., the DEM (data elevation model) raster dataset associates the elevation of a small region to a pixel, grid-based satellite images.

- **Vector data:** Vector data uses geometry (polygons, polylines and points) to represent (spatial) objects. Additionally, each object can be associated with attributes.

## 1.2 Installation of Quantum GIS

### Installation on Windows

Download QGIS from the following link:

<http://hub.qgis.org/projects/quantum-gis/wiki/Download>

This tutorial is based on Quantum GIS version 1.8.0.

Run the setup, follow the instructions and install QuantumGIS.

### Installation on Linux

Follow the instructions given in the link above to install QGIS on Ubuntu/Debian/Fedora.

The instructions includes the installation of prerequisites like python, grass etc.

## 1.3 File types

- Shape:  
A shape file is a popular geospatial vector data format for geographic information systems software. Shape files spatially describe geometries: points, polylines, and polygons. These, for example, could represent water wells, rivers, and lakes, respectively. Each item may also have attributes that describe the items, such as the name or temperature.
- Raster:  
Raster images are made up of individual square colored pixels that, when combined, form some image. Each pixel color specifies the property associated with that pixel, for example, in a gray scale raster image of data elevation model (DEM), darker the pixel color more is the elevation. Landuse-landcover image is a good example of raster file.
- PostGIS:  
The database files from postGIS server. PostGIS is the open source software program that supports geographic objects additional to object-relational database.
- WMS layer:  
Web map service is a standard protocol for serving geo-referenced map images over the Internet that are generated by a map server using data from a GIS database.  
The file type with which we mostly deal is SHAPE file (.shp). We will see the operations in next few sections only for SHAPE files.

## 2 Working with layers

### 2.1 What is layer?

Conceptually, a layer is a slice or stratum of the geographic reality in a particular area, and is more or less equivalent to a legend item on a paper map. On a road map, for example, roads, national parks, political boundaries, and rivers might be considered different layers.

The companion dataset has the following layers for purposes of this tutorial: district layer, tehsil layer, drainage layer.

The next sub-sections introduce different operations relevant to layers and corresponding QGIS actions for the same.

### 2.2 Operations with layers

#### · **Importing a Layer**

1. Go to ‘ ‘Layer’ ’ option on the topmost panel of the Quantum GIS frame.
2. Following options are available:  
Add vector layer, add raster layer, add postGIS layer etc.  
Select add vector layer.
3. Browse the location where you have saved the shape files.
4. You can select one or more shape files at the same time.
5. Click on ‘ ‘Open’ ’ .

#### · **View layer panel**

- To view the layer panel: 1. Go to ‘ ‘View’ ’ on the top of the frame.
2. Click on the option -> ‘ ‘Panels’ ’ .
  3. Check on the option -> ‘ ‘Layers’ ’ .
  4. You can drag and resize the ‘ ‘Layer Panel’ ’ .

#### · **Adding multiple layers**

Multiple layers can be added using the “Adding/Importing a Layer” procedure. Layers are overlapped on top of each other, in the order shown in the view panel. If a layer made up of lines or points is overlapped by a layer of polygons, the point/line layer wont be visible. Thus, we may have to bring the layers above other layers. The following steps will change overlap sequence between layers,

1. Select the layer we want to move and drag it
2. Drop layer at the level we want it at

Figure 1 shows two views related to adding/importing an layer and the view panel (on the left) displaying the list of added layers. A simple example showing how an overlapping layer hides the previously added layer is shown in Figure 2a.

#### · **Remove layer**

1. Right click on the layer
2. Click on ‘ ‘Remove’ ’ .

#### · **Zoom to the layer**

To see the full layer in one screen, we need to zoom to the layer extent. To do so, 1. Right

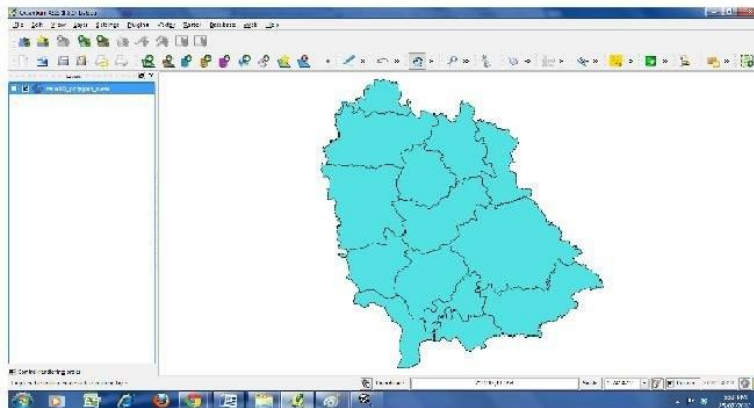
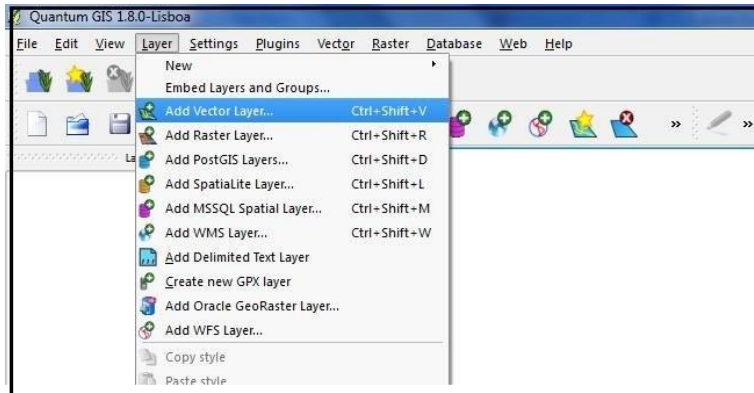


Figure 1: Adding/importing a layer and viewing list of layers on the view panel.

click on the layer we want to zoom into.

2. Click on 'Zoom to layer extent'.

- **View the co-ordinates and scale**

The co-ordinates and scale can be seen on the bottom of the screen.

- **Set the Projection system**

Projection system defines the geographic co-ordinate system, units of the map etc. Usually, we set the co-ordinate system to "WGS 84". The files given for the experimental purpose are already in the "WGS 84" co-ordinate reference system. The CRS can be changed as follows,

1. Right click on layer whose CRS is to be changed or set.

2. Click on Set layer CRS.

3. Select the CRS we want (we use WGS 84).

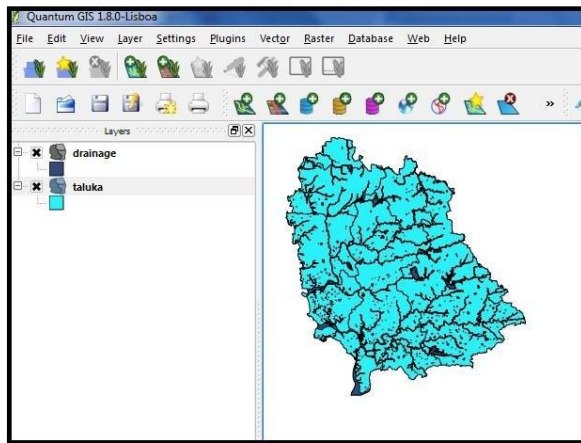
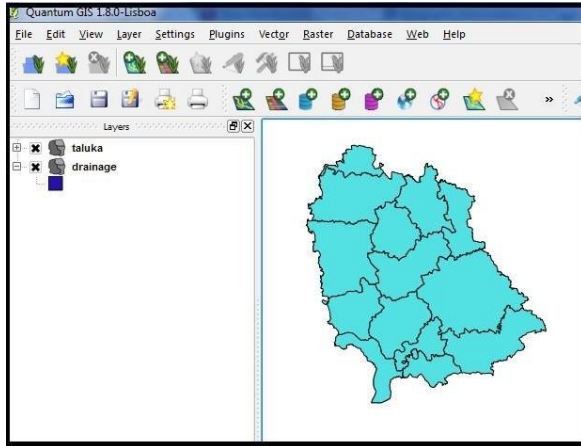
4. Click OK. Now check the co-ordinates. They should be matching as the co-ordinates of the location of the layer on Google earth or any other earth browser.

- **View attributes**

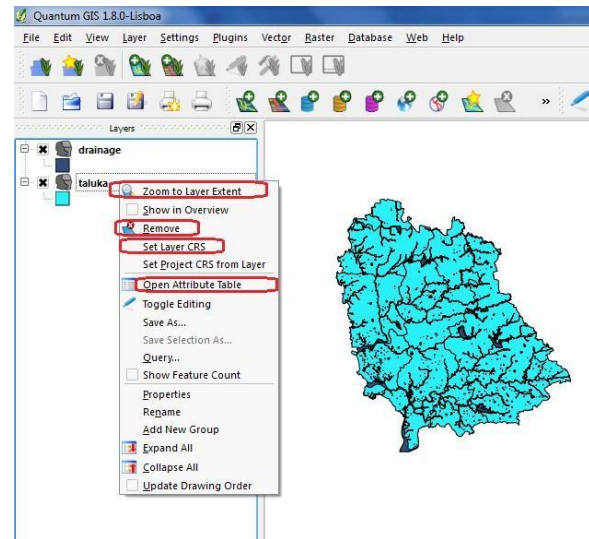
Attributes of the layer can be viewed by following steps below:

1. Right click on the layer in layer panel.

2. Click on 'Open attribute table'.



(a) Effect of adding multiple layers.



(b) Operation on layers (available on right-click).

Figure 2: Operations on layers.

3. The tabs in the bottom represent operations like copy, select, deselect rows, edit row, add new column, delete new column.

Figure 2b shows the operations that QGIS offers for layer, on right clicking the layer name and highlighting the ones which are described here.

**Exercise:**

1. Import Layer- Drainage from the given folder.
2. Import Layer- Taluka.
3. View the layer panel.
4. The Drainage layer is below the Taluka Layer, as shown in Figure 2a. Thus the drainage layer is not visible as Taluka polygons are getting overlapped over it.
5. Drag the drainage layer above the Taluka layer. So, the layers look as shown in Figure 2a.

## 2.3 General operations on maps

- **Pan map, zoom in , zoom out**

Panning the map, Zooming in , Zooming out options are available in ” View” , also the legends are available on the panel on the top.

The panels can be made visible by right clicking on the top of QGIS frame, and checking the boxes of panels we want to make visible.

- **Identify the feature/ properties of selected feature**

To identify the object and its features,

1. Go to ‘ View’ .
2. Select ‘ Identify Feature’ .

- **Measure angle, area, line, giving bookmark etc.**

Make the toolbar - “attributes” visible. The above operations and few more can be done using this tool.

The length is measured in *Km* and angle in *degrees*.

### 3 Properties of maps

This section describes how to change the properties for visualization of the map.

Steps:

1. Right click on the layer name. (Figure 3 shows the properties toolbar.)
2. Click on properties.
3. Following are the properties that we can change for visualization.

Note: Options may change according to software release version of Quantum GIS.

#### · **Symbology/ Style**

##### 1. Renderer:

The renderer has following options: Single symbol, categorized, graduated.

Figure 4 shows a taluka layer with different renderings.

Single symbol (default):

The whole layer selected will be rendered with a single color.

- Color change - by selecting the color by clicking on the “change” button.
- Transparency - can be changed by dragging the pointer from 0 transparency level to 100 percent.
- Unit can be changed from default millimeter to map unit.
- Style [solid fill, horizontal lines fill, vertical lines fill etc.] can be used to fill styles with a solid color.

Graduated:

This option helps to color a layer according to different attribute values of the vector polygons. For example, different talukas can be color coded based on their area, taluka name etc.

- Select the ‘Graduated’ style option.
- Select the ‘Column’ that should be used for color coding, e.g., perimeter, area etc.
- Select number of classes. An automatic color coding based on number of classes should be displayed.
- Select ‘OK’ to view graduated styling on the map.

##### 2. Labels:

Labels are notations on the objects which we can visualize on the map. Labels can be chosen from one of the attributes that are associated with the object/vector polygon.

For labeling the objects on a map, follow these steps:

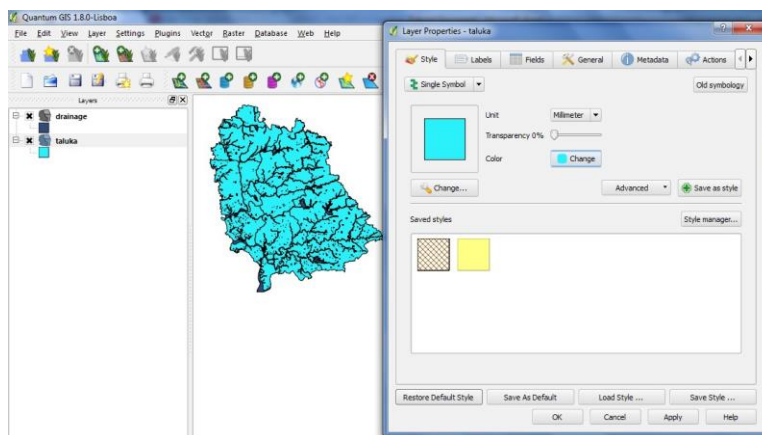


Figure 3: The properties panel for a layer.



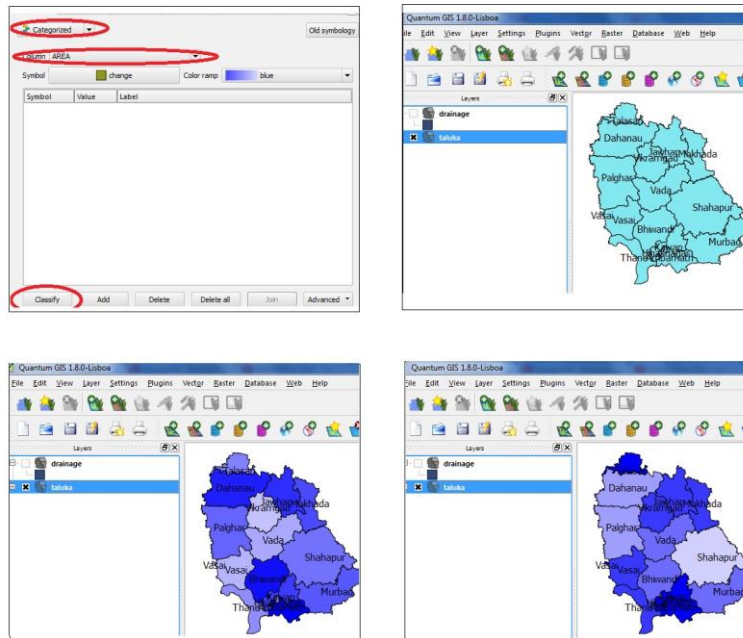


Figure 4: The Thane taluka layer with different renderings.

- Check on the checkbox “Display labels” .
  - Select the attribute whose value is to be given as label “Field containing label” .
  - Select the font size, placement of the label.
3. Click the “Field” tab.  
The “Field” tab displays the list of attributes associated with objects.
4. The “General” tab can be used specify the co-ordinate system, CRS etc.

### Exercise:

1. Import only the taluka layer. If other layers are imported, turn then off by checking on the check box.
2. Change color of the Taluka Layer.
3. Label Taluka layer with the Taluka name attribute.
4. Change the transparency of the Taluka layer.
5. Now try changing the color in different ways.
6. Single symbol
7. Categorized - select categorize, select the field Taluka Name, click on classify
8. Graduated- select categorize, select the field Area, click on classify

Figure 4 shows sample outputs corresponding to this exercise.

## 4 Querying maps

### What is a query?

A query is question often required to be expressed in a formal way. For querying maps, SQL (sequential query language) support is required. QGIS provides querying facility on maps, results of which are visual outputs, i.e., sub-objects on a map. The output of query can be stored as a separate shape file to be imported as layer. A query can be issued on attributes of the shape file/object. The geometries satisfying the conditions of attributes are returned as the map.

The general format to specify a condition is:

“FIELDNAME” “OPERATOR” “VALUE”

e.g., “Talukaname=Thane” will show all sub-object/polygons of the map/vector layer that have it Talukaname attribute as Thane.

The procedure to query a map is as follows:

1. Right click on the layer.
2. Click on ‘Query..’.
3. Select the ‘Field’ to be used as condition for the query. The fields displayed on the bottom tab named ‘SQL where clause’.
4. Next, select the operator for the condition by double clicking on the ‘Operator’ button.
5. To see what all values are associated with the select field, click ‘ALL’ at the bottom of the ‘value’ block.
6. Double click on the value, which gets written in the ‘SQL where clause’. Now the query takes the form of expression described above.
7. Click on ‘OK’.
8. The layer will show the objects satisfying condition given.
9. The layer can be saved by right clicking on layer and selecting the option ‘Save’.
10. The original layer can be restored choosing ‘Clear’ (instead of specifying a query condition) in the query builder menu of the layer. This clears the condition and original view of the layer is restored.

### Example

*Given data:*

1. District boundary (using the district layer).
2. Tehsil Boundary - Area, perimeter, taluka ID, taluka name, District name, Hilly Block, Geometry (Polygon).
3. Drainage - Area, perimeter, drainage polygon ID, Type (reservoir, tanks, river), area in hectares, Geometry (Polyline).

*Query* : Locate on map the Tehsil with name “Thane” .

*Steps:*

First import the above layers and arrange them such that district layer will be the bottommost layer, the taluka layer next and the drainage layer at the top.

1. In Query builder select the field - “TNAME” which stands for name of tehsil.
2. Select the operator “=” as the name of Tehsil is compared.
3. Click on the “All” button in the values block to see all the values for the Tehsil field.

4. Select Thane (double click).
5. The “SQL where clause” should display “TNAME = Thane” .
6. Click OK.
7. The Tehsil layer should display only the Thane tehsil.
8. The query result is just viewed on query execution, and not saved until the layer is saved as a new shape file.
9. To bring back the original layer as it was, clear the query as instructed in the instructions above.

**More examples:**

1. Query: Locate talukas Thane, Murbad, Mokhada.  
The SQL where clause is:  
TNAME = Thane OR TNAME = Murbad OR TNAME = Mokhada
2. Query: Locate talukas which are in District Thane and are in “Hilly Sub-Block” .  
The SQL where clause is:  
DNAME = THANE AND HILLYBLOC = Hilly Sub-block  
The result should display the Vasai and Bhiwandi talukas.

**Exercise:**

1. Import the taluka layer and open the attributes table.
2. To add a new column, first click on Toggle Editing mode symbol.
3. Click on Add Column button.
4. Enter name of a new column as “population” and type “integer” .  
A new column named population has been added with all values initiated as NULL.
5. Edit all the values by entering values from the given population dataset of the talukas.
6. As an exercise, try rendering map with graduation of population.
7. Query on the map for showing talukas with population greater than 1 million and which are in hilly block.

## 5 The Analysis Tool

1. Go to ‘ ‘Vector’ ’ tab on the toolbar and select the ‘ ‘Analysis Tool’ ’ .
2. Following operations can be performed,
  - Sum Line length (sums up the line length),
  - Distance Matrix (gives distance matrix between points of two different layers),
  - Points in polygon (given a polygon layer, gives number of points of another layer in it)
  - Nearer Neighbor (gives statistic of nearest neighbor)
  - etc.

### Exercise:

1. Import District Layer.
2. Import Road Arc Layer.
3. Go to Vector.
4. Go to Analysis Tool.
5. Select Sum line lengths.
6. Select the district polygon layer and road arc layer in the tool, which means that the sum of lines (road arcs) in the district polygon will be stored in the output layer.
7. Give a new output file name.
8. Now check the attributes of new output layer, which will give you total length of road arcs in district polygon.
9. As an exercise, do the same with Taluka layer and Road arc. The output will have Taluka layer with one extra column having total length of road arc in each taluka polygon.

## 6 The Geo-Processing Tool

Another useful tool is geo-processing tool having operations like union, intersection, buffer.

1. Go to ‘ ‘Vector’ ’ .
2. Go to ‘ ‘Geoprocessing tool’ ’ .
3. The functions in it do following tasks -
  - Intersection (gives intersection of two layers)
  - Convex hull (creates convex hull for selected layer, for selected field)
  - Union (Gives union of two layers)
  - Buffer (buffer of specified area)
  - Dissolve (dissolve the polygons of some specified selected features)
  - Difference (Difference between two layers)
  - Clip (Clip a layer to the target layer)

Output is saved as a new file, for which the folder has to be browsed.

### Exercise :

1. Import drainage layer.
2. Query on taluka for Taluka name - Shahapur  
Consider the layer taluka consisting of only the Shahapur taluka.
3. Intersect this taluka layer with drainage.
4. Save the layer.

**Exercise :**

1. Import village layer.
2. Import layer with elevation points .
3. Import drainage layer.
4. Query on the elevation point layer and pick up points with elevation greater than 500ft.
5. Buffer the points with .01 i.e 1 km
6. Buffers of 1 km area will be formed around the queried ' elevation of village points' layer.
7. With this buffering you can check which villages are having reservoirs in area of 1 km.

**Exercise:**

1. Import District layer.
2. Import Village layer.
3. Query on the village layer and form a new layer named Tanker-fed villages. The list of tanker-fed villages is part of the data directory for this tutorial. Use tanker-fed villages names to query the Village-layer and generate and save a new tanker-fed villages layer.

**Exercise:**

1. As an exercise dissolve the villages with same taluka name in the new tanker-fed layer villages, and form a new layer from it.

The dissolve feature combines polygon boundaries of polygons which meet a certain common criteria, e.g., same taluka name. In the above operation, “ ‘dissolve” will plot all villages with the same taluka name with the same color/style and append all taluka attributes/fields to the village attributes list.

**Exercise:**

1. Import the watershed layer.
2. Choose any one taluka and intersect the watershed layer with that taluka.
3. Output view should show watersheds of selected taluka and none for other talukas.

## 7 Importing other file formats

Quantum GIS can import files in formats like kml, smw, image(raster), postGIS database etc. While importing a vector file, the file format option can be selected for any vector file, (from bottom of the import tab) before browsing the file. The following is an example importing of a kml file—making a kml file in Google Earth and importing the kml file in QGIS.

Steps:

1. Search Tansa Lake, Thane, Maharashtra.
2. Draw polygon with the drawing tool around the lake.
3. Save the file by right clicking as kml file.
4. Now go to add vector file in QGIS and select the file format kml before browsing the file.
5. Import the file.
6. Import the thane taluka file, which is given in the data folder as well.
7. See that the kml file overlaps on the Shahapur taluka.

## 8 Additional references:

1. <http://qgis.spatialthoughts.com/>
2. <http://qgis.org/en/documentation.html>