Project "Integrated planning and practices for mangrove management associated with agriculture and aquaculture in Myanmar - 2017P1-MYR"

QGIS training manual

Version 1.0

Using QGIS for natural resources management

APFNet

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

MONREC

FOREST

Table of Contents

Disclaimer iv

1 CREATING A MAP IN QGIS 4

1.1 Getting the data 4

1.2 Procedure 4

1.2.1 Step 1. Open QGIS 4

1.2.2 Step 2. Browse the data 4

1.2.3 Step 3. View the map data 5

1.2.4 Step 4. Zoom to Myanmar 6

1.2.5 Step 5. Use the layer control 6

1.2.6 Enable on the fly CRS 6

1.2.7 Step 7. Make print page 7

1.2.8 Map title 8

1.2.9 Step 9. Add map 8

1.2.10 Step 10. Draw map canvas 9

1.2.11 Step 11. Move map content 10

1.2.12 Set zoom level 11

1.2.13 Lock layer style 12

1.2.14 Zoom to Aligarh 13

1.2.15 Turn off duplicate label 14

1.2.16 Inset map 15

1.2.17 Add inset map – step 2 16

1.2.18 Highlight the inset map area in the main map 17

1.2.19 Adding grid 19

1.2.20 Adding North arrow 25

1.2.21 Add label 28

2 WORKING WITH ATTRIBUTE DATA 33

2.1 Overview of the task 33

2.2 Procedure 33

2.2.1 Step 1. Adding data 33

2.2.2 Viewing attribute 36
2.2.3 Query the data 39
3 WORKING WITH SPREADSHEET AND CSV DATA 49
3.1 Overview of the task 49
3.2 Procedure 49
3.2.1 Examine tabular data 49
3.2.2 Import tabular data into QGIS 50
4 USING PLUG-IN 56
4.1 Overview of the task 56
4.2 Procedure 56
4.2.1 Core Plugins 56
4.2.2 External Plugins 59
4.2.3 Experimental Plugins 63
5 Searching and Downloading OpenStreetMap Data 69
5.1 Overview of the task 69
5.2 Procedure 69
6 Basic Vector Styling 83
6.1 Overview of the task 83
6.2 Get the data 83
6.2.1 Procedure 83
7 Basic Raster Styling and Analysis 101
7.1 Overview of the task 101
7.1.1 Other skills you will learn 101
7.2 Get the data 101
7.3 Procedure 102
8 Working with Terrain Data 125
8.1 Overview of the task 125
8.1.1 Other skills you will learn 125
8.2 Get the data 125
8.3 Procedure 127

9 Digitizing Map Data 146
9.1 Overview of the task 146
9.2 Other skills you will learn 146
9.3 Get the data 146
9.4 Procedure 146
10 Working with satellite image 182
10.1 Overview of the task 182
10.2 Other skill you will learn 182
10.3 Get the data 182
10.4 Procedure 184
10.4.1 Loading image into QGIS 184
10.4.2 Create a virtual raster 185
10.4.3 Clipping image 187
10.4.4 Viewing image pixel value 188
11 Image classification for land use/ land cover 190
11.1 Overview of the task 190
11.2 Other skill you will learn 190
11.3 Get the data 190
11.4 Procedure 190
11.4.1 Install or Enable SCP plugin 190
11.4.2 Loading Sentinel image into QGIS 191
11.5 Classification 193
11.5.1 Create region of interest (ROI) 193
11.5.2 Run the classification 200
11.5.3 Post classification 202
11.5.4 Accuracy assessment 204

Disclaimer

This document is adapted from the QGIS tutorial (Ujaval Gandhi, 2014) with modification on maps, data source and picture.

The source code of the book Ujaval Gandhi (2014) is available on Github at:

https://github.com/spatialthoughts/qgis-tutorials

Chapter 10 and 11 on image processing and classification are written from scratch and did not base on Ujaval Gandhi (2014).

INTRODUCTION

QGIS is a user friendly Open Source Geographic Information System (GIS) licensed under the GNU General Public License. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). It runs on Linux, Unix, Mac OSX, Windows and Android and supports numerous vector, raster, and database formats and functionalities.

QGIS aims to be a user-friendly GIS, providing common functions and features. The initial goal of the project was to provide a GIS data viewer. QGIS has reached the point in its evolution where it is being used by many for their daily GIS data-viewing needs. QGIS supports a number of raster and vector data formats, with new format support easily added using the plugin architecture.

QGIS provides a continuously growing number of capabilities provided by core functions and plugins. You can visualize, manage, edit, analyse data, and compose printable maps. Get a first impression with a more detailed feature list.

QGIS feature

QGIS offers many common GIS functionalities provided by core features and plugins. A short summary of six general categories of features and plugins is presented below, followed by first insights into the integrated Python console.

View data

You can view and overlay vector and raster data in different formats and projections without conversion to an internal or common format. Supported formats include:

- Spatially-enabled tables and views using PostGIS, SpatiaLite and MS SQL Spatial, Oracle Spatial, vector formats supported by the installed OGR library, including ESRI shapefiles, MapInfo, SDTS, GML and many more. See section Working with Vector Data.
- Raster and imagery formats supported by the installed GDAL (Geospatial Data Abstraction Library) library, such as GeoTIFF, ERDAS IMG, ArcInfo ASCII GRID, JPEG, PNG and many more. See section Working with Raster Data.
- GRASS raster and vector data from GRASS databases (location/mapset). See section GRASS GIS Integration.
- Online spatial data served as OGC Web Services, including WMS, WMTS, WCS, WFS, and WFS-T. See section Working with OGC Data.

Explore data and compose maps

You can compose maps and interactively explore spatial data with a friendly GUI. The many helpful tools available in the GUI include:

- QGIS browser
- On-the-fly reprojection
- DB Manager

- Map composer
- Overview panel
- Spatial bookmarks
- Annotation tools
- Identify/select features
- Edit/view/search attributes
- Data-defined feature labelling
- Data-defined vector and raster symbology tools
- Atlas map composition with graticule layers
- North arrow scale bar and copyright label for maps
- Support for saving and restoring projects

Create, edit, manage and export data

You can create, edit, manage and export vector and raster layers in several formats. QGIS offers the following:

- Digitizing tools for OGR-supported formats and GRASS vector layers
- Ability to create and edit shapefiles and GRASS vector layers
- Georeferencer plugin to geocode images
- GPS tools to import and export GPX format, and convert other GPS formats to GPX or down/upload directly to a GPS unit (On Linux, usb: has been added to list of GPS devices.)
- Support for visualizing and editing OpenStreetMap data
- Ability to create spatial database tables from shapefiles with DB Manager plugin
- Improved handling of spatial database tables
- Tools for managing vector attribute tables
- Option to save screenshots as georeferenced images
- DXF-Export tool with enhanced capabilities to export styles and plugins to perform CAD-like functions

Analyze data

You can perform spatial data analysis on spatial databases and other OGR- supported formats. QGIS currently offers vector analysis, sampling, geoprocessing, geometry and database management tools. You can also use the integrated GRASS tools, which include the complete GRASS functionality of more than 400 modules. (See section GRASS GIS Integration.) Or, you can work with the Processing Plugin, which provides a powerful geospatial analysis framework to call native and third-party algorithms from QGIS, such as GDAL, SAGA, GRASS, fTools and more. (See section Introduction.)

Publish maps on the Internet

QGIS can be used as a WMS, WMTS, WMS-C or WFS and WFS-T client, and as a WMS, WCS or WFS server. (See section Working with OGC Data.) Additionally, you can publish your data on the Internet using a webserver with UMN MapServer or GeoServer installed.

Extend QGIS functionality through plugins

QGIS can be adapted to your special needs with the extensible plugin architecture and libraries that can be used to create plugins. You can even create new applications with C++ or Python!

Core plugins include:

- Coordinate Capture (Capture mouse coordinates in different CRSs)
- DB Manager (Exchange, edit and view layers and tables from/to databases; execute SQL queries)
- Dxf2Shp Converter (Convert DXF files to shapefiles)
- eVIS (Visualize events)
- fTools (Analyze and manage vector data)
- GDALTools (Integrate GDAL Tools into QGIS)
- Georeferencer GDAL (Add projection information to rasters using GDAL)
- GPS Tools (Load and import GPS data)
- GRASS (Integrate GRASS GIS)
- Heatmap (Generate raster heatmaps from point data)
- Interpolation Plugin (Interpolate based on vertices of a vector layer)
- Metasearch Catalogue Client
- Offline Editing (Allow offline editing and synchronizing with databases)
- Oracle Spatial GeoRaster
- Processing (formerly SEXTANTE)
- Raster Terrain Analysis (Analyze raster-based terrain)
- Road Graph Plugin (Analyze a shortest-path network)
- Spatial Query Plugin
- Topology Checker (Find topological errors in vector layers)
- Zonal Statistics Plugin (Calculate count, sum, and mean of a raster for each polygon of a vector layer)

External Python Plugins

QGIS offers a growing number of external Python plugins that are provided by the community. These plugins reside in the official Plugins Repository and can be easily installed using the Python Plugin Installer. See Section The Plugins Dialog.

1 CREATING A MAP IN QGIS

This tutorial will teach you how to make a map of Myanmar with key element such as grid line, north arrow, legend, scale bar and label

1.1 Getting the data

We will use the Natural Earth dataset - specifically the Natural Earth Quick Start Kit that comes with beautifully styled global layers that can be loaded directly to QGIS.

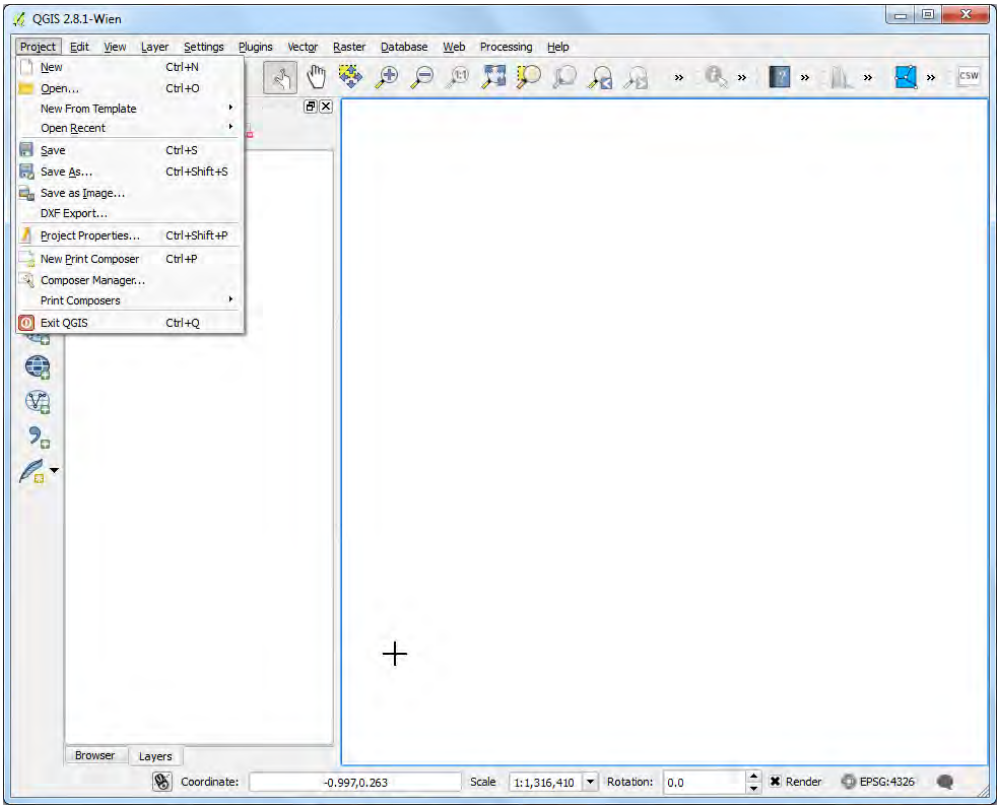
Download data from here: http://naciscdn.org/naturalearth/packages/Natural_Earth_quick_start.zip

Or you can copy it from the Tutorial Folder /Data/NaturalEarth/

1.2 Procedure

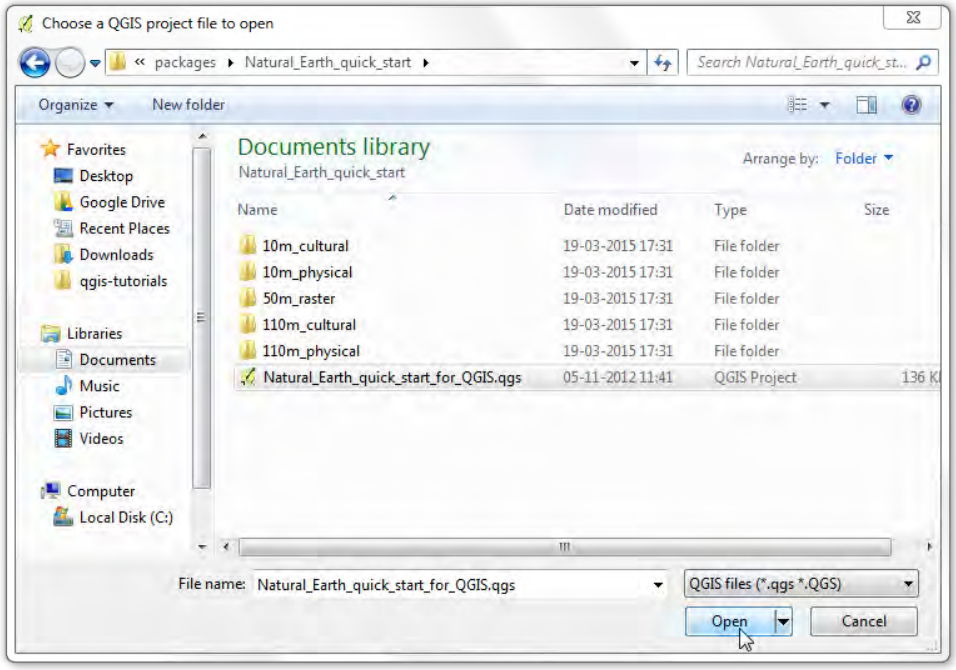
1.2.1 Step 1. Open QGIS

Open QGIS. Click on File ‣ Open Project.



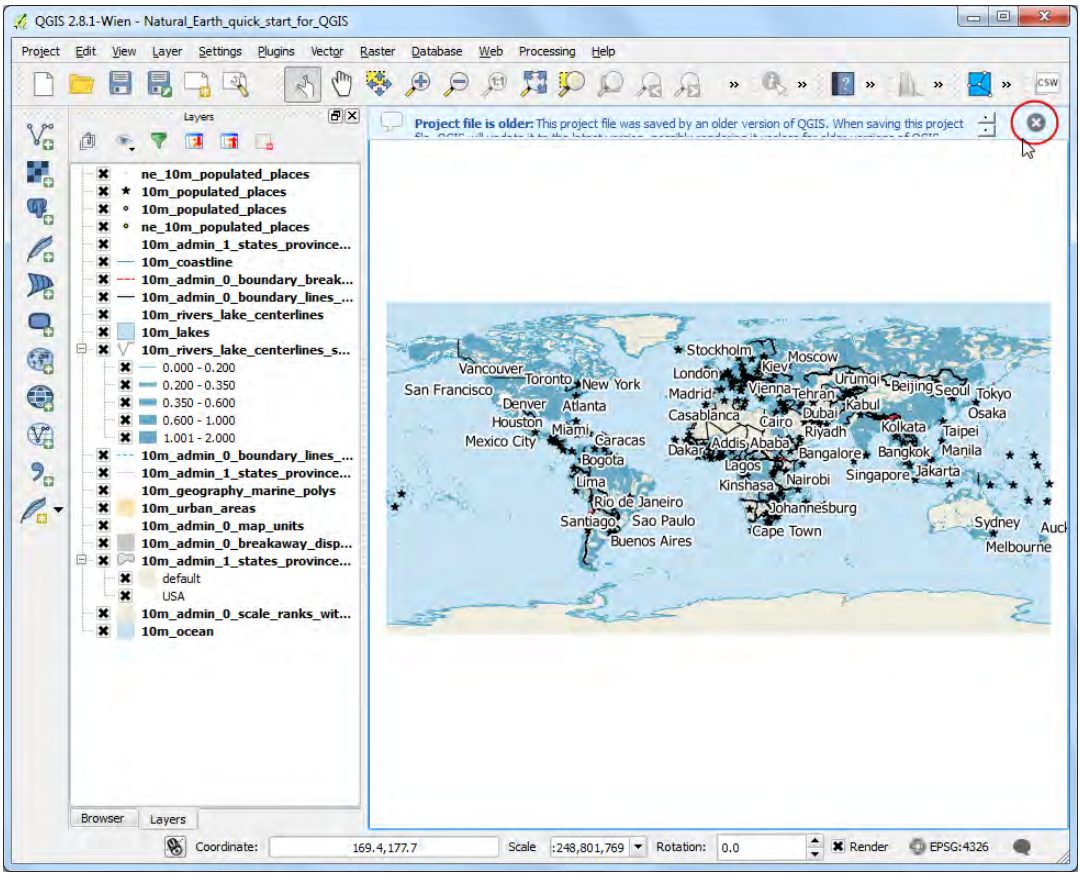
1.2.2 Step 2. Browse the data

Browse to the directory when you had extracted the natural earth data. You should see a file named Natural_Earth_quick_start_for_QGIS.qgs. This is the project file that contains styled layers in QGIS Document format. Click Open.



1.2.3 Step 3. View the map data

You would see a lot of layers in the table of content and a styled world map in the QGIS canvas. If you see errors displayed at the top of the canvas, click on the cross to close it.

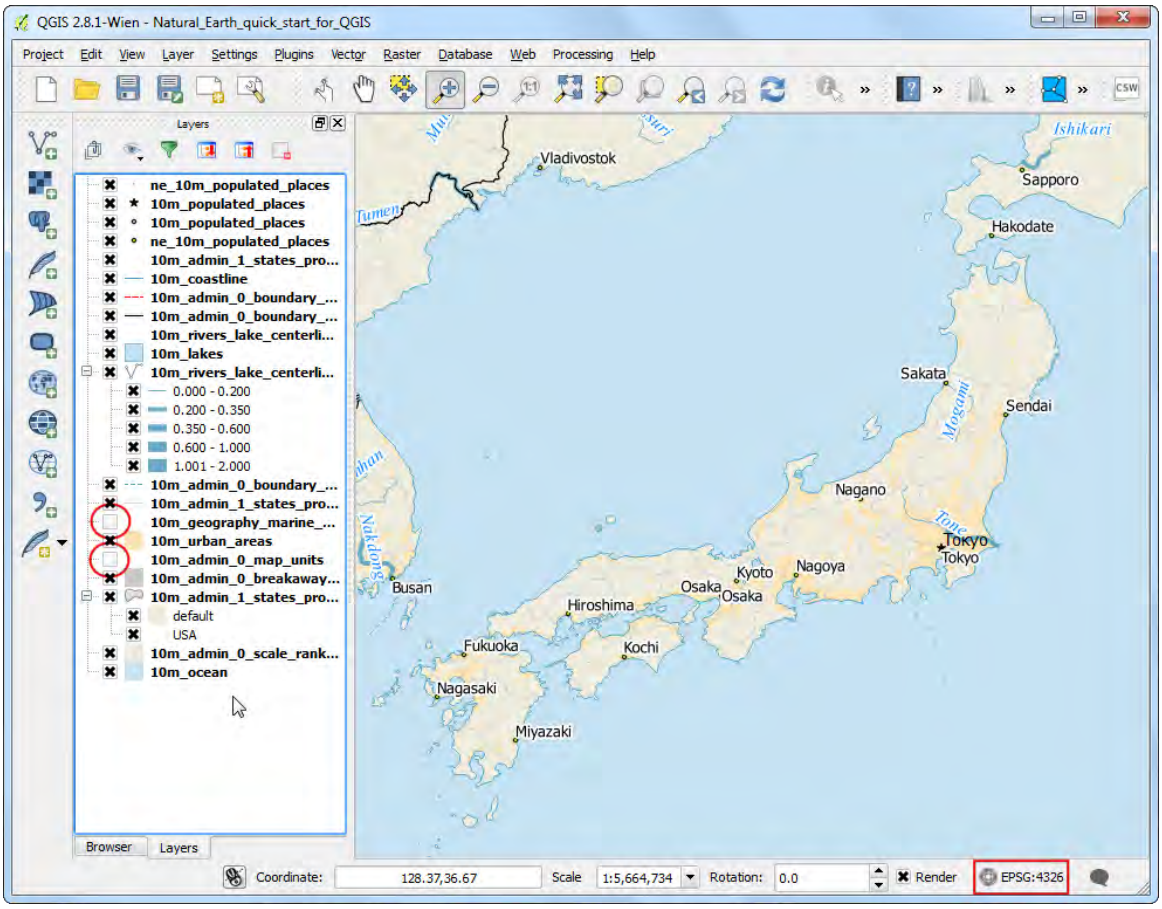


1.2.4 Step 4. Zoom to Myanmar

In this tutorial, we will make a map of Myanmar. Click the Zoom In button and draw a rectangle around Myanmar to zoom to the area.

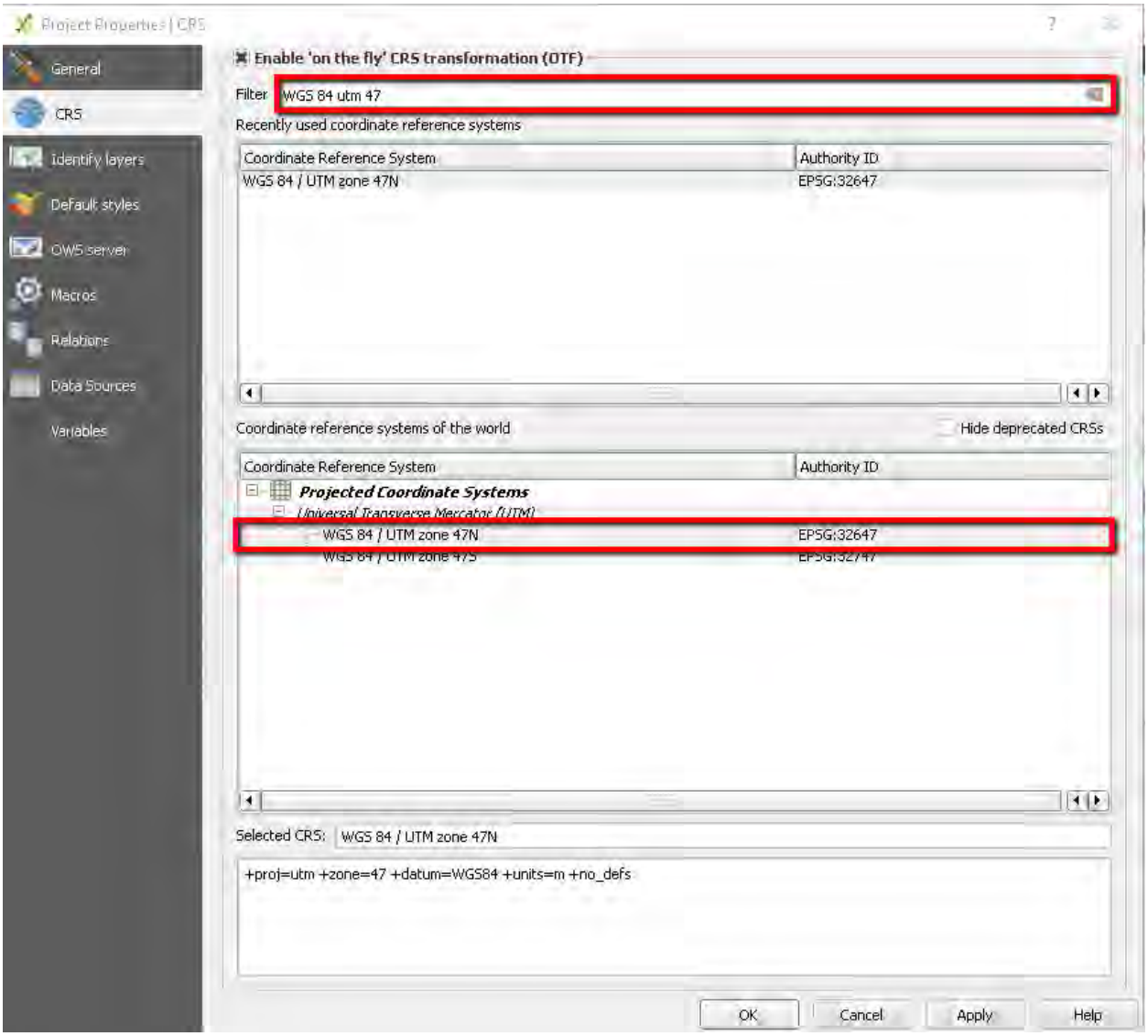
1.2.5 Step 5. Use the layer control

You can turn off some map layers for data that we do not need for this map. Un-check the box next to 10m_geography_marine_polys and 10m_admin_0_map_units layers. Before we make a map suitable for printing, we need to choose an appropriate projection. This dataset comes in Geographic Coordinate System (GCS) where the units are degrees. This is not appropriate for a map where you want the distances to be in kilometers or miles. We need to use a Projected Coordinate System that minimizes distortions for our region of interest and has units in meters. Universal Transverse Mercator (UTM) is a decent choice for a projected coordinate system. It is also global, so it's a good default that you can rely on and choose a UTM zone that contains your area of interest to minimize distortions for your region. In our case, we will use UTM Zone 47N (EPSG: 32647). Click the CRS Status button at the bottom-right of the QGIS window.



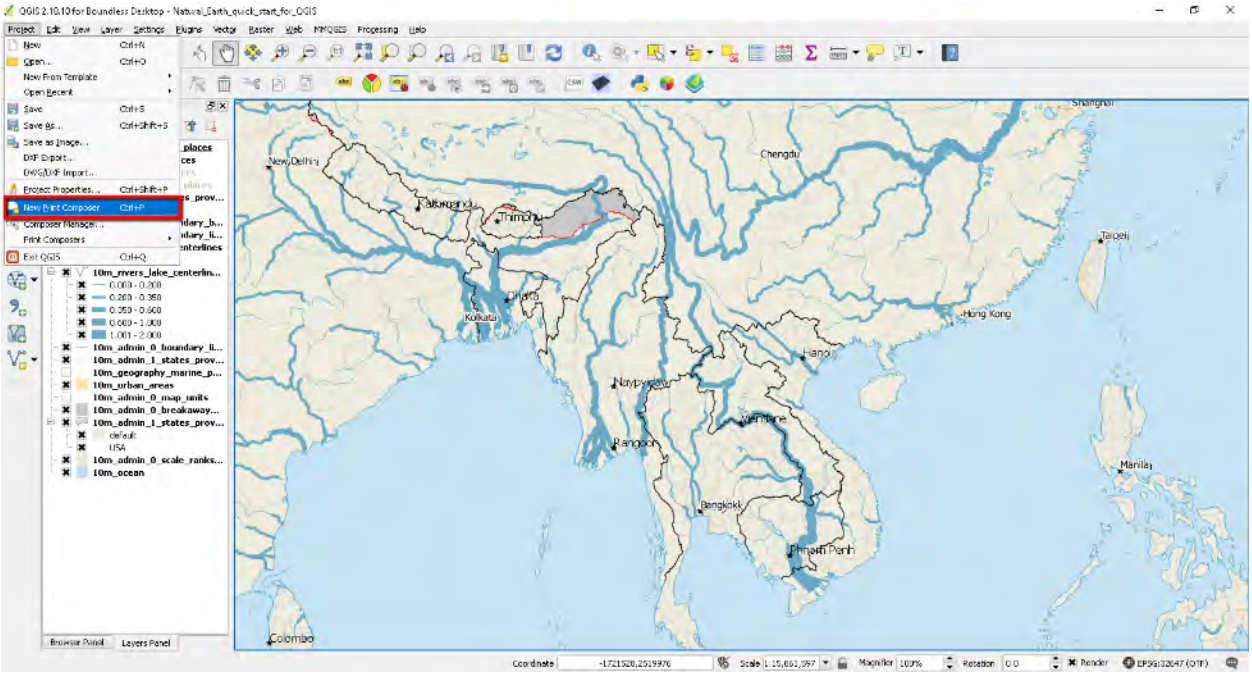
1.2.6 Enable on the fly CRS

Check the Enable on-the-fly CRS Transformation box. Type 32647 in the Filter search box. Once you see the results, select WGS84 /UTM Zone 47 (EPSG:32647). Click Apply.



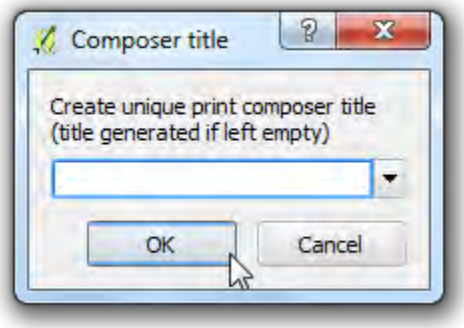
1.2.7 Step 7. Make print page

Now we can start to assemble our map. Go to Project ▸ New Print Composer.



1.2.8 Map title

You will be prompted to enter a title for the composer. You can leave it empty and click Ok.

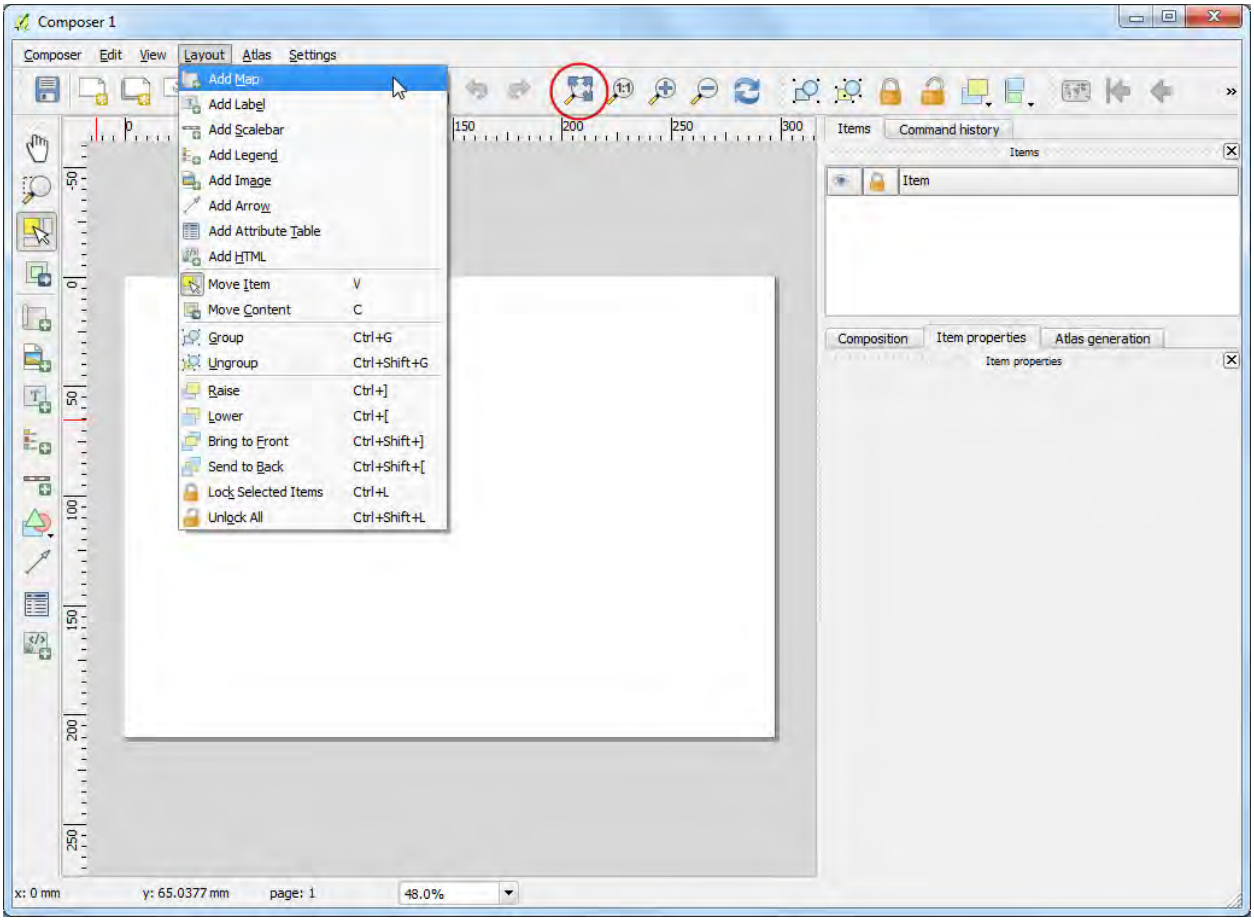


Note

Leaving the composer name empty will assign a default name such as Composer 1.

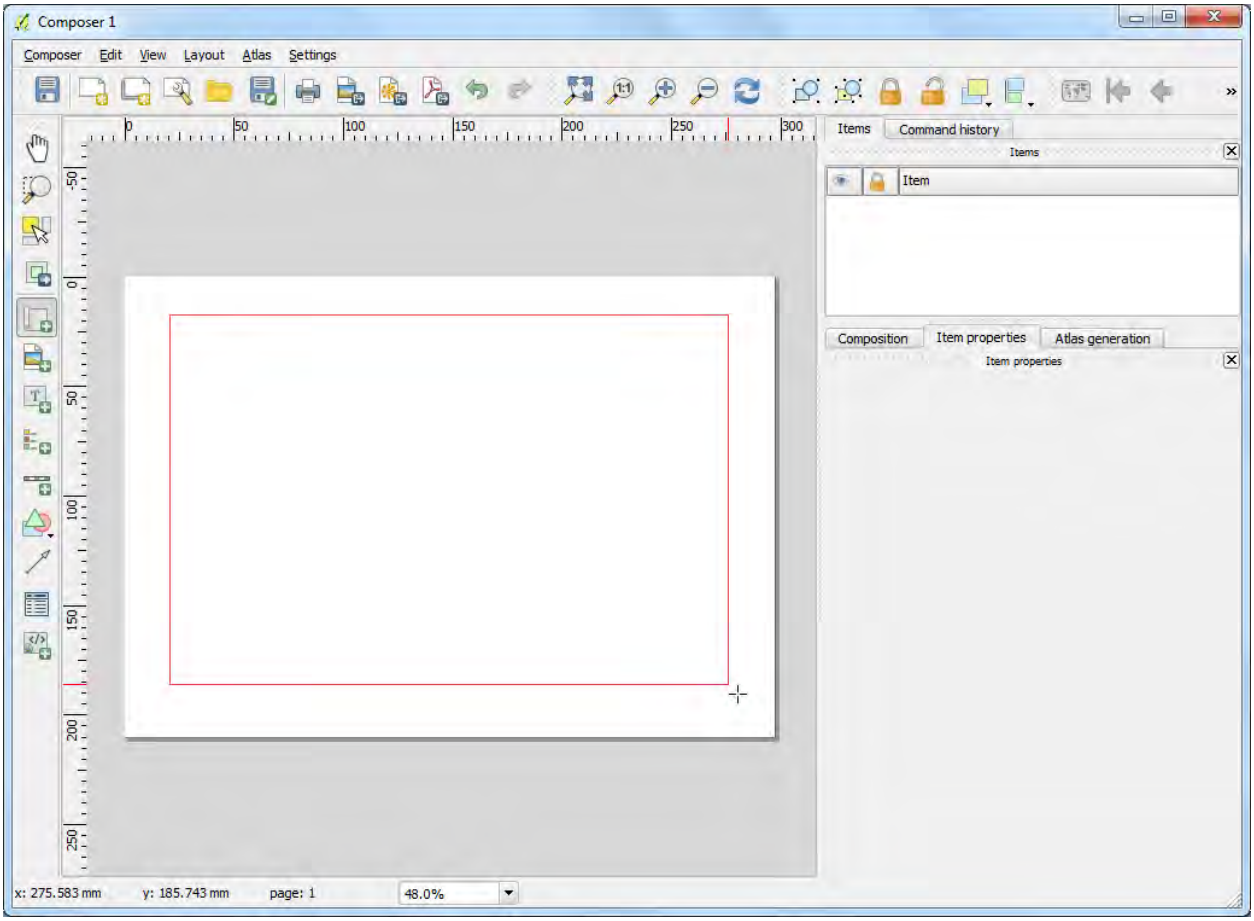
1.2.9 Step 9. Add map

In the Print Composer window, click on Zoom full to display the full extent of the Layout. Now we would have to bring the map view that we see in the QGIS Canvas to the composer. Go to Layout ▸ Add Map.



1.2.10 Step 10. Draw map canvas

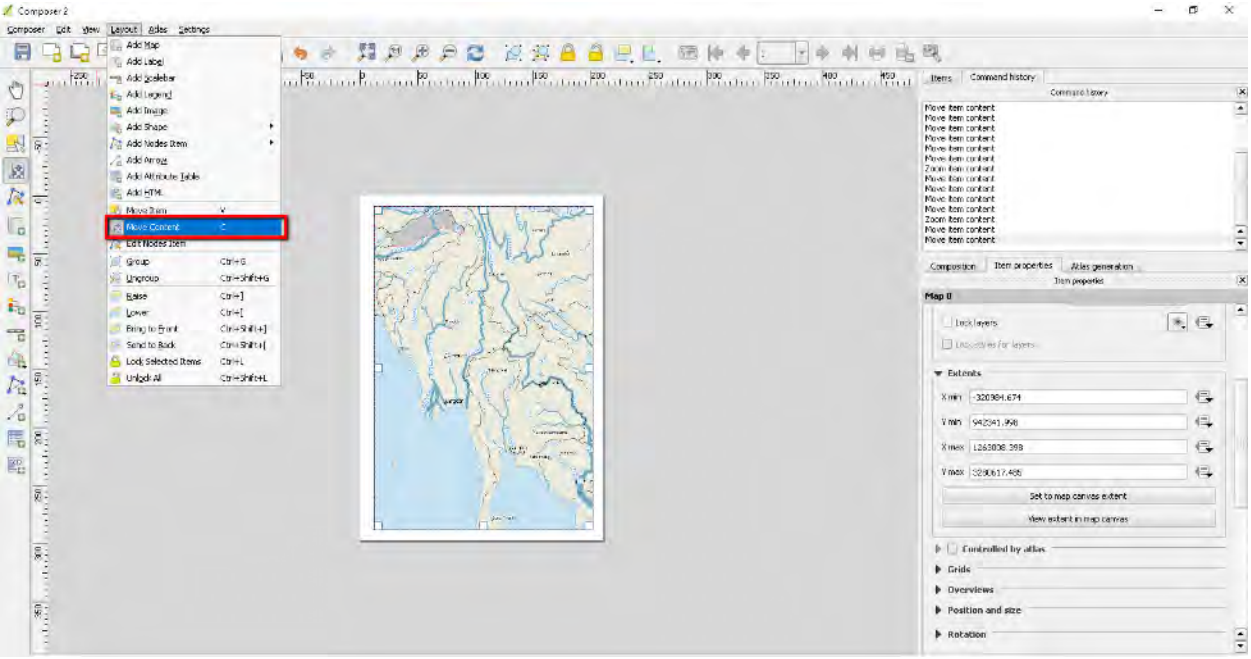
Once the Add Map button is active, hold the left mouse button and drag a rectangle where you want to insert the map.



1.2.11 Step 11. Move map content

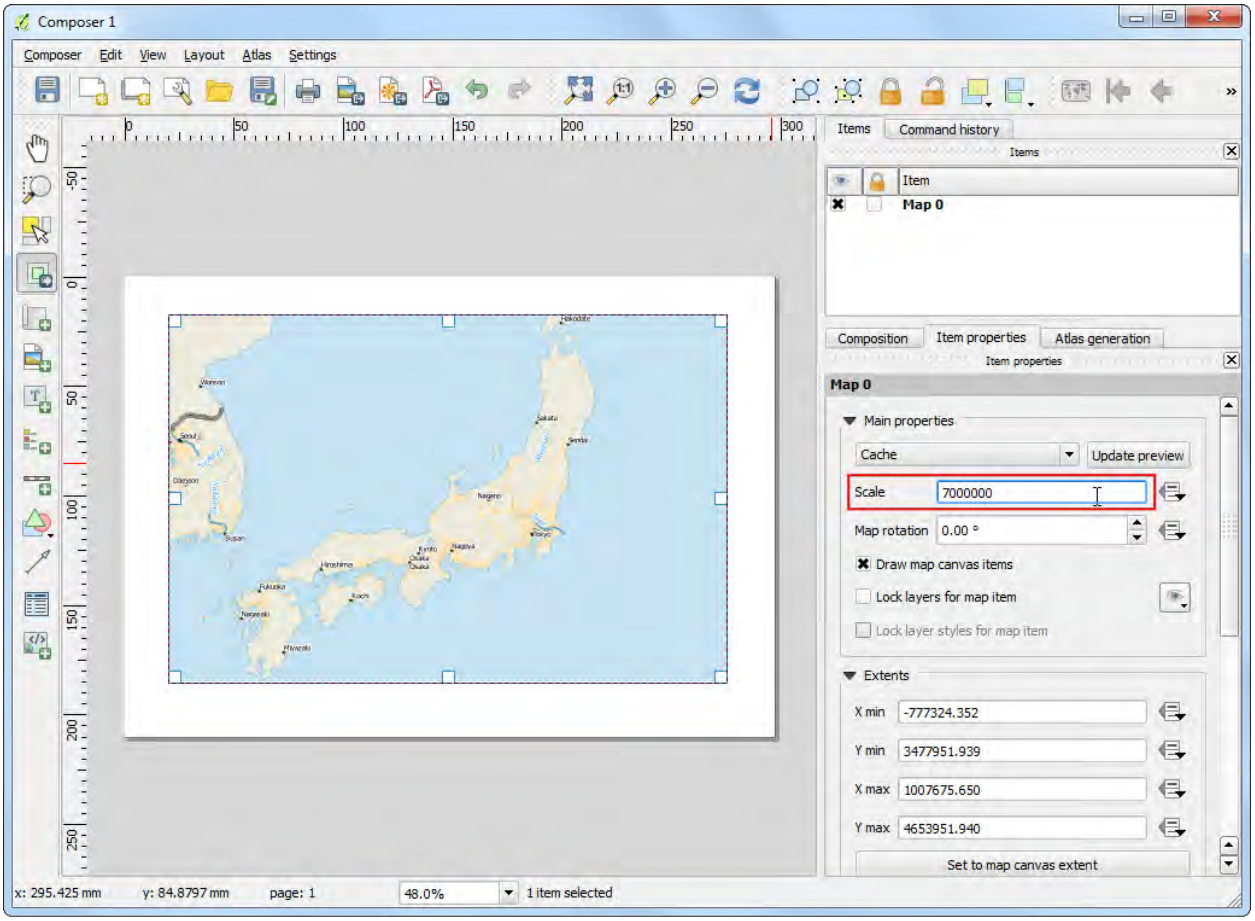
You will see that the rectangle window will be rendered with the map from the main QGIS canvas. The rendered map may not be covering the full extent of our interest area. Select Layout ▸ Move item content to pan the map in the window and center it in the composer.

Press Control key and Scroll mouse to adjust zooming of the map content until you get map at the desired view.



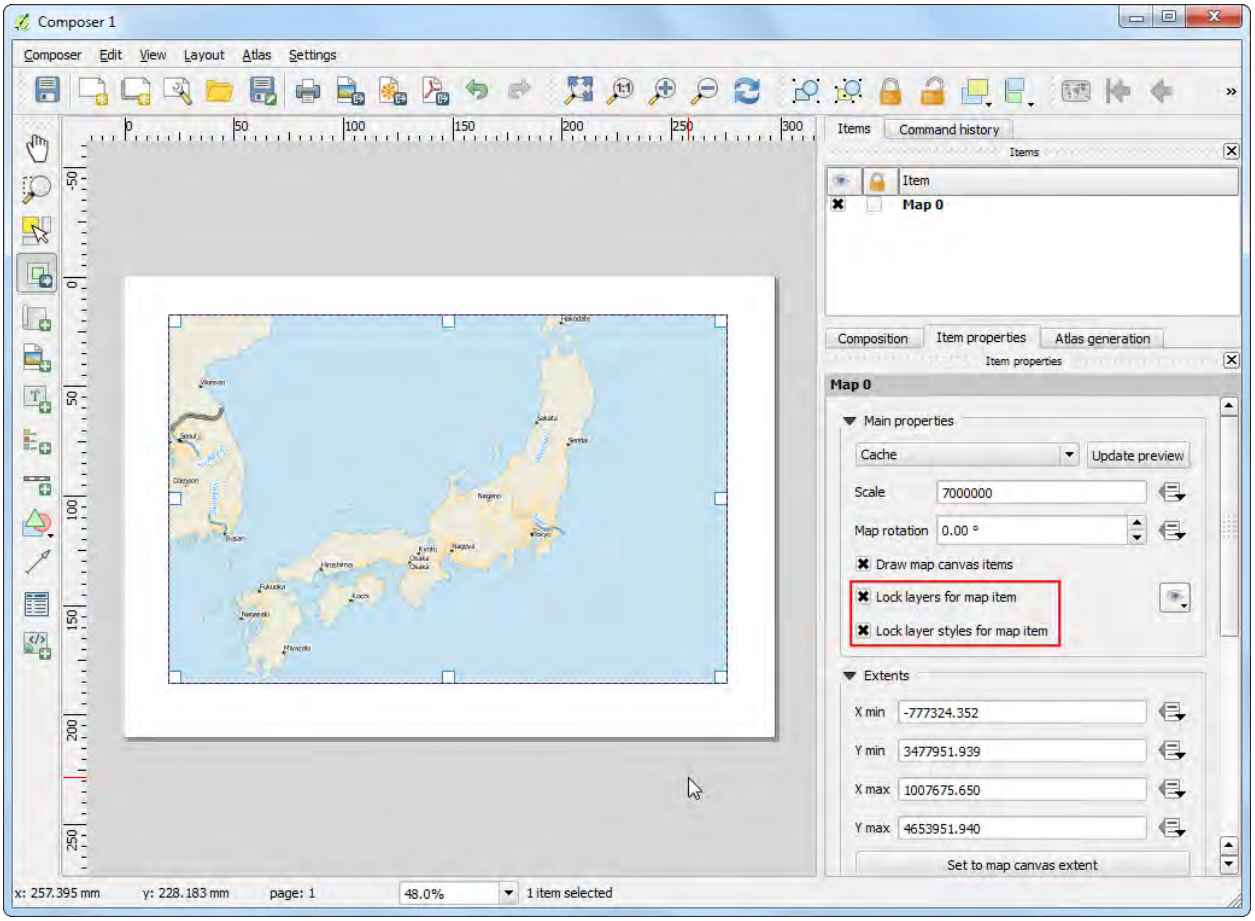
1.2.12 Set zoom level

Let us adjust the zoom level for the given map. Click on the Item Properties tab and enter 7000000 for Scale value.



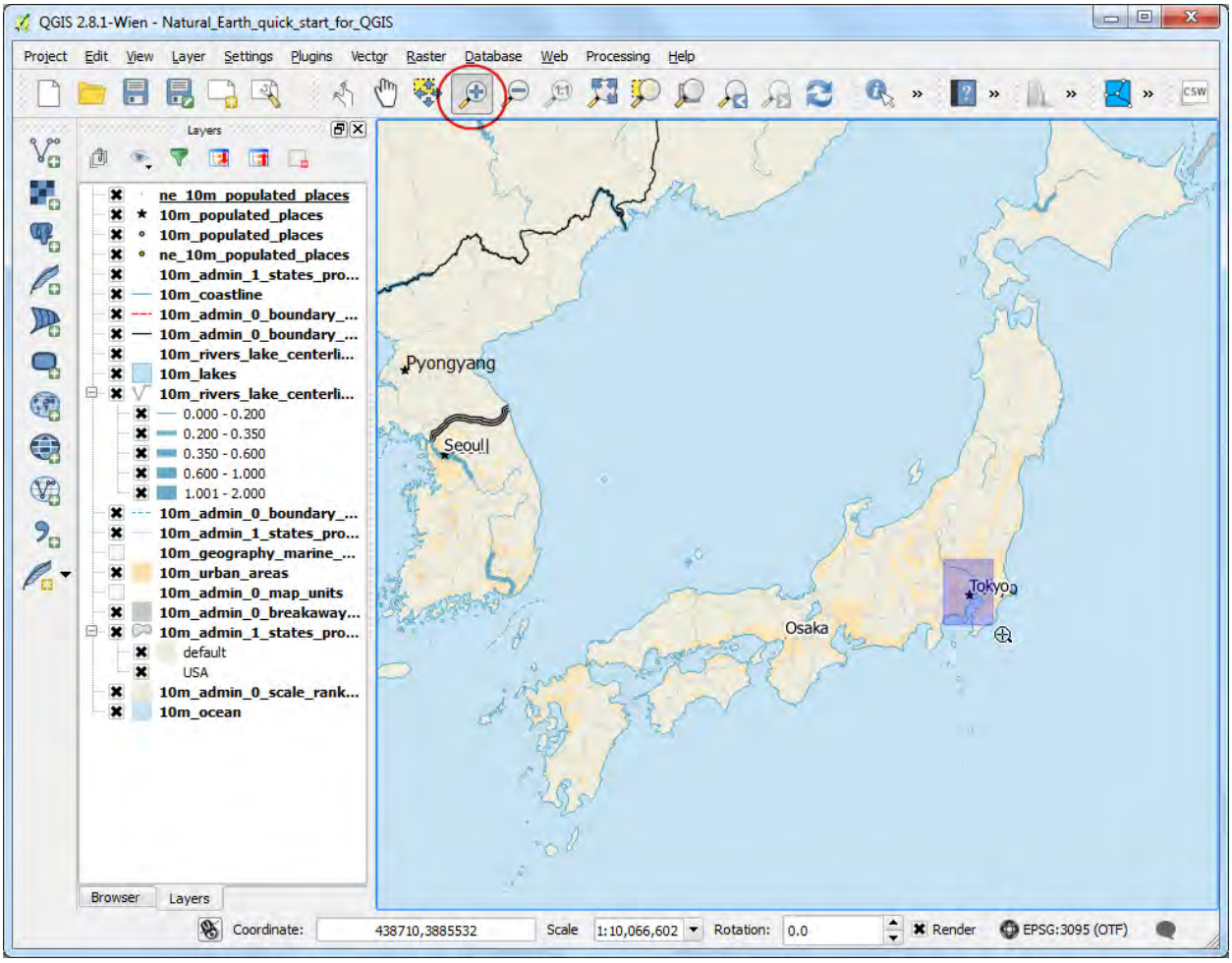
1.2.13 Lock layer style

Now we will add a map inset that shows a zoomed in view for the Tokyo area. Before we make any changes to the layers in the main QGIS window, check the Lock layers for map item and Lock layer styles for map item boxes. This will ensure that if we turn off some layers or change their styles, this view will not change.



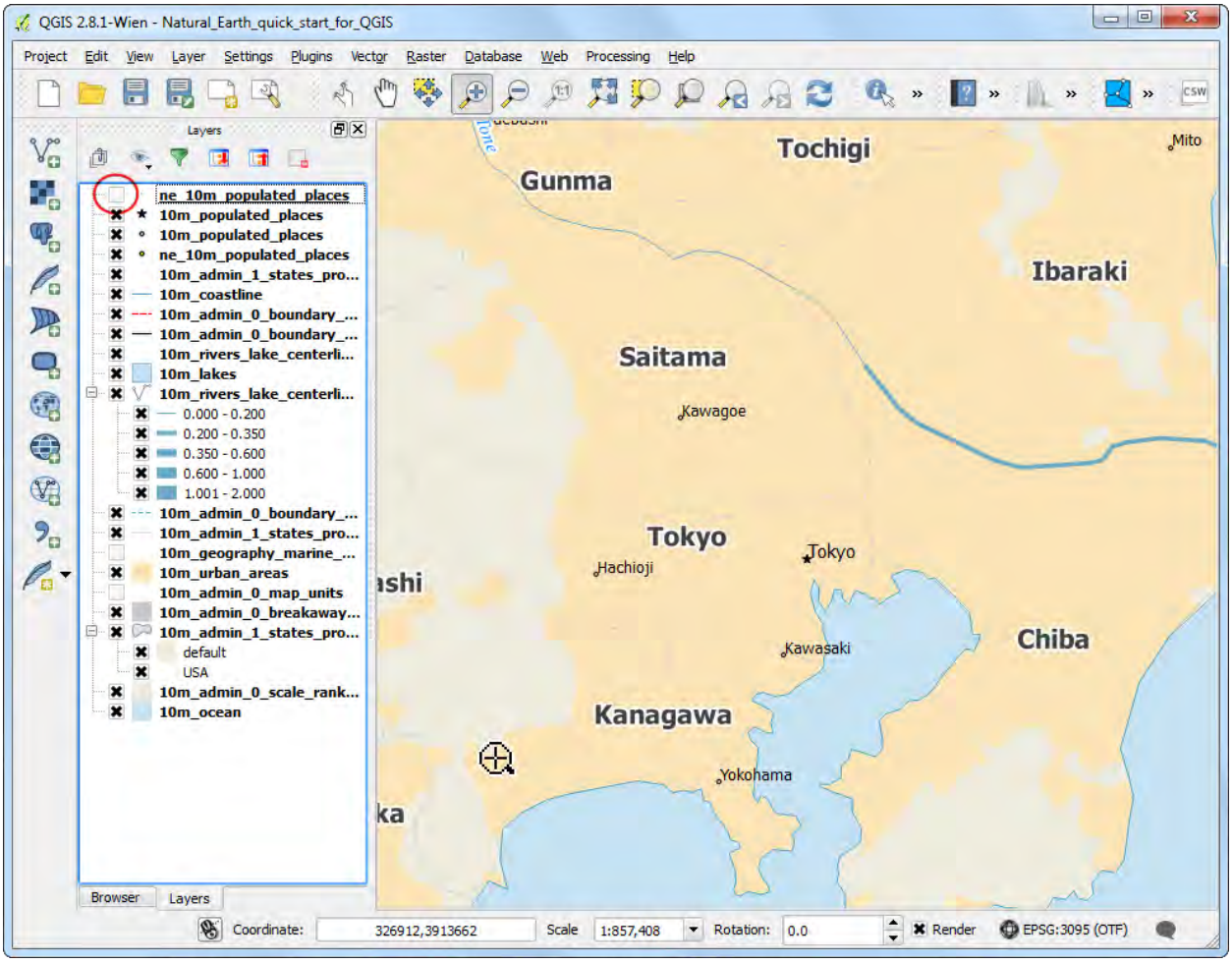
1.2.14 Zoom to Aligarh

Switch to the main QGIS window. Use the Zoom In button to zoom to the area around Yangon.



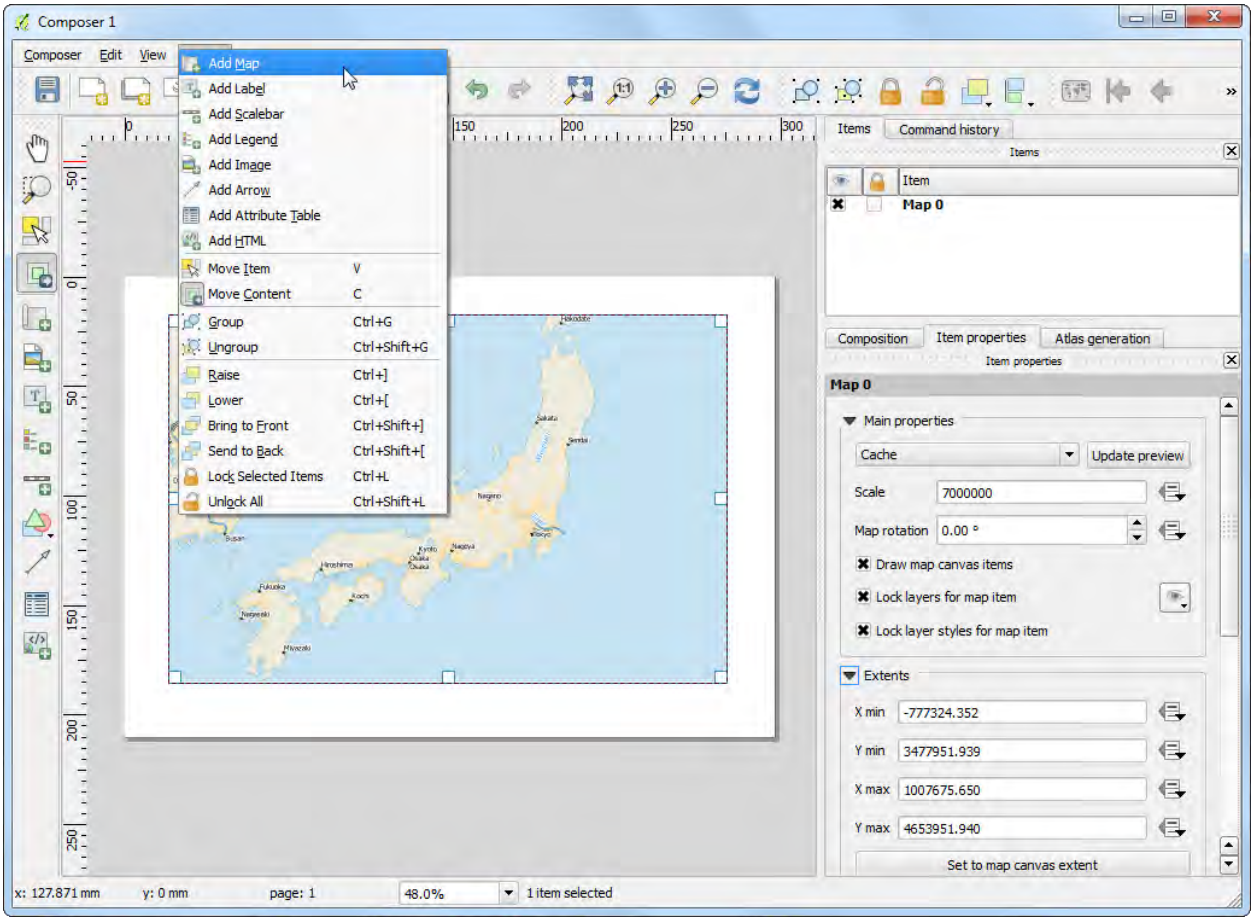
1.2.15 Turn off duplicate label

There are some duplicate labels coming from the ne_10m_populated_places layer. You can turn it off for this view.



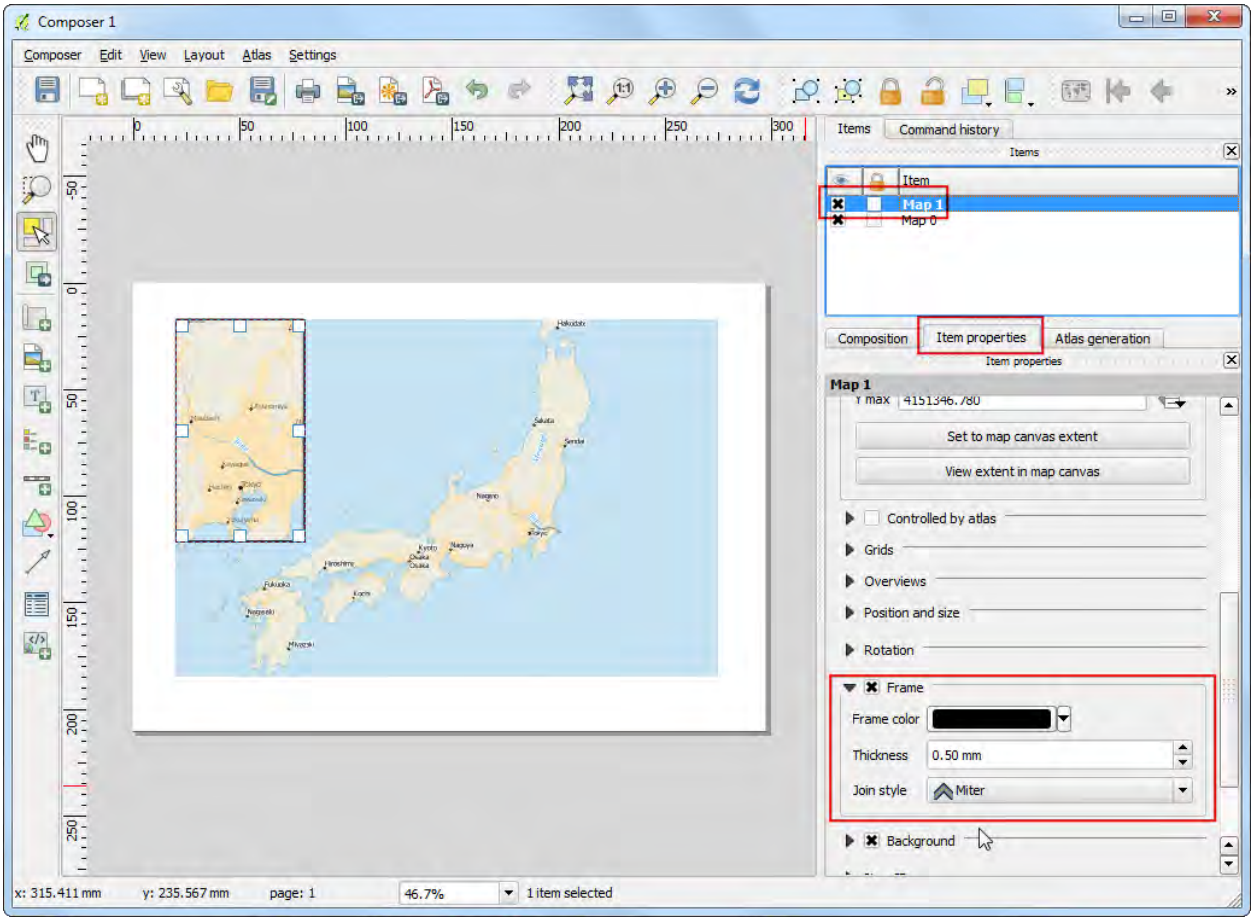
1.2.16 Inset map

We are now ready to add the map inset. Switch the the Print Composer window. Go to Layout ▸ Add Map.



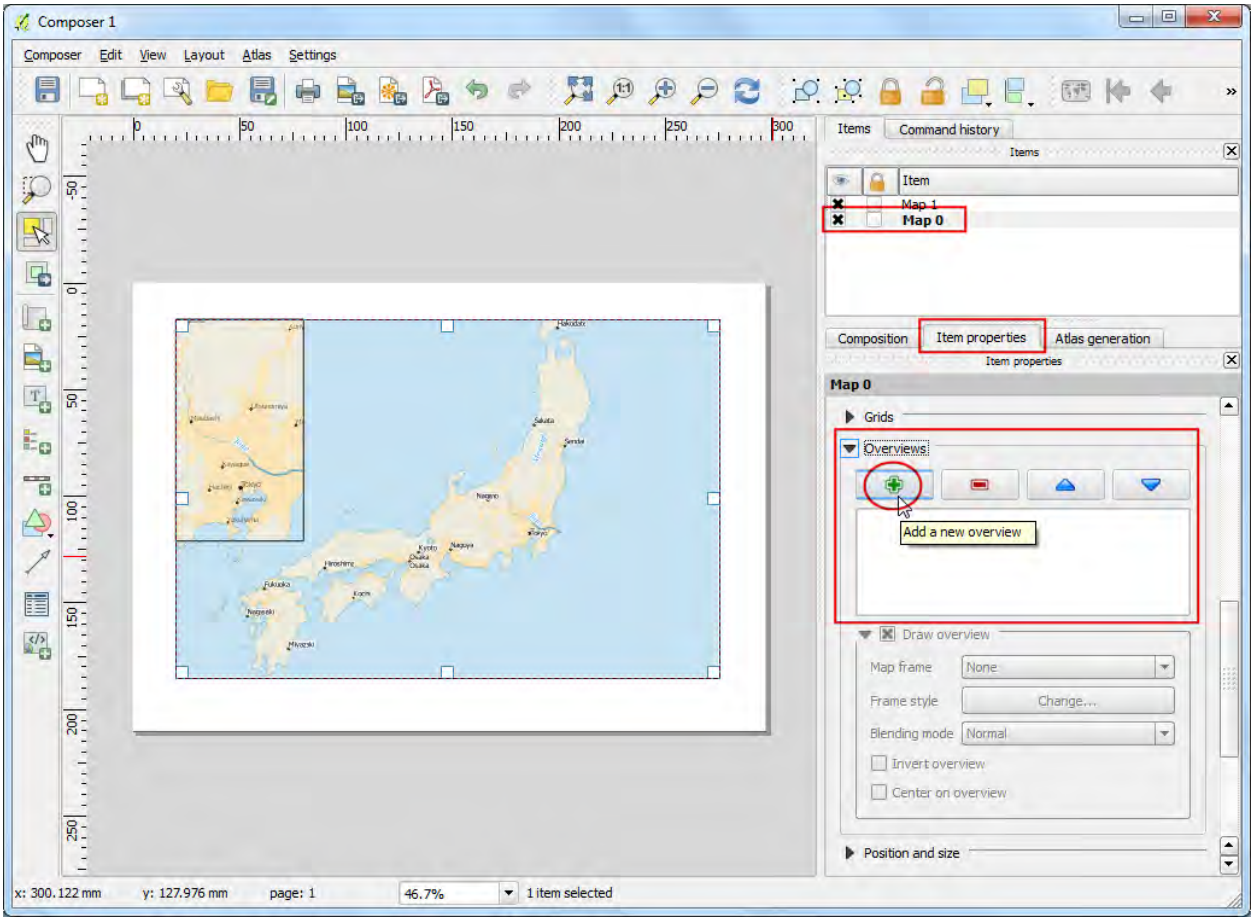
1.2.17 Add inset map – step 2

Drag a rectangle at the place where you want to add the map inset. You will now notice that we have 2 map objects in the Print Composer. When making changes, make sure you have the correct map selected. Select the Map 1 object that we just added from the Items panel. Select the Item properties tab. Scroll down to the Frame panel and check the box next to it. You can change the color and thickness of the frame border so it is easy to distinguish against the map background.

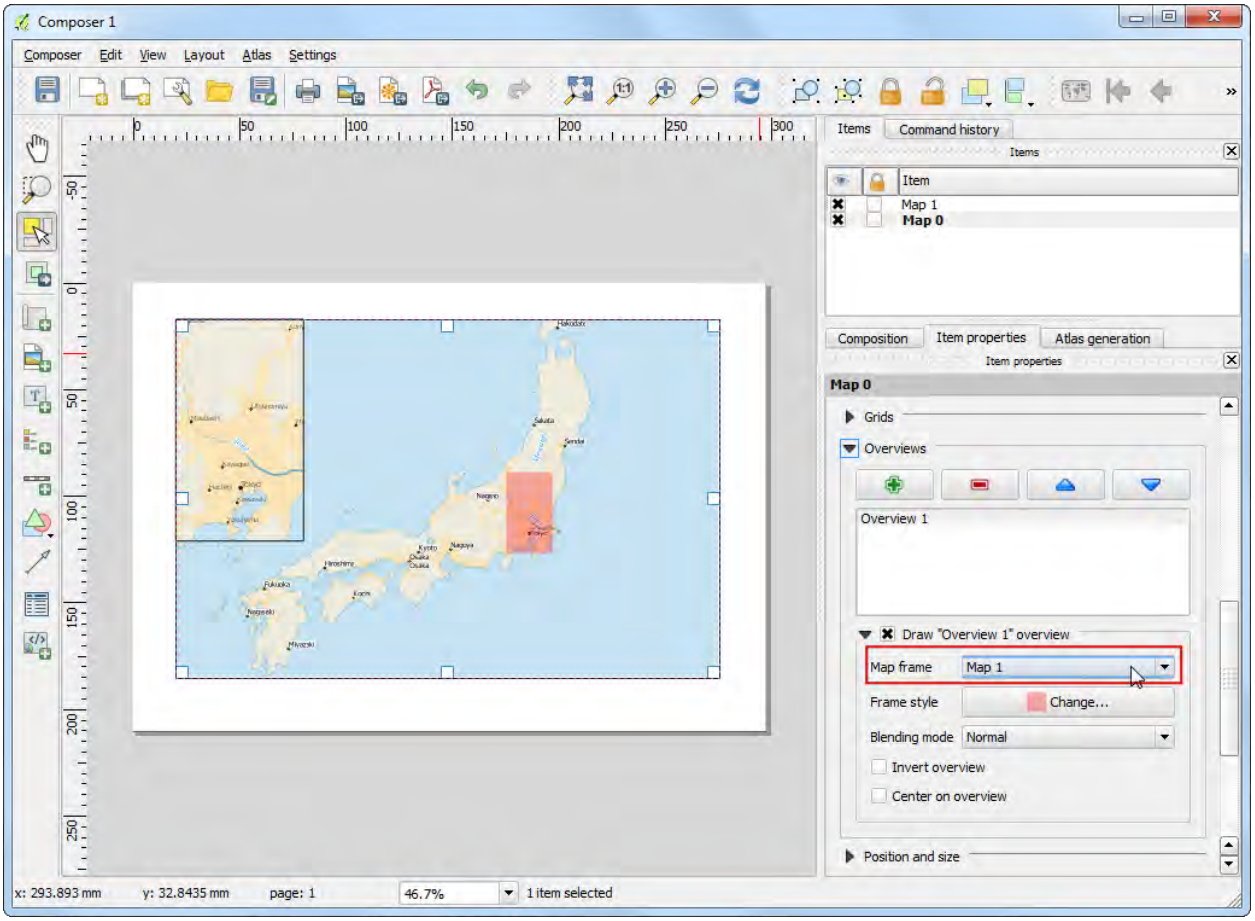


1.2.18 Highlight the inset map area in the main map

One neat feature of the Print Composer is that it can automatically highlight the area from the main map which is represented in our inset. Select the Map 0 object from the Items panel. In the Item properties tab, scroll down to the Overviews section. Click the Add a new overview button.

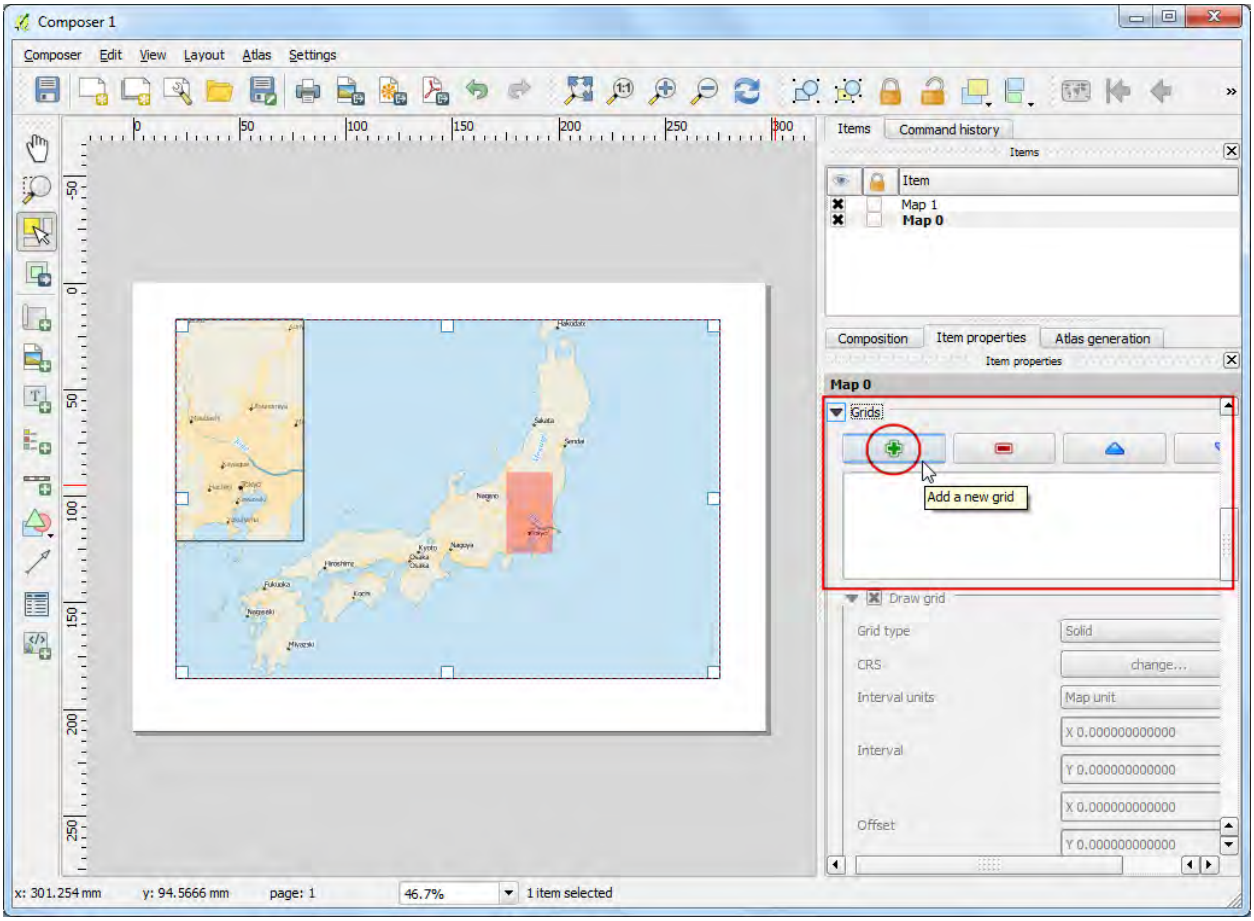


Select Map 1 as the Map Frame. What this is telling the Print Composer is that it must highlight our current object Map 0 with the extent of the map shown in the Map 1 object.

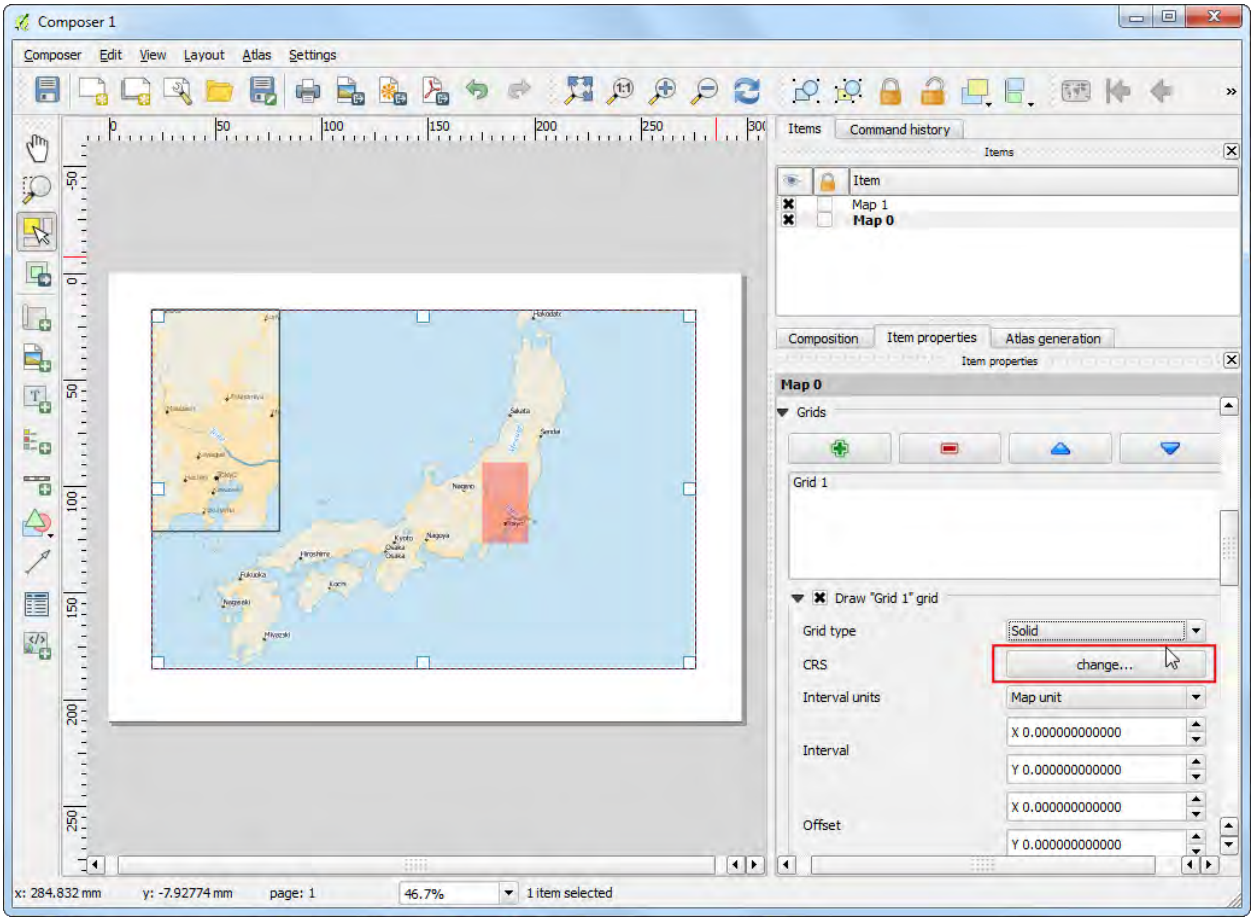


1.2.19 Adding grid

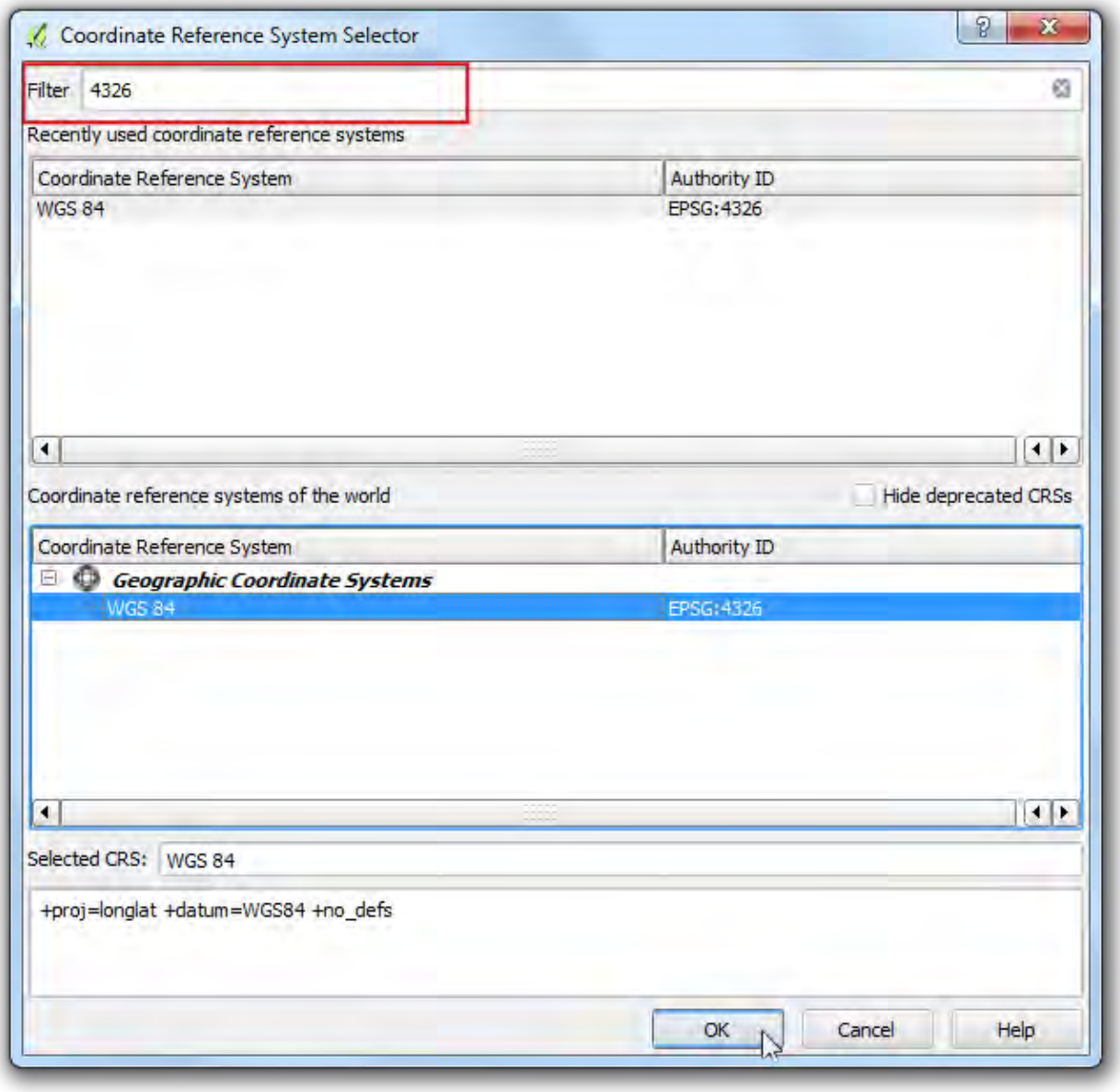
Now that we have the map inset ready, we will add a grid and zebra border to the main map. Select the Map 0 object from the Items panel. In the Item properties tab, scroll down to the Grids section. Click the Add a new grid button.



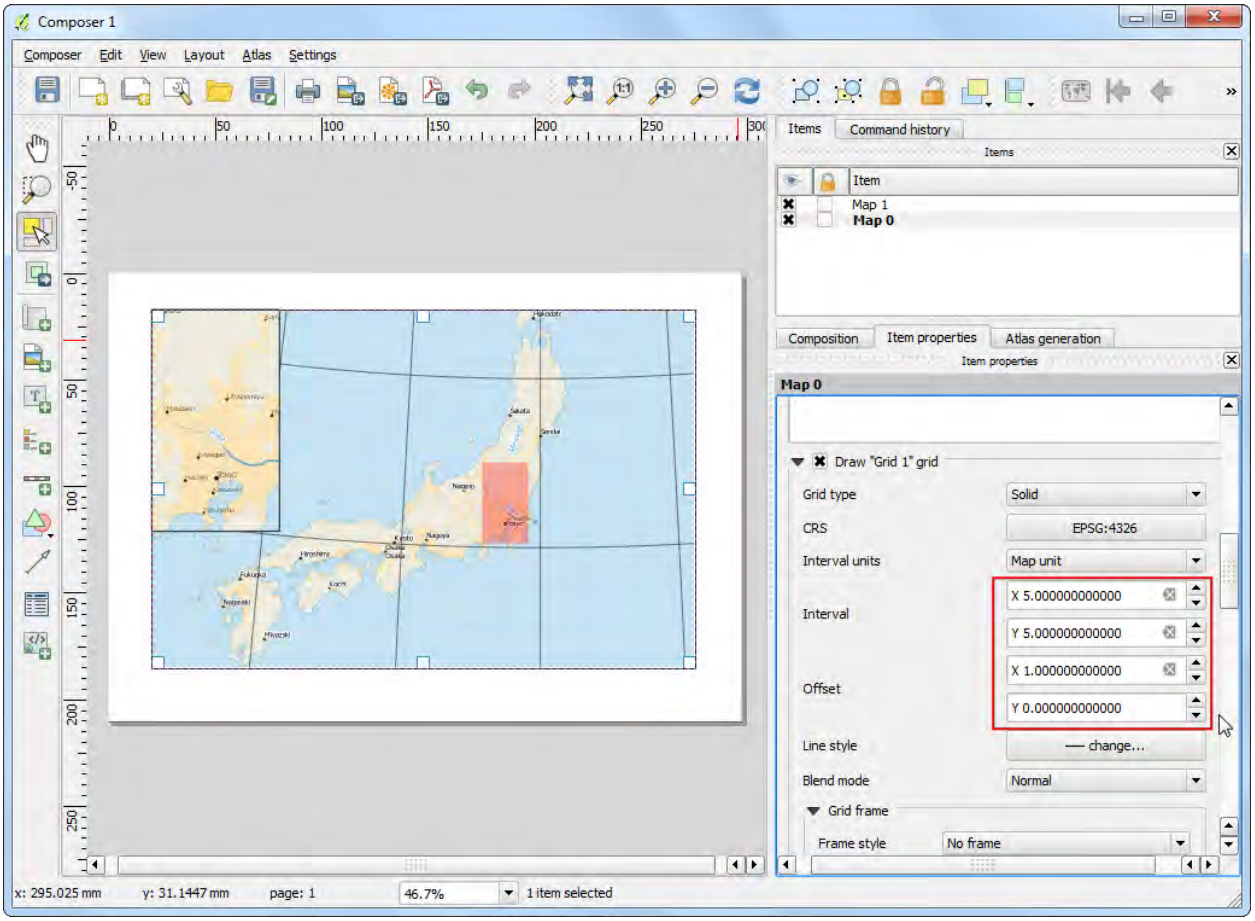
By default, the grid lines use the same units and projections as the currently selected map projections. However, it is more common and useful to display grid lines in degrees. We can select a different CRS for the grid. Click on the change... button next to CRS.



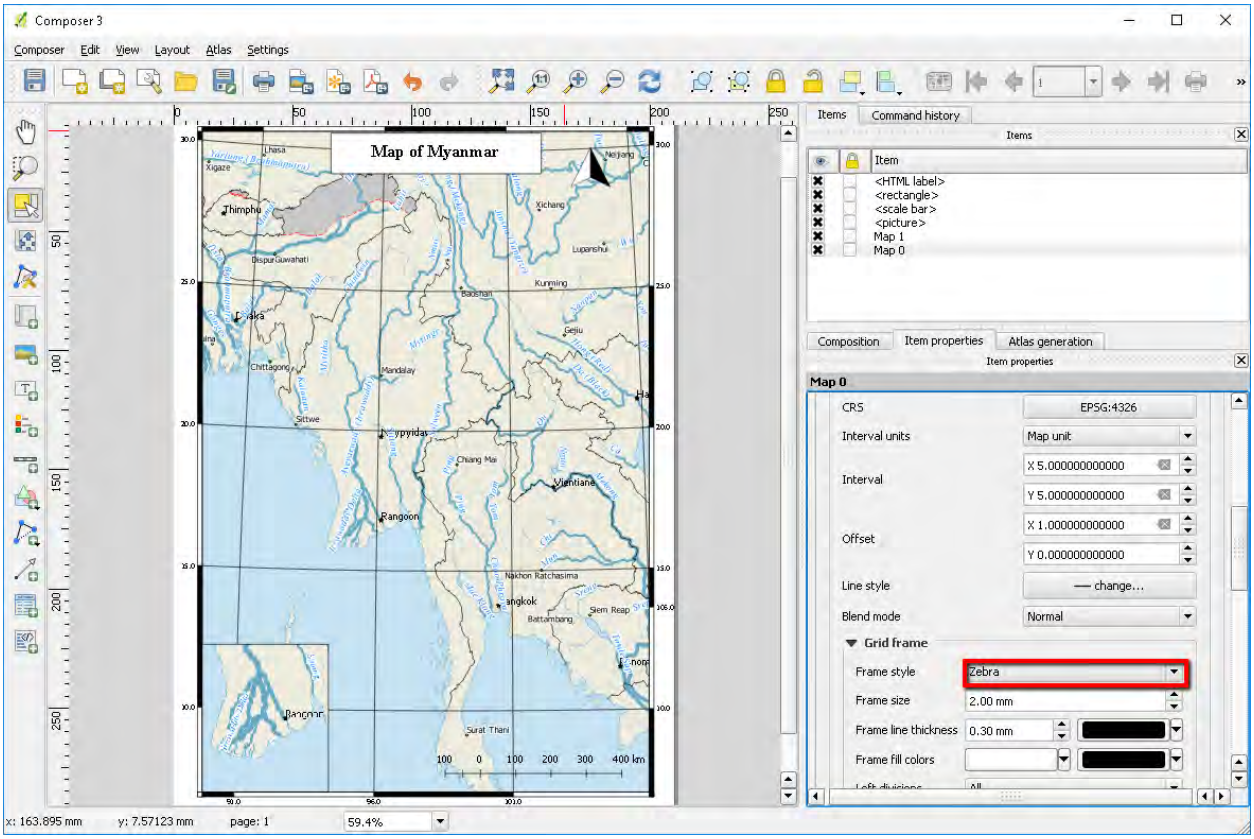
In the Coordinate Reference System Selector dialog, enter 4326 in the Filter box. From the results, select the WGS84 EPSG:4326 as the CRS. Click OK.



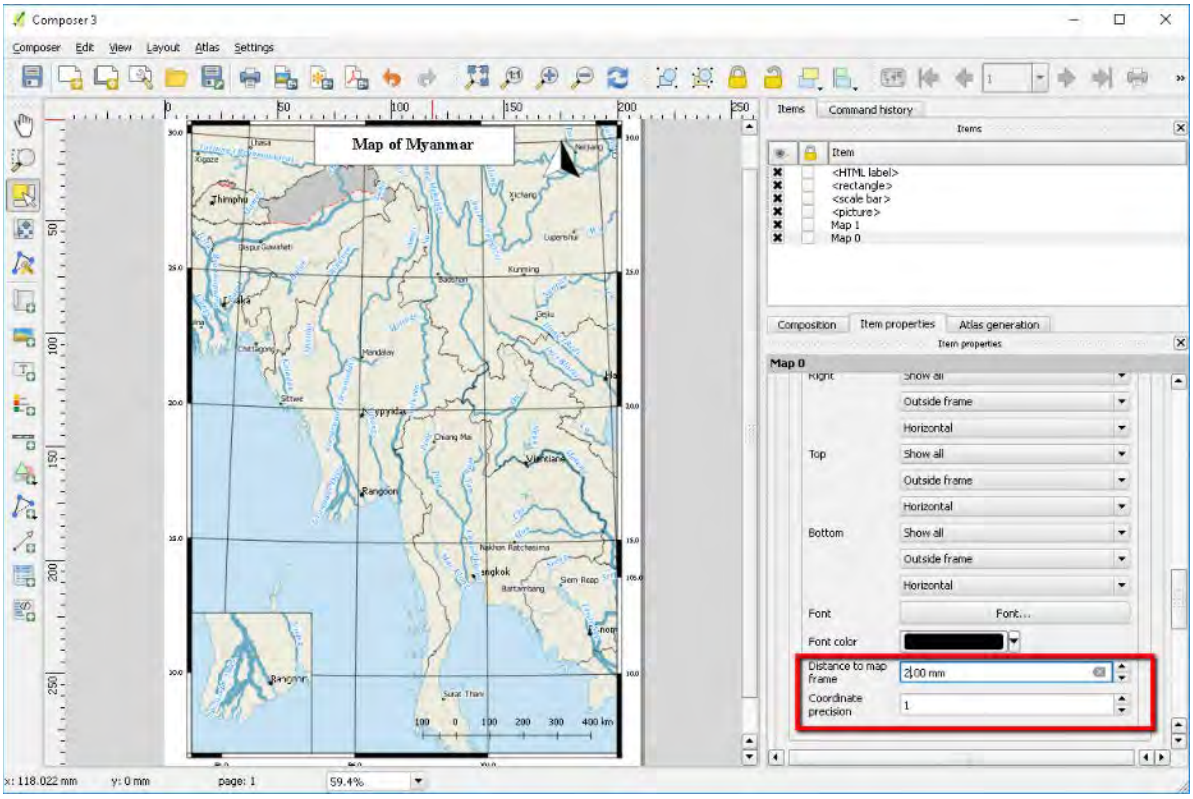
Select the Interval values as 5 degrees in both X and Y direction. You can adjust the Offset to change where the grid lines appear.



Scroll down to the Grid frame section and select a frame style that suits your taste. Also check the Draw coordinates box.

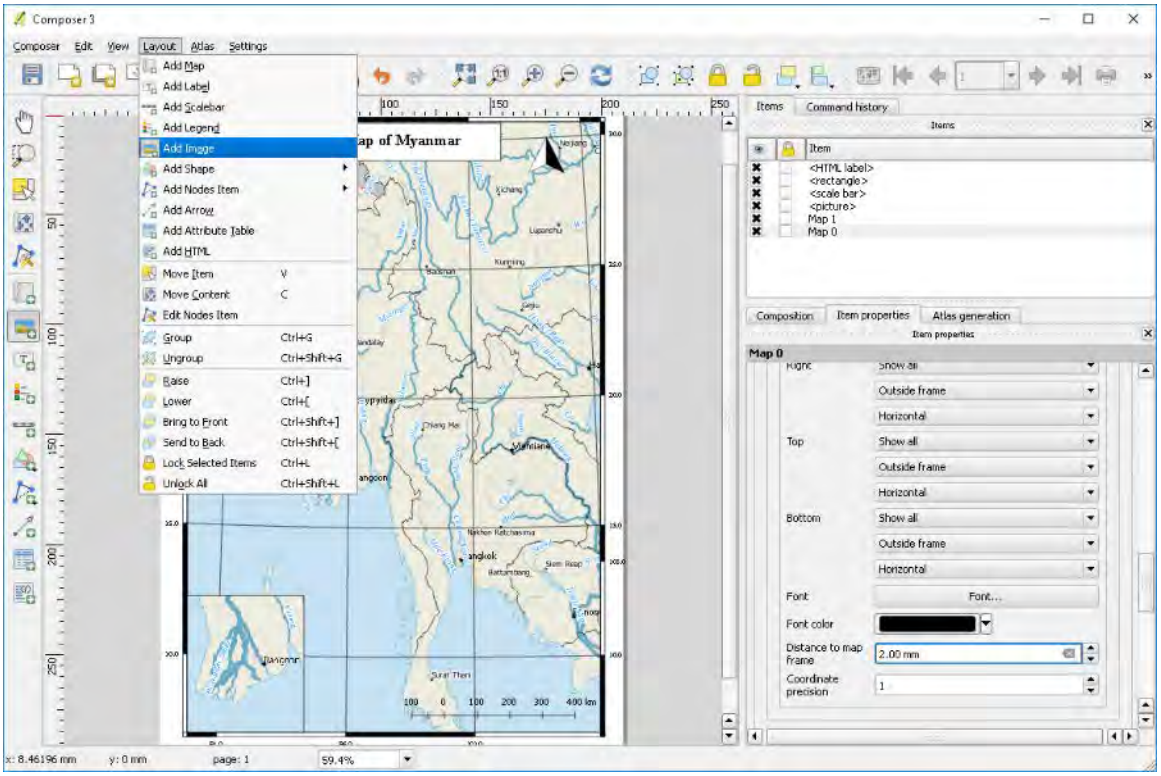


Adjust the Distance to map frame till the coordinates are legible. Change the Coordinate precision to 1 so the coordinates are displayed only upto the first decimal

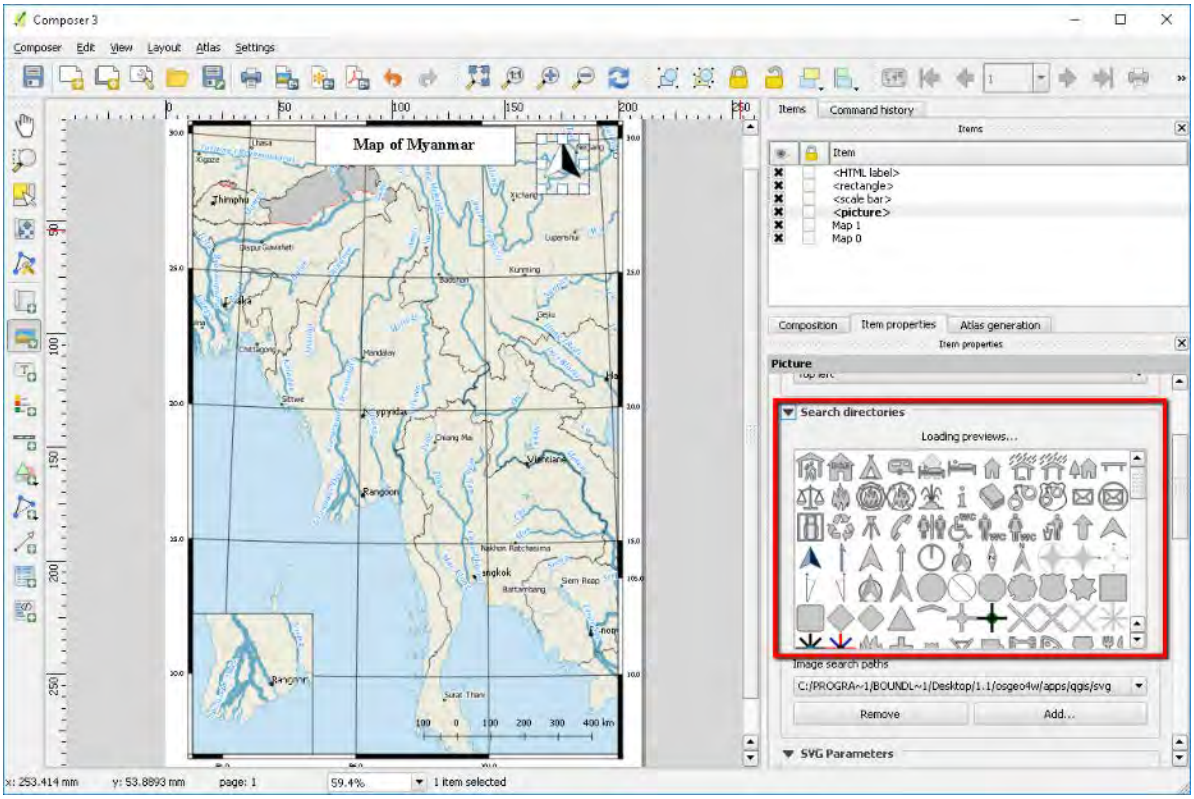


1.2.20 Adding North arrow

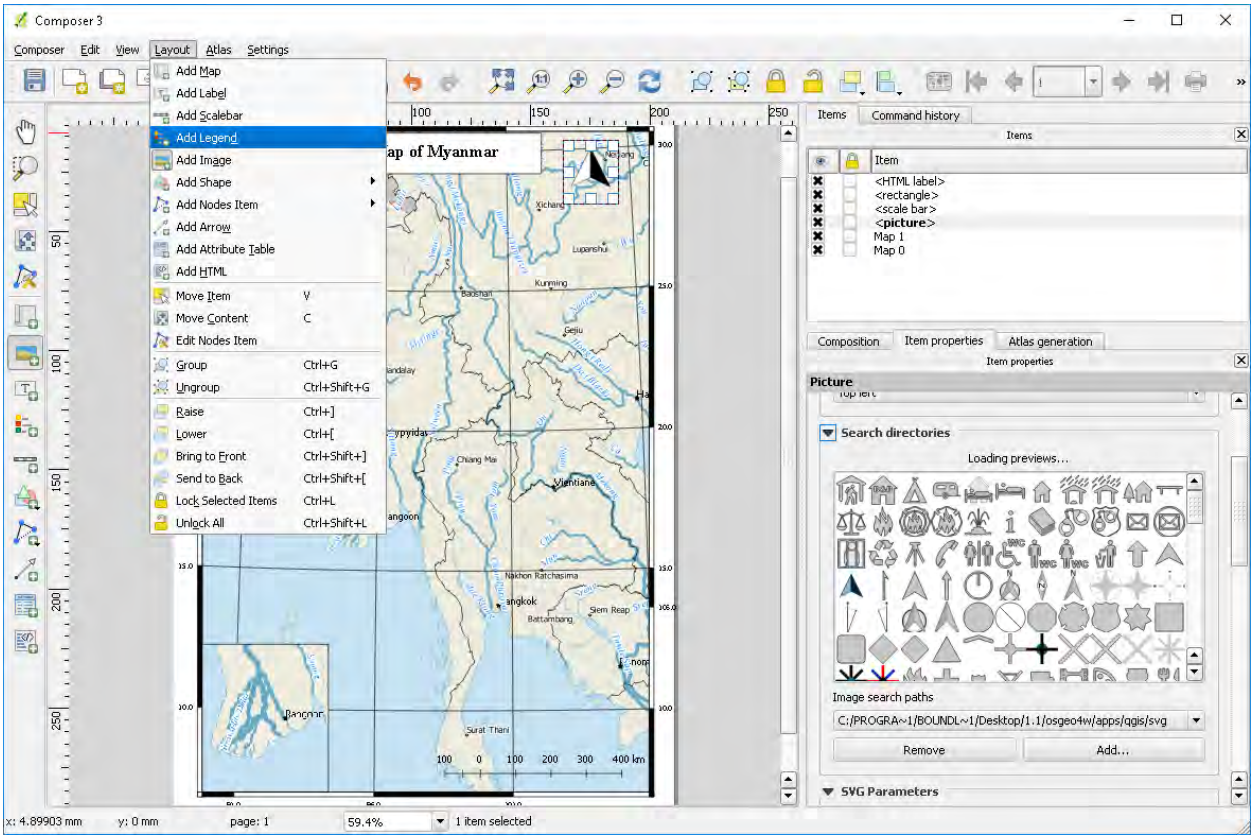
Now we will add a North Arrow to the map. The Print Composer comes with a nice collection of map-related images - including many types of North Arrows. Click Layout ▸ Add Image.



Holding your left mouse button, draw a rectangle on the top-right corner of the map canvas. On the right-hand panel, click on the Item Properties tab and expand the Search directories section and select the North Arrow image of your liking.



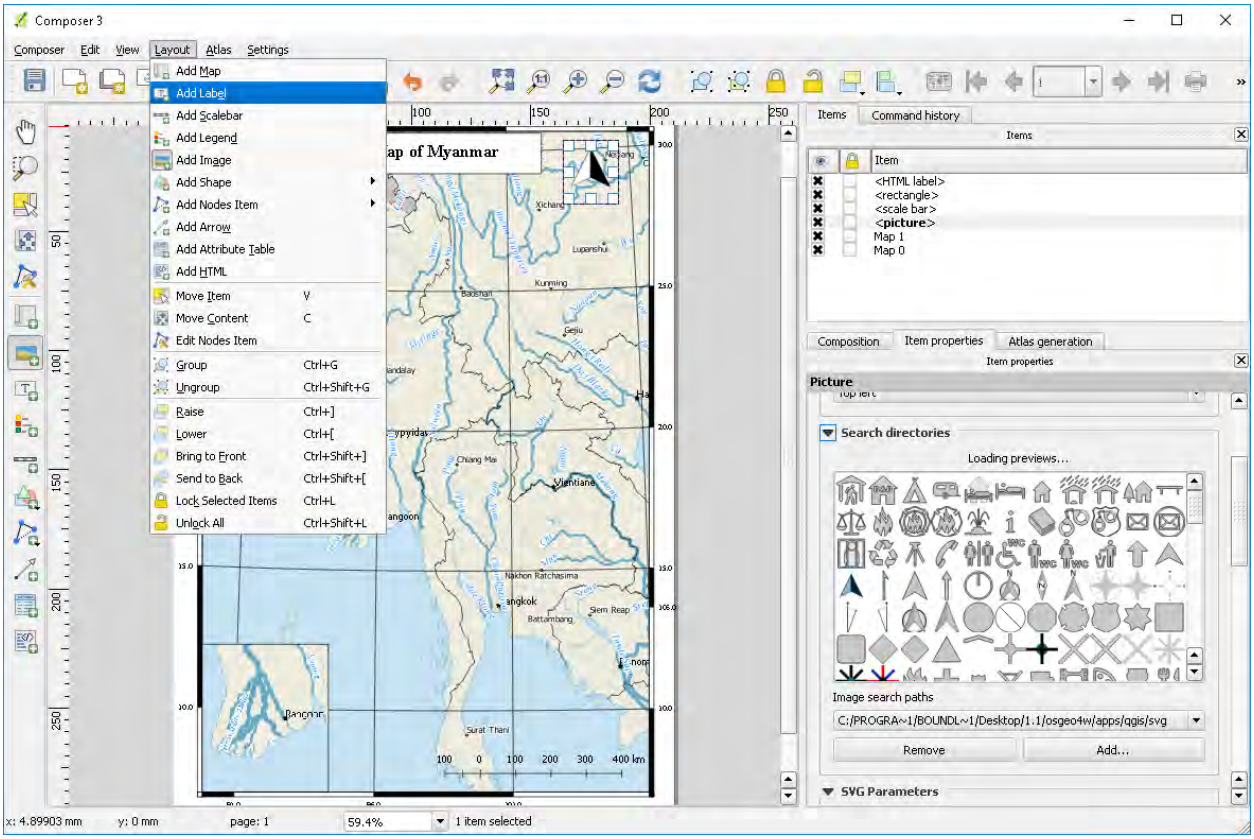
Now we will add a scale bar. Click on Layout ‣ Add Scalebar.



Click on the layout where you want the scalebar to appear. In the Item Properties tab, make sure you have chosen the correct map element for which to display the scalebar. Choose the Style that fit your requirement. In the Segments panel, you can adjust the number of segments and their size.

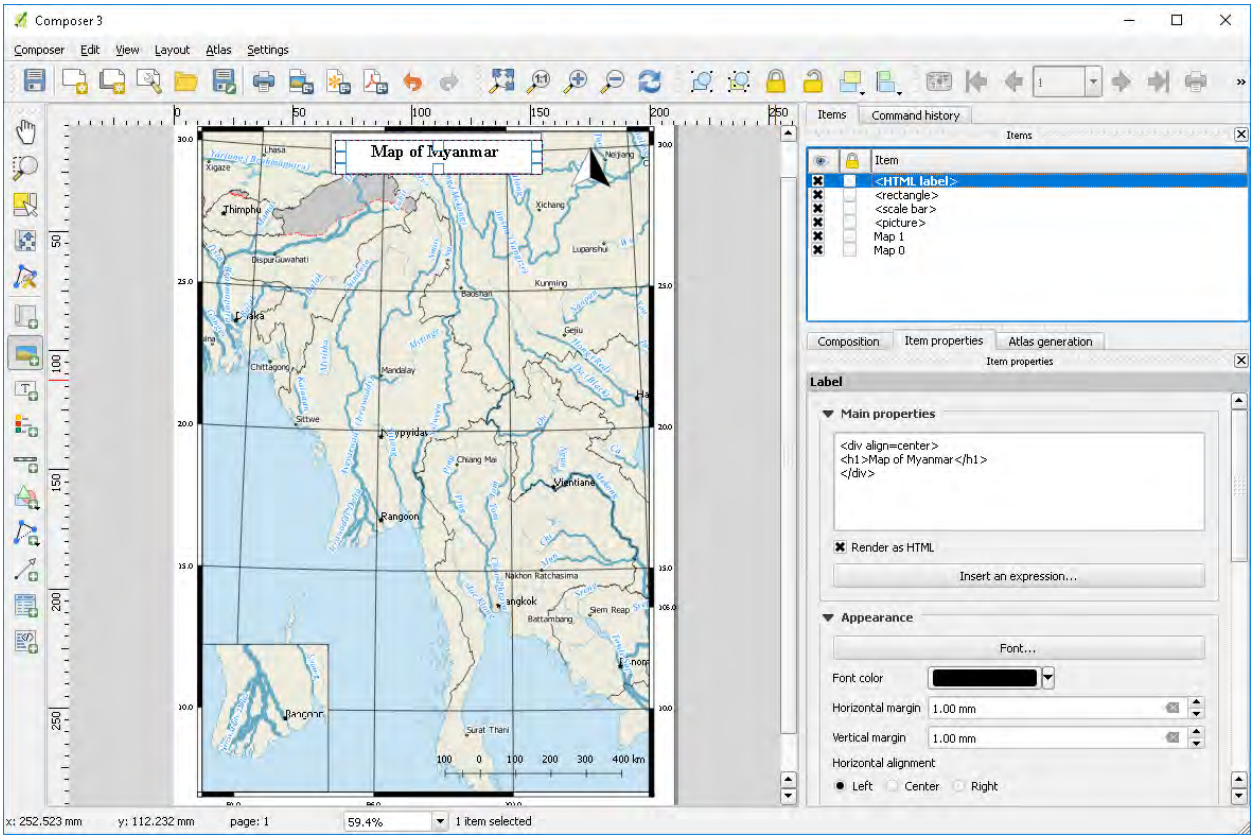
1.2.21 Add label

It is time to label our map. Click on Layout ▸ Add Label.



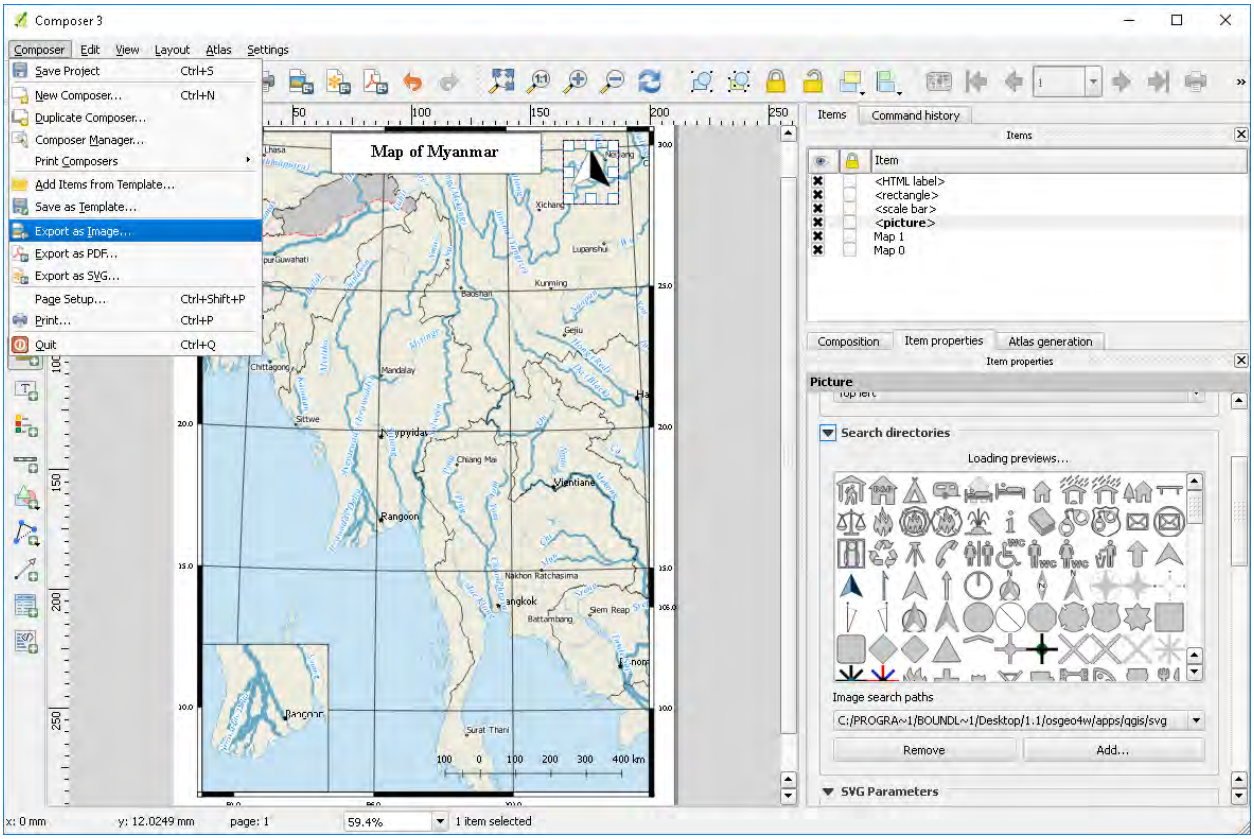
Click on the map and draw a box where the label should be. In the Item Properties tab, expand the Label section and enter the text as shown below. We can enter the text as HTML as well. Check the box Render as Html so the composer will interpret the HTML tags.

```
<div align=center>
<h1>Map of Myanmar</h1>
</div>
```



Similarly add another label to add the data and software credits.

Once you are satisfied with the map, you can export it as Image, PDF or SVG. For this tutorial, let's export it as an image. ClickComposer ▸ Export as Image.



Save the image in the format of your liking. Below is the exported PNG image.


Map of Myanmar
Lhasa
Xigaze
Thimphu
Dispur
Guwahati
Chittagong
Sittwe
Mandalay
Rangoon
Baoshan
Kunming
Xichang
Lupanshui
Neijiang
Gejiu
Chiang Mai
Vientiane
Nakhon Ratchasima
Battambang
Siem Reap
Surat Thani
Chindwin
Mytinge
Mytitha
Kaladan
Ayeyarwady (Irrawaddy)
Irrawaddy Delta
Salween
Sittong
Lancang (Mekong)
Jinsha (Yangtze)
Ping
Yom
Mekong
Chi
Mun
Chao Phraya
Brahmaputra
Ganges
Tista
Hong (Red)
Da (Black)
Ou
Ngum
Nanpan
Tonle Sap
Rangoon
100 0 100 200 300 400 km
91.0
96.0
101.0
106.0
30.0
25.0
20.0
15.0
10.0

2 WORKING WITH ATTRIBUTE DATA

GIS data has two parts - features and attributes. Attributes are structured data about each feature. This tutorial shows how to view the attributes and do basic queries on them in QGIS.

2.1 Overview of the task

The dataset for this tutorial contains information about populated places of the world. The task is to query and find all the capital cities in the world that have a population greater than 1,000,000.

Other skills you will learn

Select features from a layer using expressions.

Deselect features from a layer using the Attributes toolbar.

Using Query Builder to show a subset of features from a layer.

Getting the data

Natural Earth has a nice Populated Places dataset. Download the simple (less columns) dataset

For convenience, you may directly download a copy of datasets from the link below:

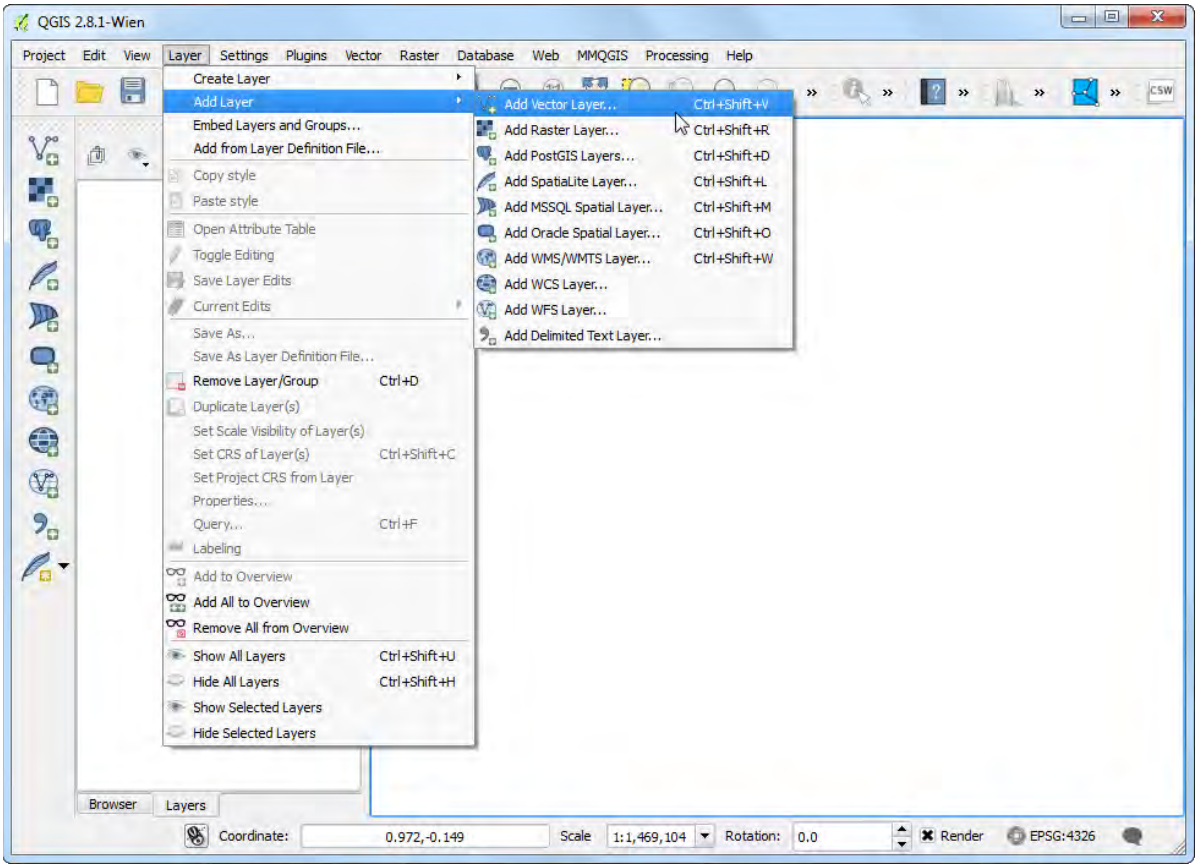
ne_10m_populated_places_simple.zip

Data Source [NATURALEARTH]

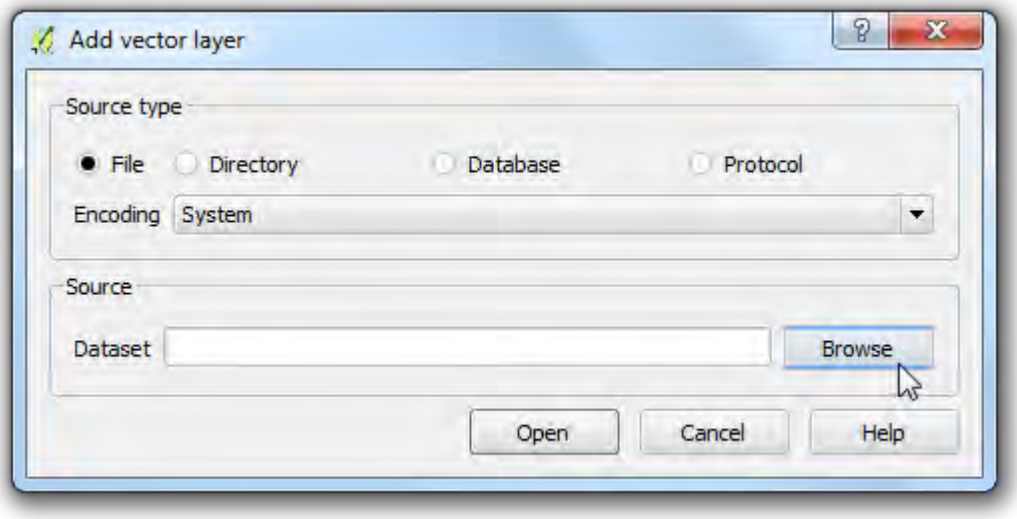
2.2 Procedure

2.2.1 Step 1. Adding data

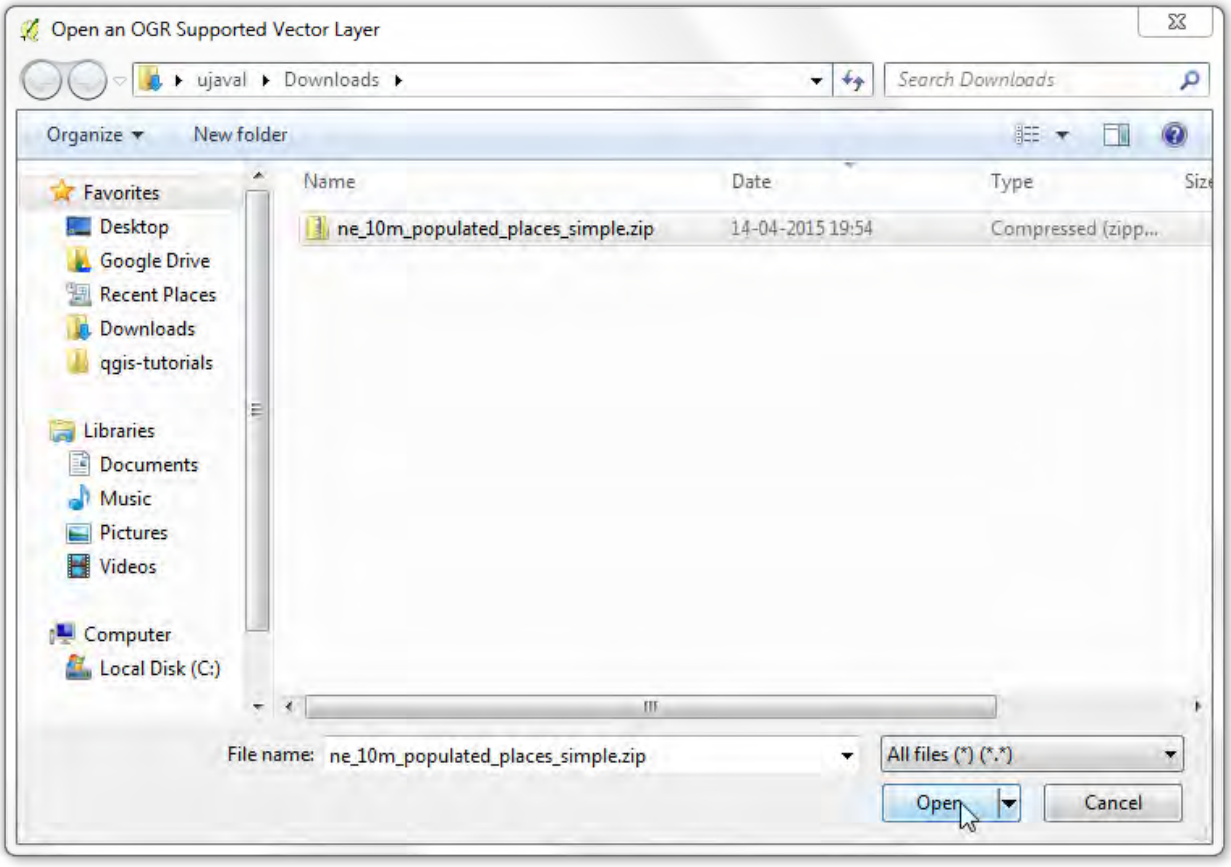
Once you have downloaded the data, open QGIS. Go to Layer ‣ Add Layer ‣ Add Vector Layer.



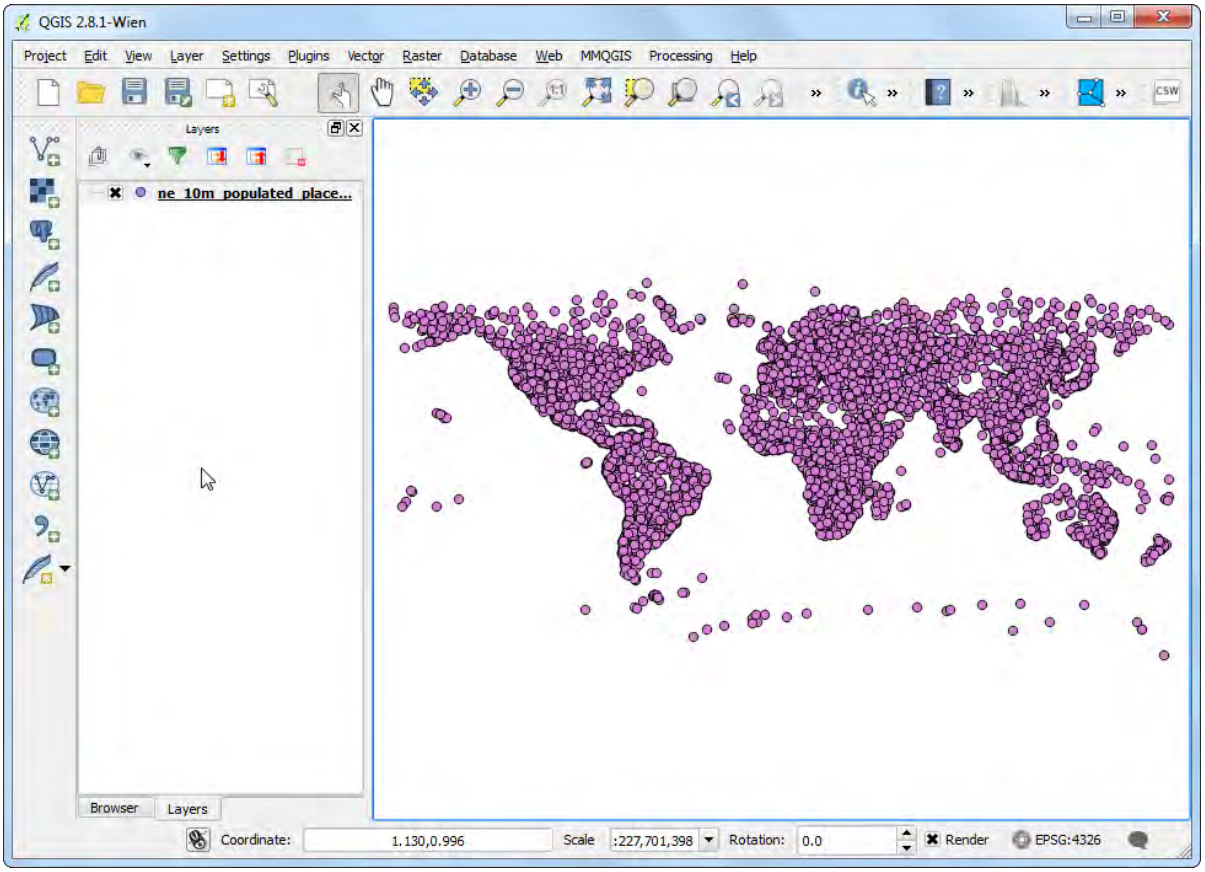
Click on Browse and navigate to the folder where you downloaded the data.



Locate the downloaded zip file ne_10m_populated_places_simple.zip. You do not need to unzip the file. QGIS has the ability to read zip files directly. Select the file and click Open.

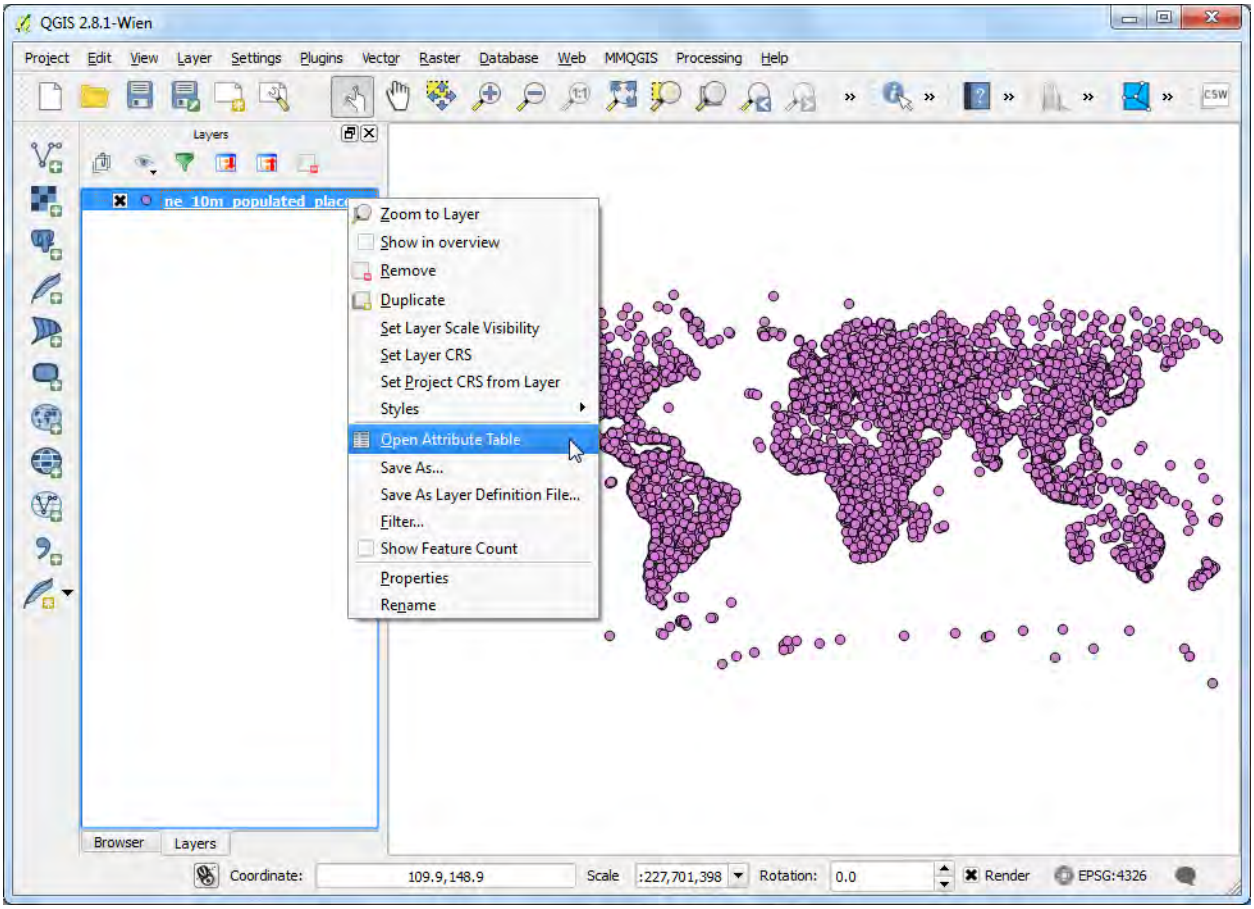


The selected layer will now be loaded in QGIS and you will see many points representing the populated places of the world.

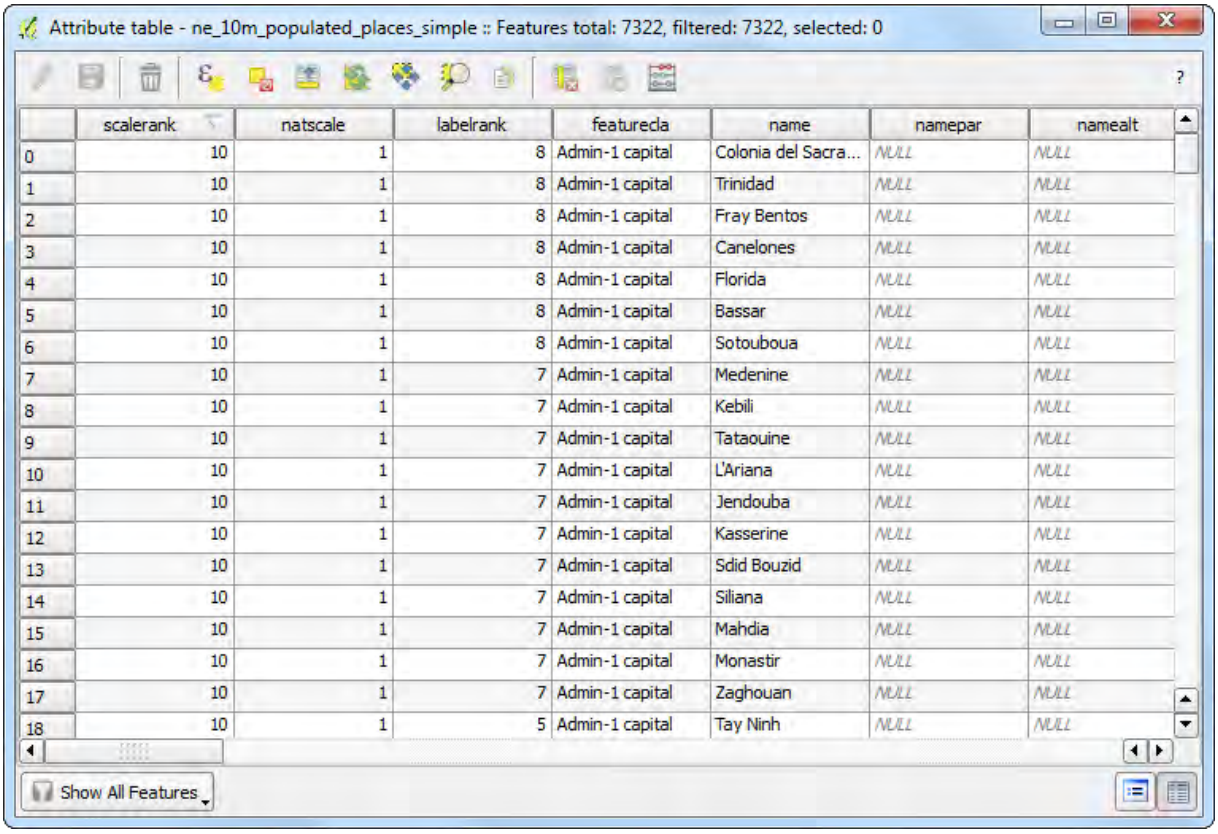


2.2.2 Viewing attribute

Right-click the layer and select Open Attribute Table.

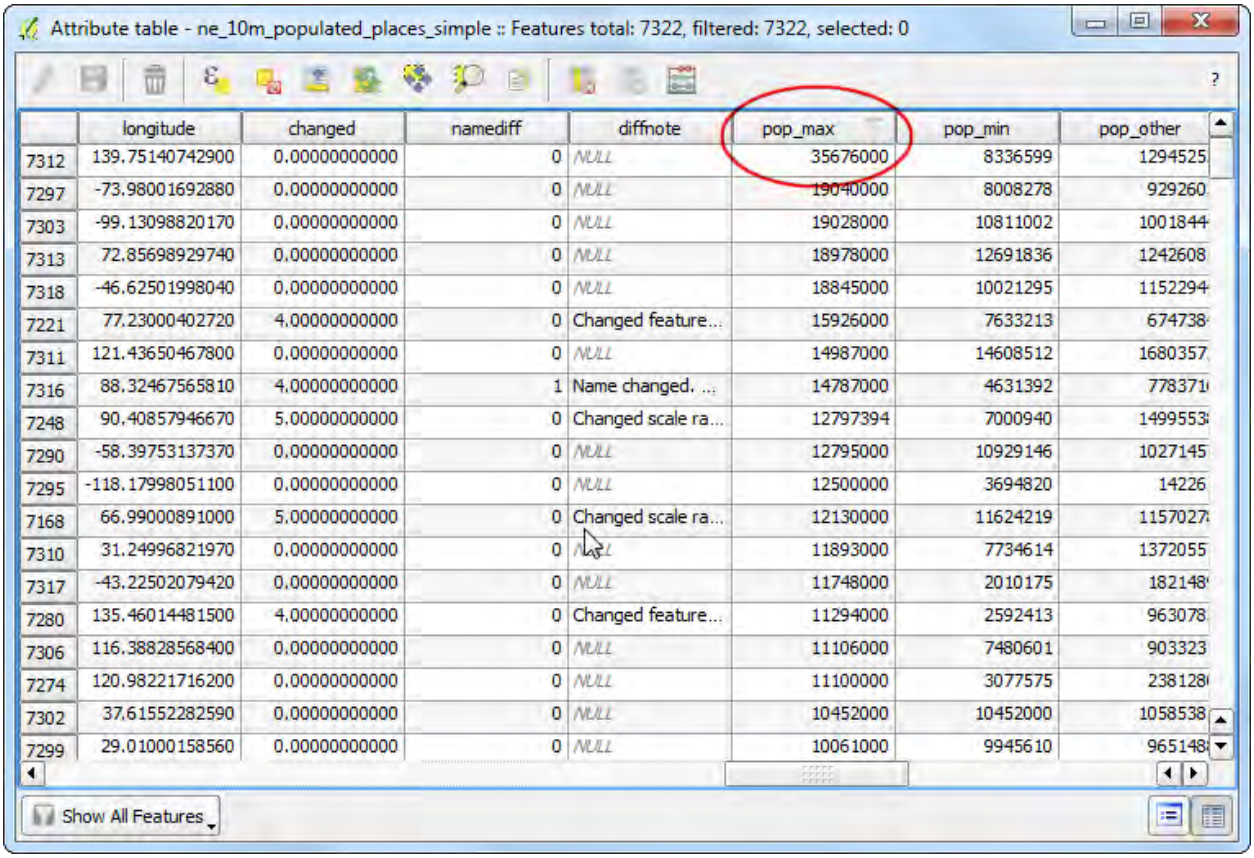


Explore the various attributes and their values.



	scalerank	natscale	labelrank	featurecla	name	namepar	namealt
0	10	1	8	Admin-1 capital	Colonia del Sacra...	NULL	NULL
1	10	1	8	Admin-1 capital	Trinidad	NULL	NULL
2	10	1	8	Admin-1 capital	Fray Bentos	NULL	NULL
3	10	1	8	Admin-1 capital	Canelones	NULL	NULL
4	10	1	8	Admin-1 capital	Florida	NULL	NULL
5	10	1	8	Admin-1 capital	Bassar	NULL	NULL
6	10	1	8	Admin-1 capital	Sotouboua	NULL	NULL
7	10	1	7	Admin-1 capital	Medenine	NULL	NULL
8	10	1	7	Admin-1 capital	Kebili	NULL	NULL
9	10	1	7	Admin-1 capital	Tataouine	NULL	NULL
10	10	1	7	Admin-1 capital	L'Ariana	NULL	NULL
11	10	1	7	Admin-1 capital	Jendouba	NULL	NULL
12	10	1	7	Admin-1 capital	Kasserine	NULL	NULL
13	10	1	7	Admin-1 capital	Sdid Bouzid	NULL	NULL
14	10	1	7	Admin-1 capital	Siliana	NULL	NULL
15	10	1	7	Admin-1 capital	Mahdia	NULL	NULL
16	10	1	7	Admin-1 capital	Monastir	NULL	NULL
17	10	1	7	Admin-1 capital	Zaghouan	NULL	NULL
18	10	1	5	Admin-1 capital	Tay Ninh	NULL	NULL

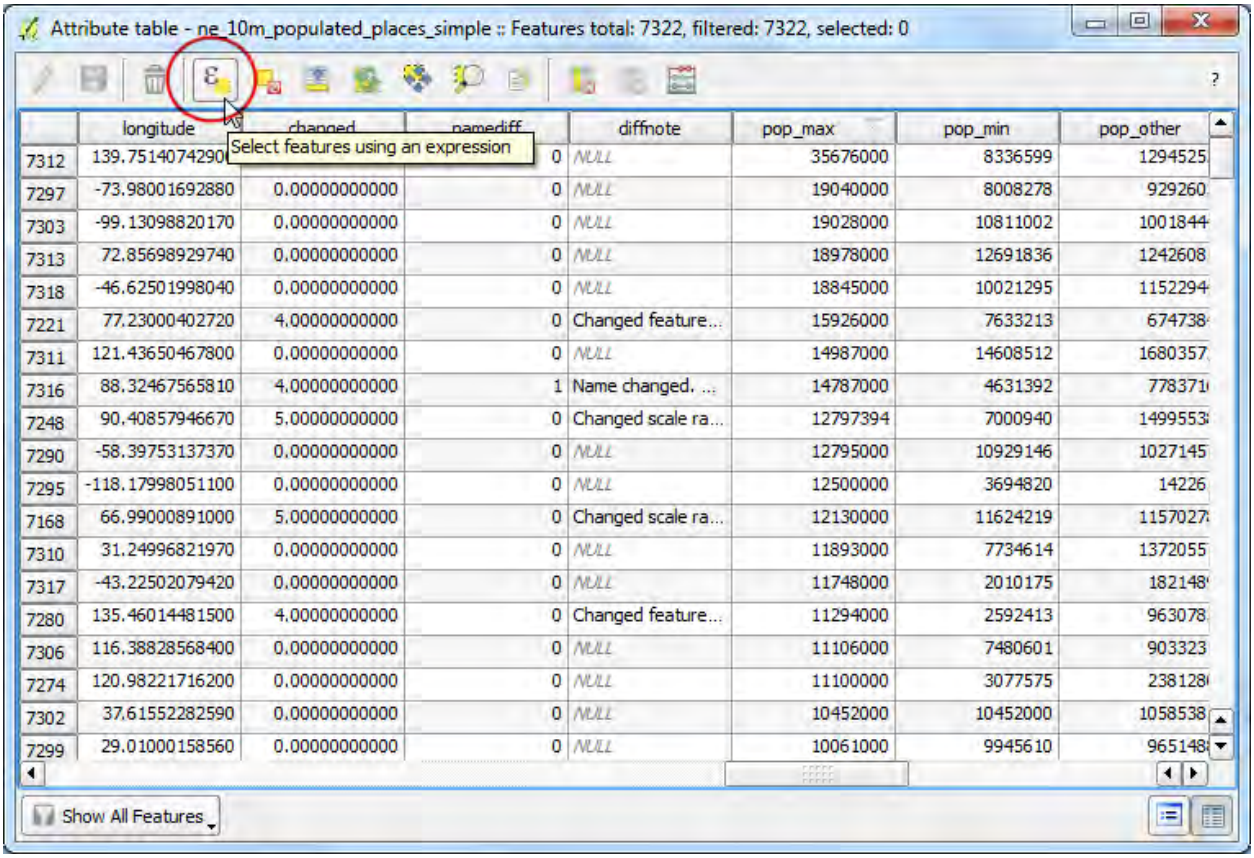
We are interested in the population of each feature, so pop_max is the field we are looking for. You can click twice on the field header to sort the column in descending order.



	longitude	changed	namediff	diffnote	pop_max	pop_min	pop_other
7312	139.75140742900	0.00000000000	0	NULL	35676000	8336599	1294525
7297	-73.98001692880	0.00000000000	0	NULL	19040000	8008278	929260
7303	-99.13098820170	0.00000000000	0	NULL	19028000	10811002	1001844
7313	72.85698929740	0.00000000000	0	NULL	18978000	12691836	1242608
7318	-46.62501998040	0.00000000000	0	NULL	18845000	10021295	1152294
7221	77.23000402720	4.00000000000	0	Changed feature...	15926000	7633213	674738
7311	121.43650467800	0.00000000000	0	NULL	14987000	14608512	1680357
7316	88.32467565810	4.00000000000	1	Name changed. ...	14787000	4631392	778371
7248	90.40857946670	5.00000000000	0	Changed scale ra...	12797394	7000940	1499553
7290	-58.39753137370	0.00000000000	0	NULL	12795000	10929146	1027145
7295	-118.17998051100	0.00000000000	0	NULL	12500000	3694820	14226
7168	66.99000891000	5.00000000000	0	Changed scale ra...	12130000	11624219	1157027
7310	31.24996821970	0.00000000000	0	NULL	11893000	7734614	1372055
7317	-43.22502079420	0.00000000000	0	NULL	11748000	2010175	182148
7280	135.46014481500	4.00000000000	0	Changed feature...	11294000	2592413	963078
7306	116.38828568400	0.00000000000	0	NULL	11106000	7480601	903323
7274	120.98221716200	0.00000000000	0	NULL	11100000	3077575	238128
7302	37.61552282590	0.00000000000	0	NULL	10452000	10452000	1058538
7299	29.01000158560	0.00000000000	0	NULL	10061000	9945610	965148

2.2.3 Query the data

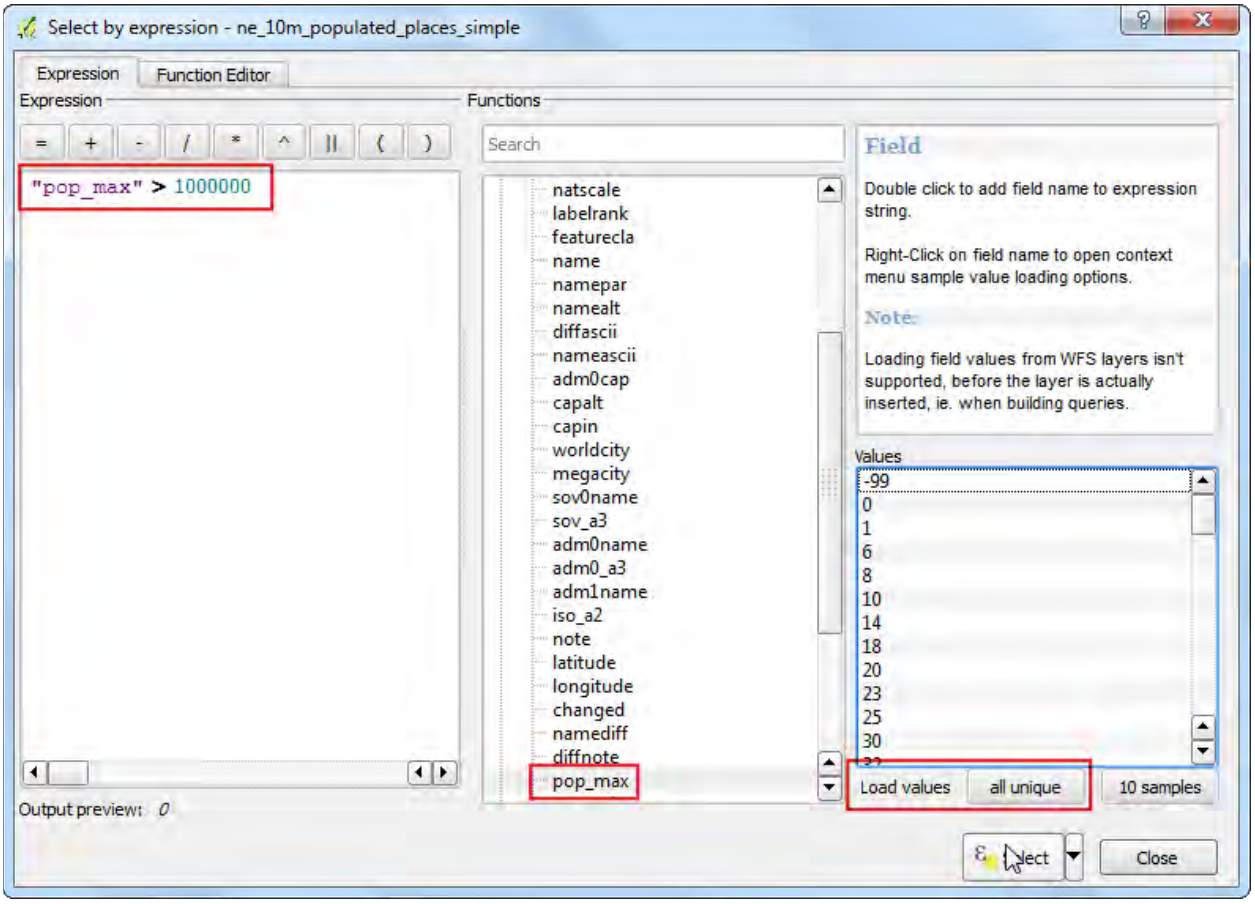
Now we are ready to perform our query on these attributes. QGIS uses SQL-like expressions to perform queries. Click Select features using an expression.



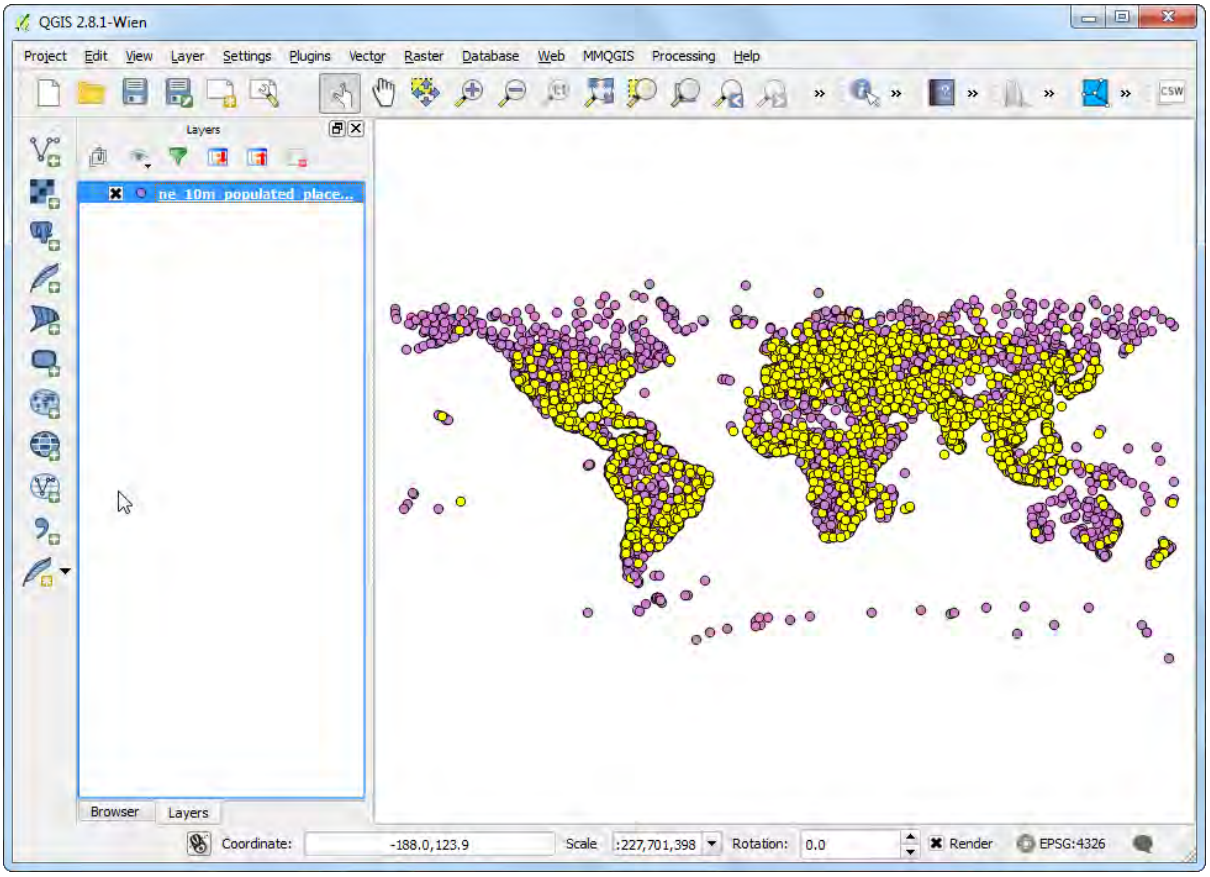
	longitude	changed	namediff	diffnote	pop_max	pop_min	pop_other
7312	139.7514074290		0	NULL	35676000	8336599	1294525
7297	-73.98001692880	0.00000000000	0	NULL	19040000	8008278	929260
7303	-99.13098820170	0.00000000000	0	NULL	19028000	10811002	1001844
7313	72.85698929740	0.00000000000	0	NULL	18978000	12691836	1242608
7318	-46.62501998040	0.00000000000	0	NULL	18845000	10021295	1152294
7221	77.23000402720	4.00000000000	0	Changed feature...	15926000	7633213	674738
7311	121.43650467800	0.00000000000	0	NULL	14987000	14608512	1680357
7316	88.32467565810	4.00000000000	1	Name changed. ...	14787000	4631392	778371
7248	90.40857946670	5.00000000000	0	Changed scale ra...	12797394	7000940	1499553
7290	-58.39753137370	0.00000000000	0	NULL	12795000	10929146	1027145
7295	-118.17998051100	0.00000000000	0	NULL	12500000	3694820	14226
7168	66.99000891000	5.00000000000	0	Changed scale ra...	12130000	11624219	1157027
7310	31.24996821970	0.00000000000	0	NULL	11893000	7734614	1372055
7317	-43.22502079420	0.00000000000	0	NULL	11748000	2010175	182148
7280	135.46014481500	4.00000000000	0	Changed feature...	11294000	2592413	963078
7306	116.38828568400	0.00000000000	0	NULL	11106000	7480601	903323
7274	120.98221716200	0.00000000000	0	NULL	11100000	3077575	238128
7302	37.61552282590	0.00000000000	0	NULL	10452000	10452000	1058538
7299	29.01000158560	0.00000000000	0	NULL	10061000	9945610	965148

In the Select By Expression window, expand the Fields and Values section and double-click the **pop_max** label. You will notice that it is added to the expression section at the bottom. If you aren't sure about the field values, you can click the Load all unique values to see what the attribute values are present in the dataset. For this exercise, we are looking to find all features that have a population greater than **1,000,000**. So complete the expression as below and click Select.

```
"pop_max" > 1000000
```

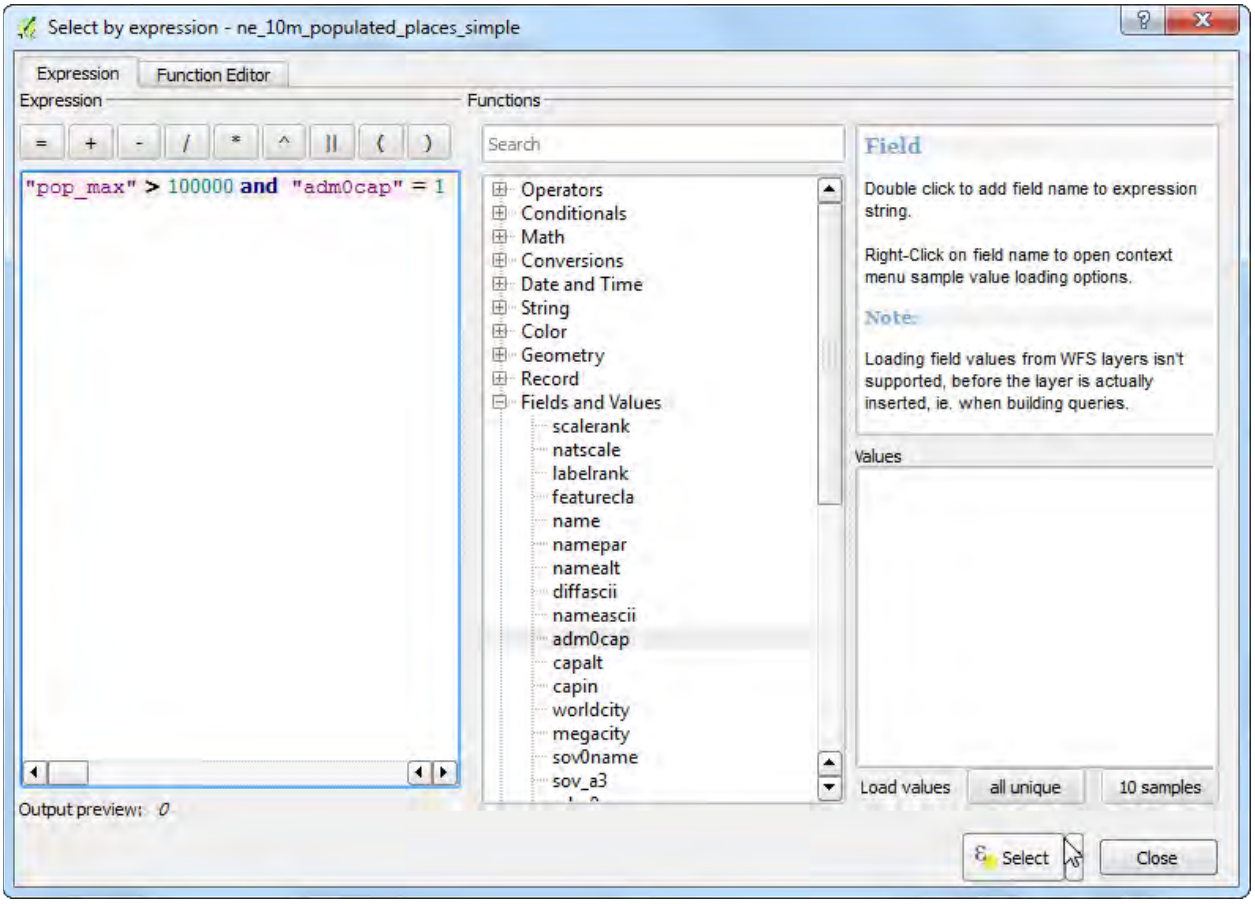


Click on Close and return to the main QGIS window. You will notice that a subset of points is now rendered in yellow. This is the result of our query and you are seeing all places from the dataset that have the **pop_max** attribute value greater than **1,000,000**

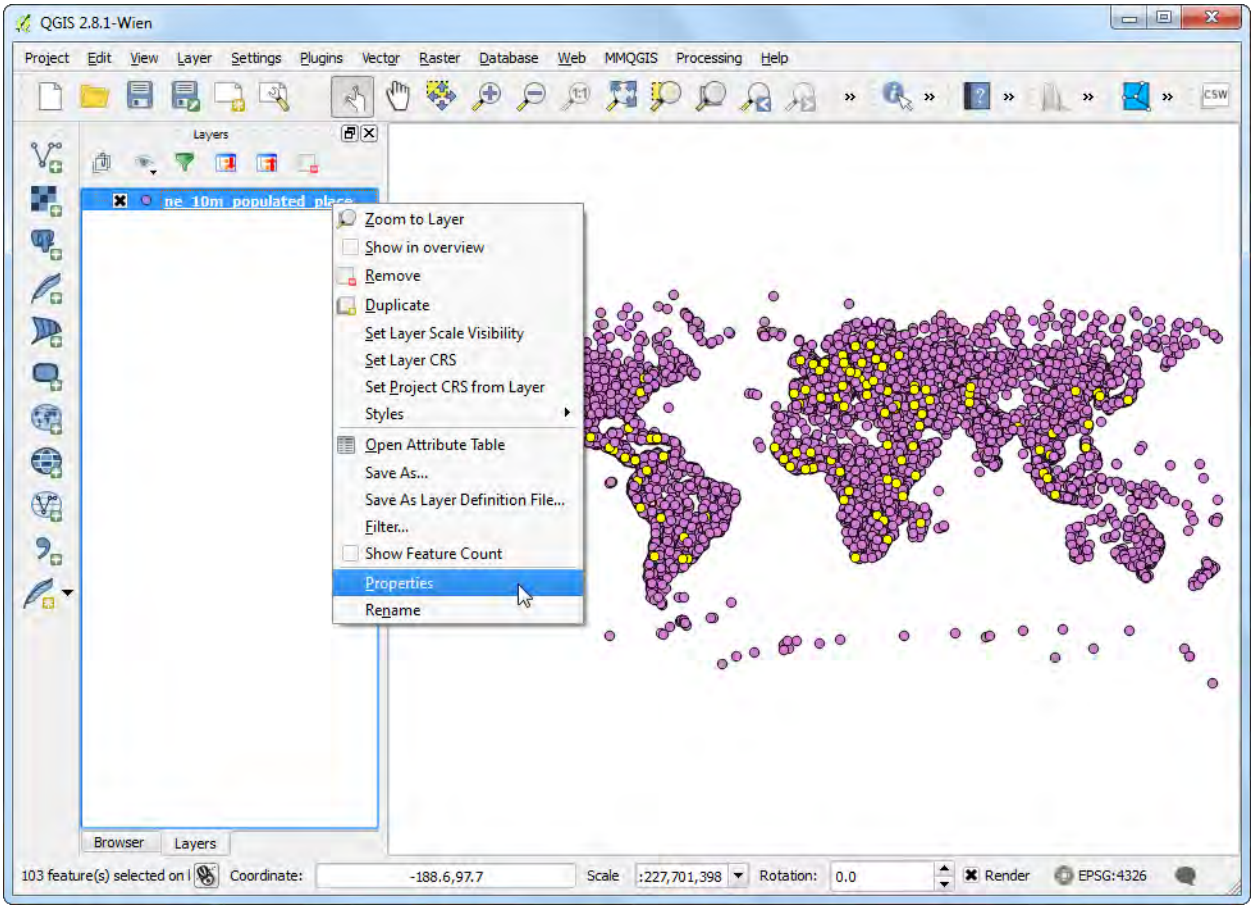


The goal for this exercise is to find the places that are country capitals. The field containing this data is adm0cap. The value 1 indicates that the place is a capital. We can add this criteria to our previous expression using the and operator. Let's refine our query to select only those places which are capitals. Click on the Select feature using an expression button in the attribute table and enter the expression as below and click Select and then Close.

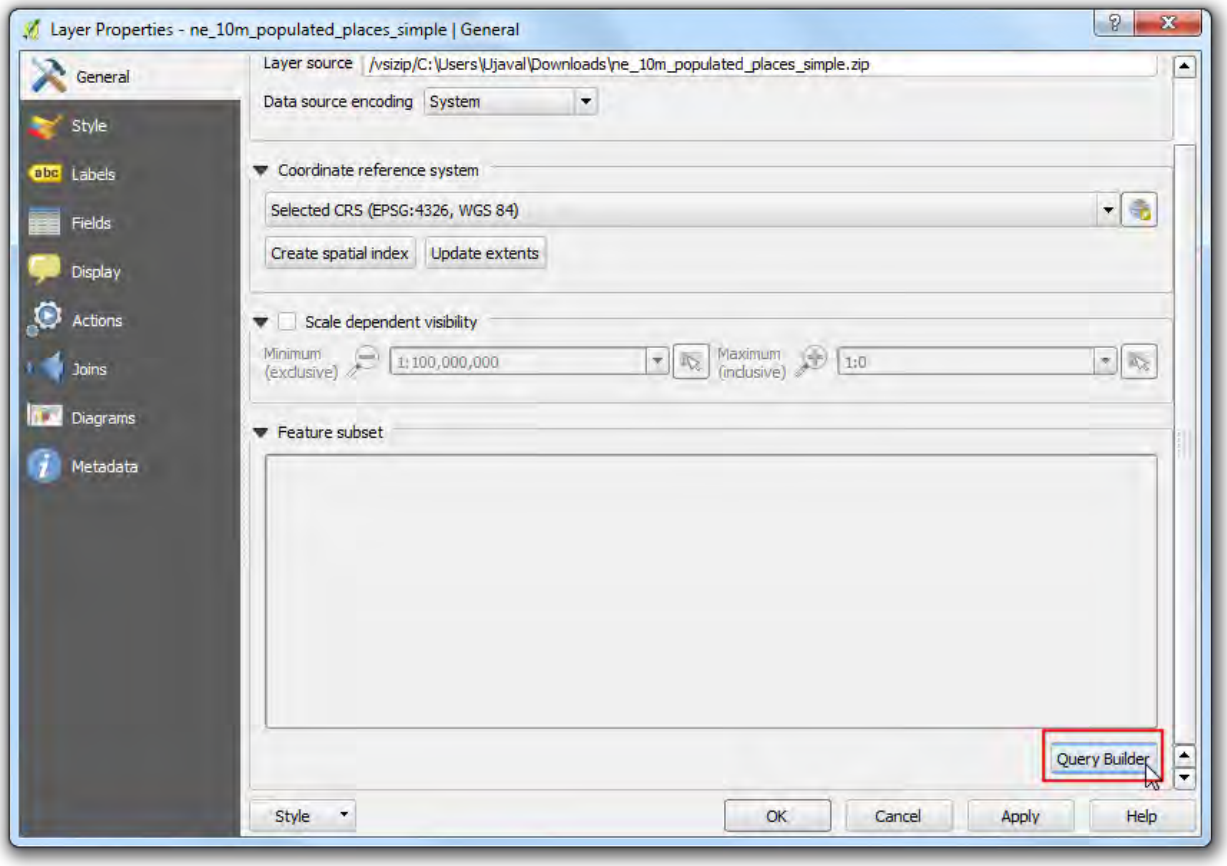
```
"pop_max" > 1000000 and "adm0cap" = 1
```



Return to the main QGIS window. Now you will see a smaller subset of the points selected. This is the result of the second query and shows all places from the dataset that are country capitals as well as have population greater than 1,000,000. If we wanted to do some further analysis on this subset of data, we can make this selection persistent. Right-click the ne_10m_populated_places_simple layer and select Properties.

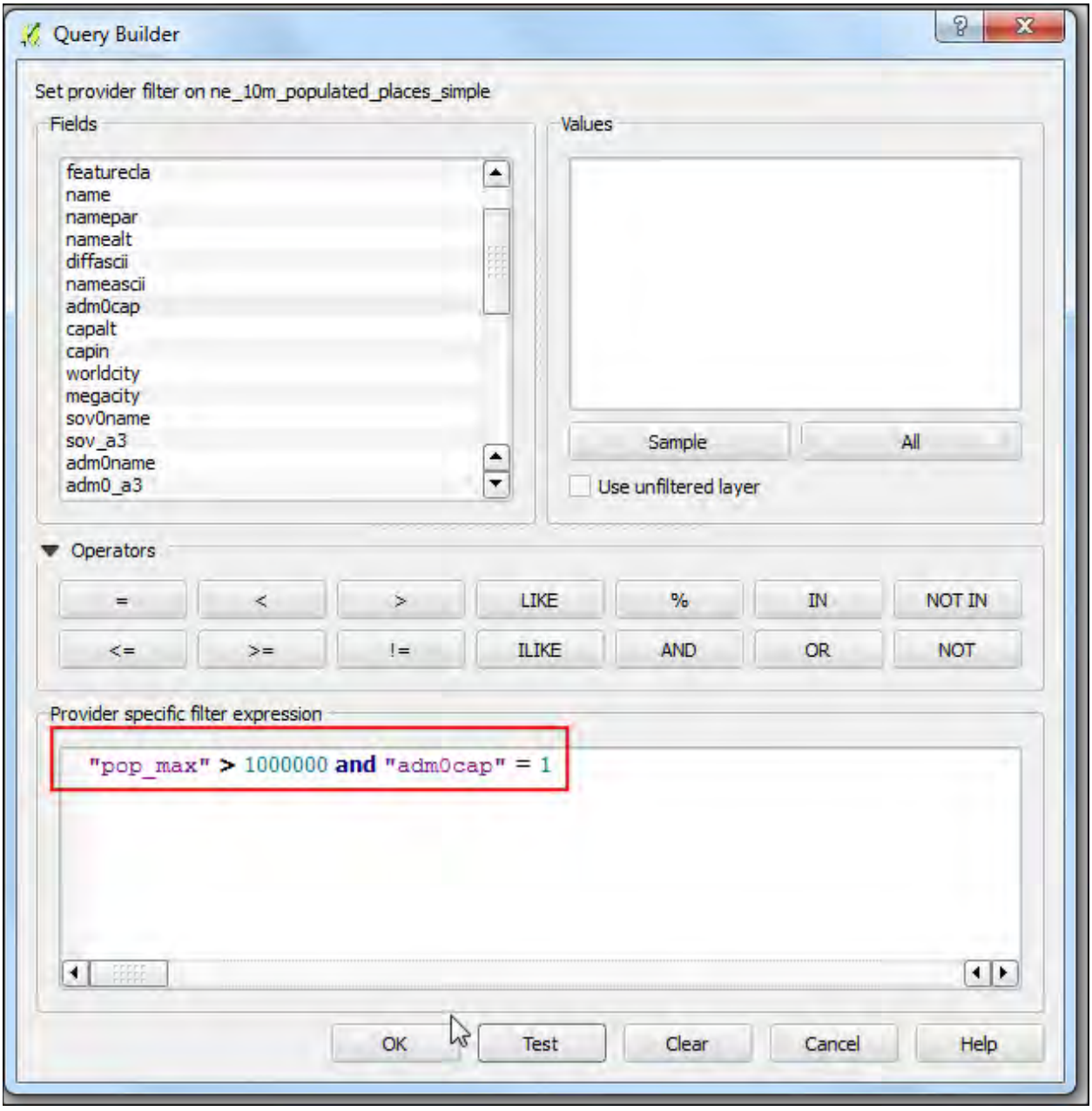


In the General tab, scroll down to the Feature subset section. Click Query Builder.

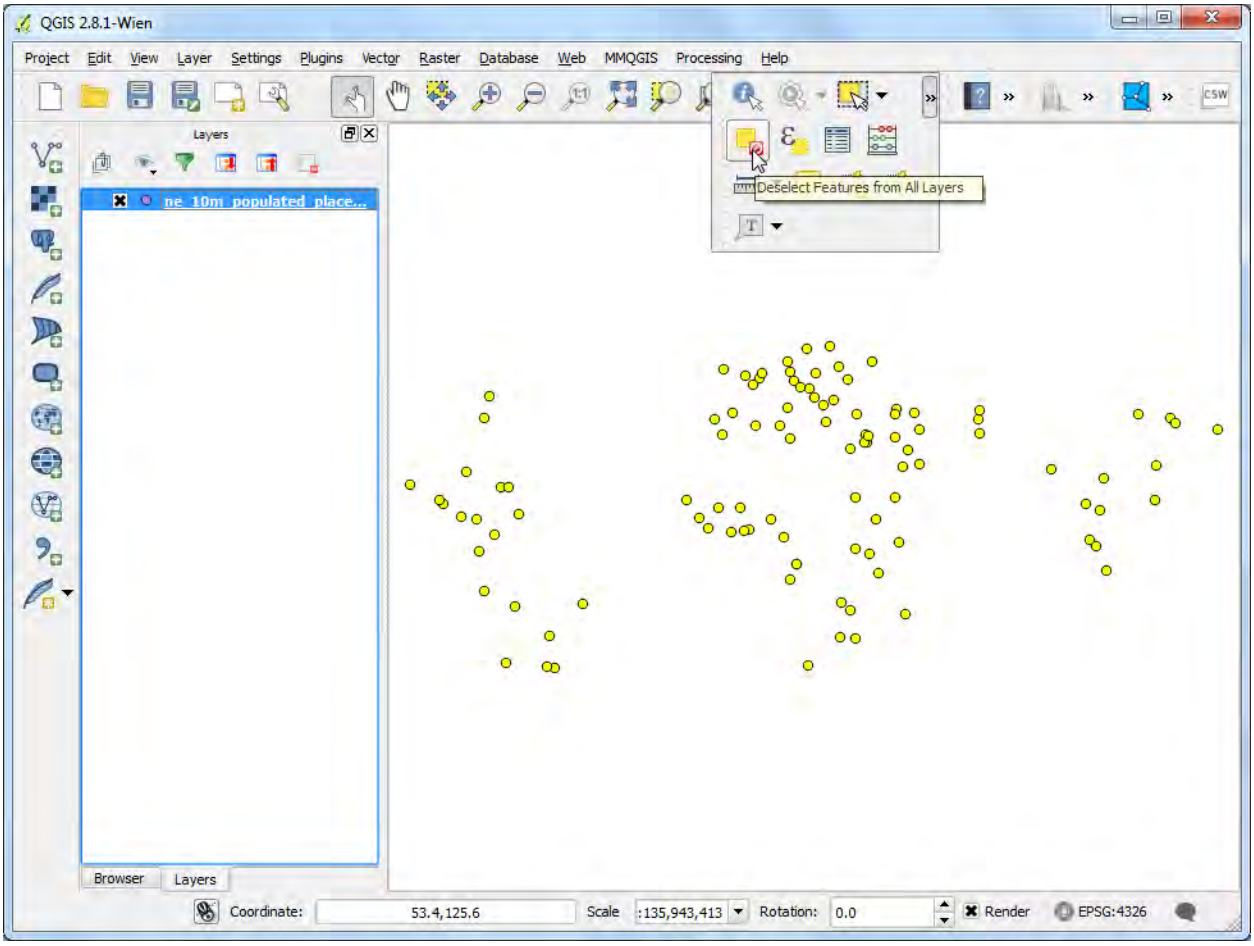


Enter the same expression you had entered earlier and click OK.

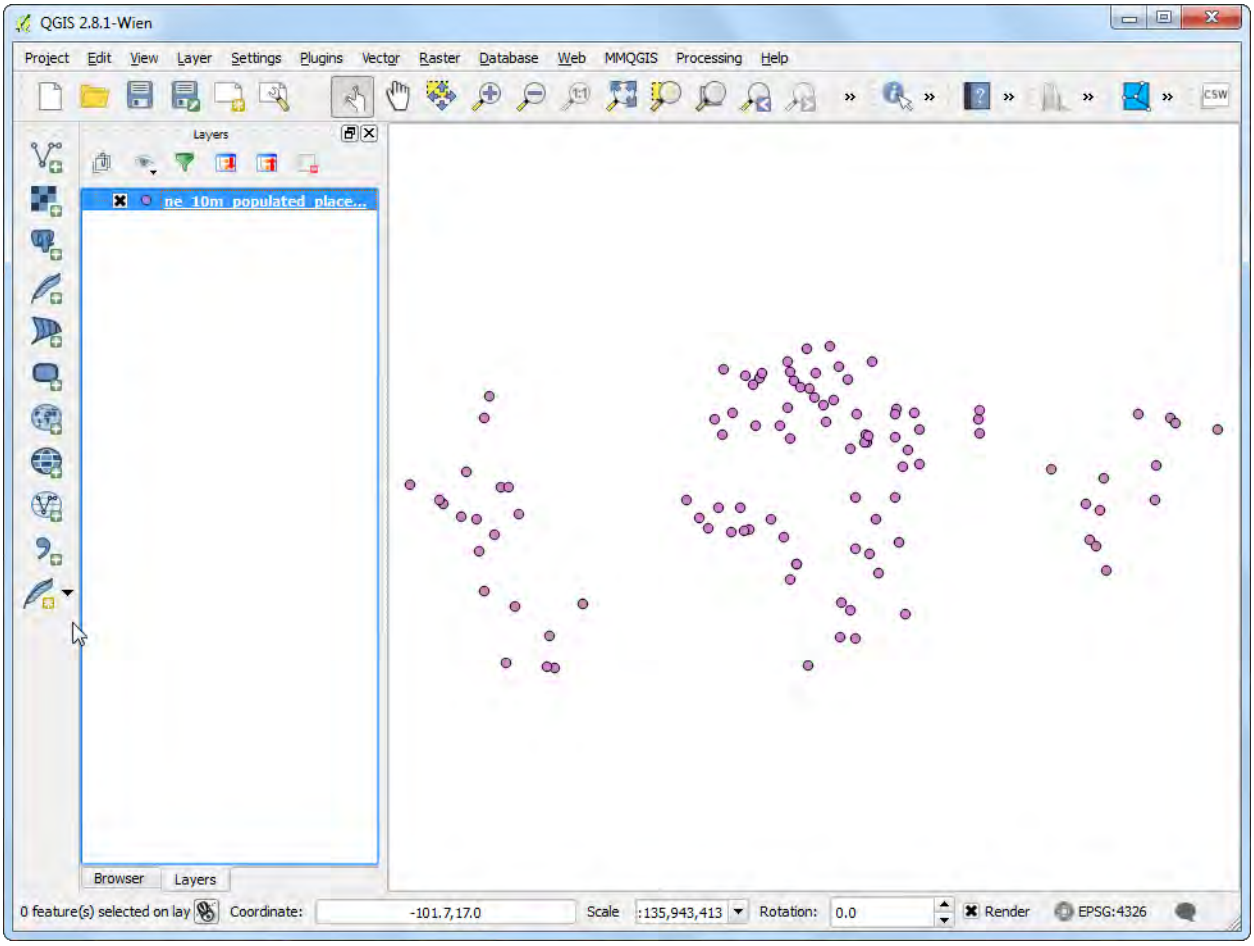
```
"pop_max" > 1000000 and "adm0cap" = 1
```



Back in the main QGIS window, you will see rest of the points disappear. You may now perform any other analysis on this layer and only the features that match our expression will be used. You will notice that the points still appear in yellow. This is because they are still selected. Find the Deselect Features from All Layers button under the Attributes toolbar and click on it.



You will see that the points are now de-selected and rendered in their original color.


QGIS 2.8.1-Wien
Project Edit View Layer Settings Plugins Vector Raster Database Web MMQGIS Processing Help
Layers
ne_10m_populated_place...
Browser
Layers
0 feature(s) selected on lay
Coordinate:
-101.7,17.0
Scale
:135,943,413
Rotation:
0.0
Render
EPSG:4326

3 WORKING WITH SPREADSHEET AND CSV DATA

Many times the GIS data comes in a table or an Excel spreadsheet. Also, if you have a list lat/long coordinates, you can easily import this data in your GIS project.

3.1 Overview of the task

We will be importing a text file of earthquake data to QGIS.

Get the data

NOAA's National Geophysical Data Center produces a great dataset of all significant earthquakes since 2150 BC.

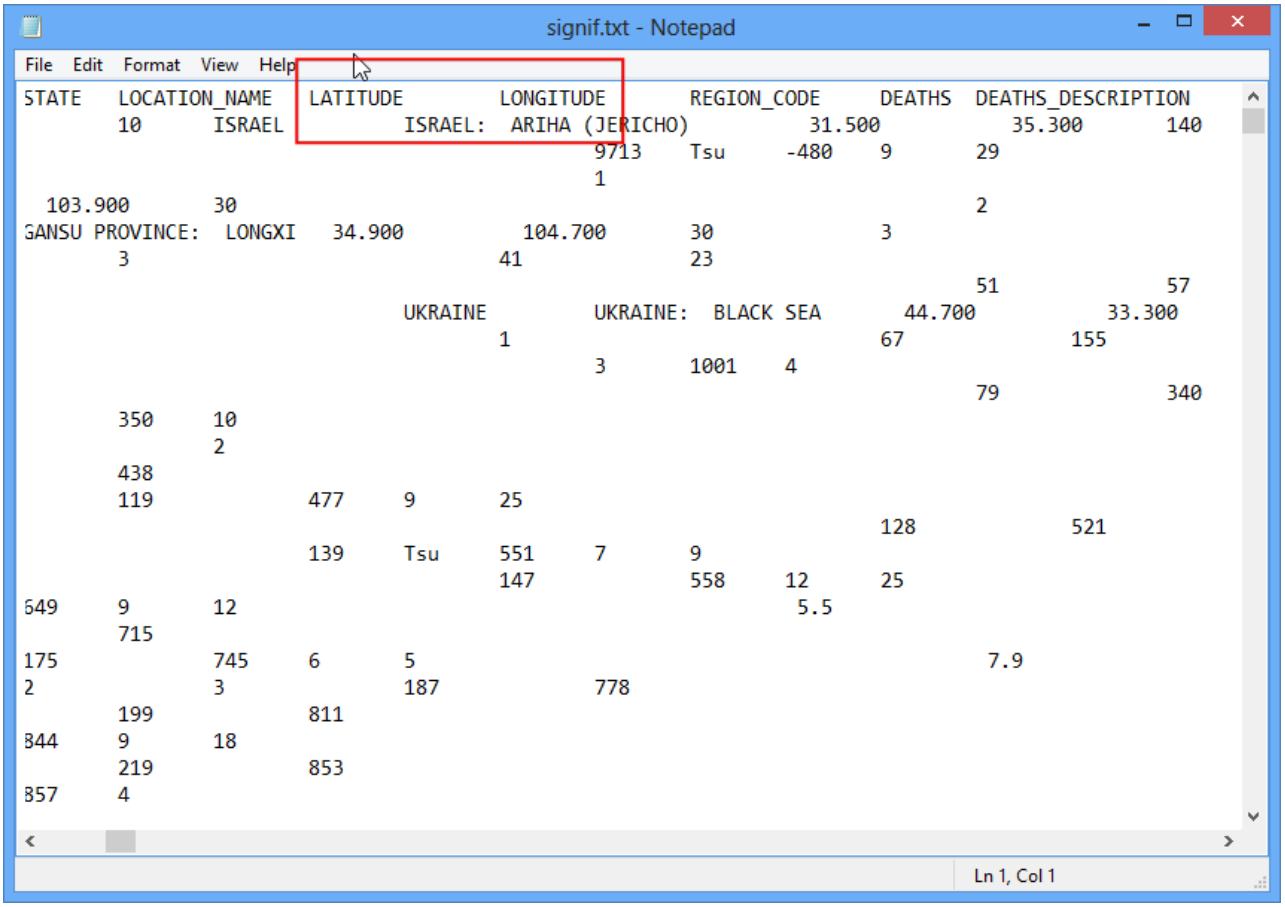
Download Significant Earthquake Database text file.

Data Source [NGDC]

3.2 Procedure

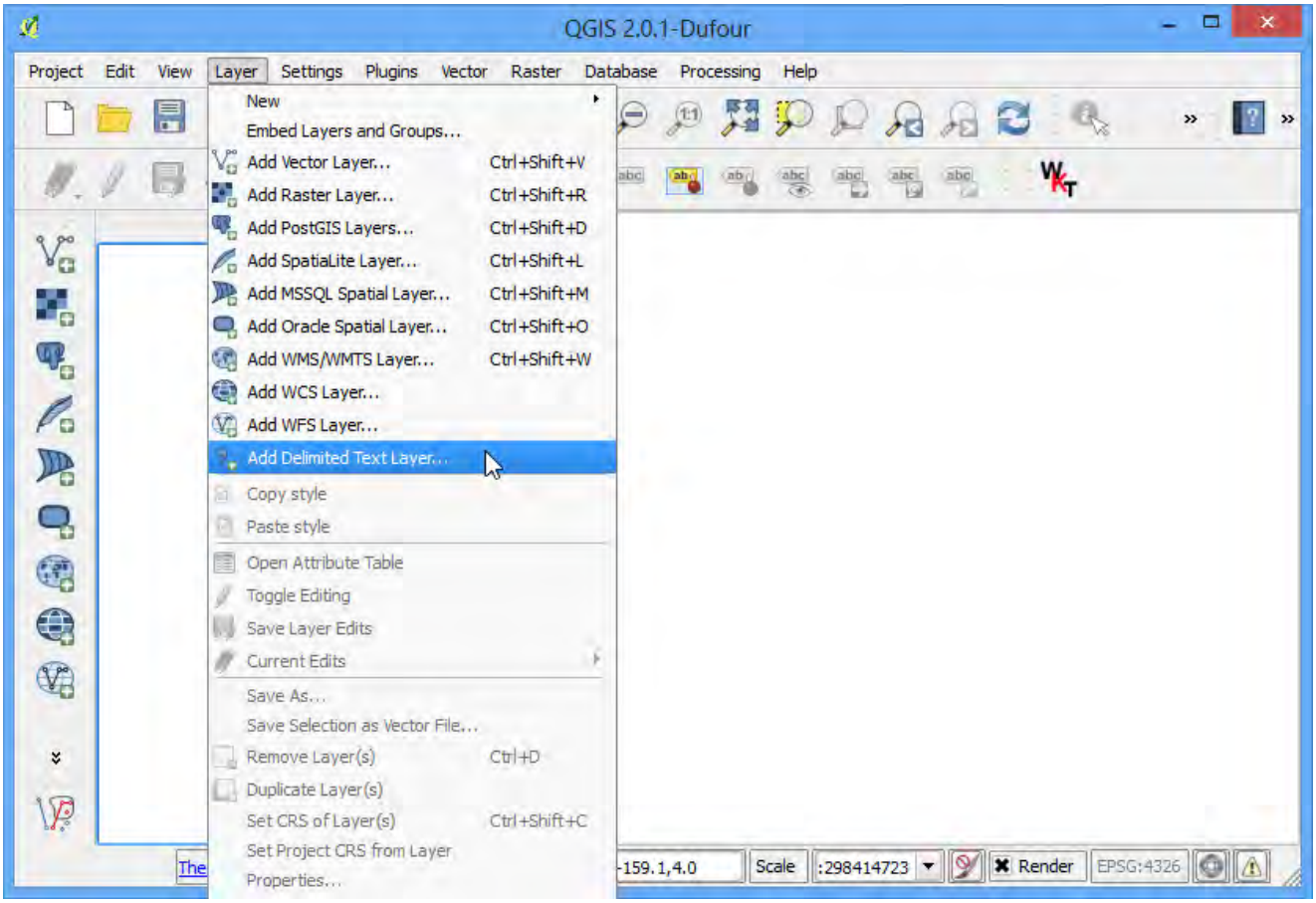
3.2.1 Examine tabular data

Examine your tabular data source. To import this data to QGIS, you will have to save it as a text file and need at least 2 columns which contain the X and Y coordinates. If you have a spreadsheet, use Save As function in your program to save it as a Tab Delimited File or a Comma Separated Values (CSV) file. Once you have the data exported this way, you can open it in a text editor such as Notepad to view the contents. In case of the Significant Earthquake Database, the data already comes as a text file which contains latitude and longitude of the earthquake centers along with other related attributes. You will see that each field is separated by a TAB.



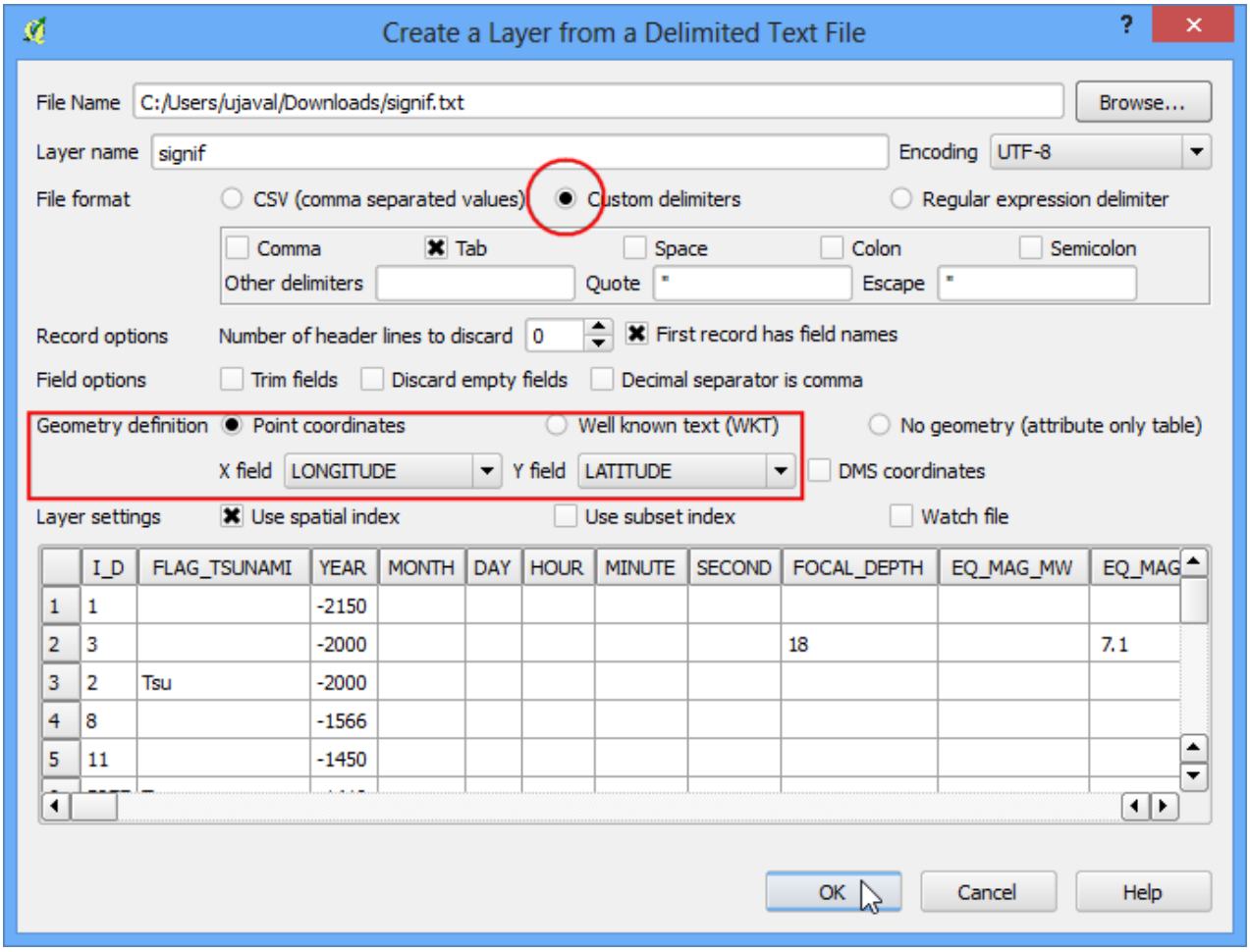
3.2.2 Import tabular data into QGIS

Open QGIS. Click on Layers › Add Delimited Text Layer.

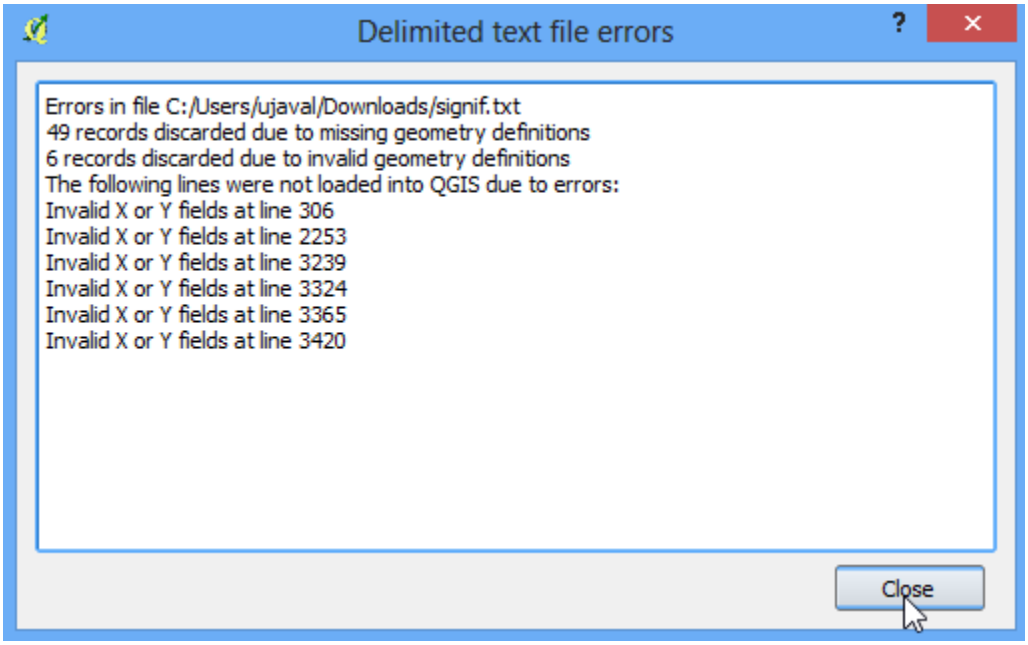


In the Create a Layer from a Delimited Text File dialog, click on Browse and specify the path to the text file you downloaded. In the File format section, select Custom delimiters and check Tab. The Geometry definition secction will be auto-populated if it finds a suitable X and Y coordinate fields. In our case they are *LONGITUDE* and *LATITUDE*. You may change it if the import selects the wrong fields. Click OK.

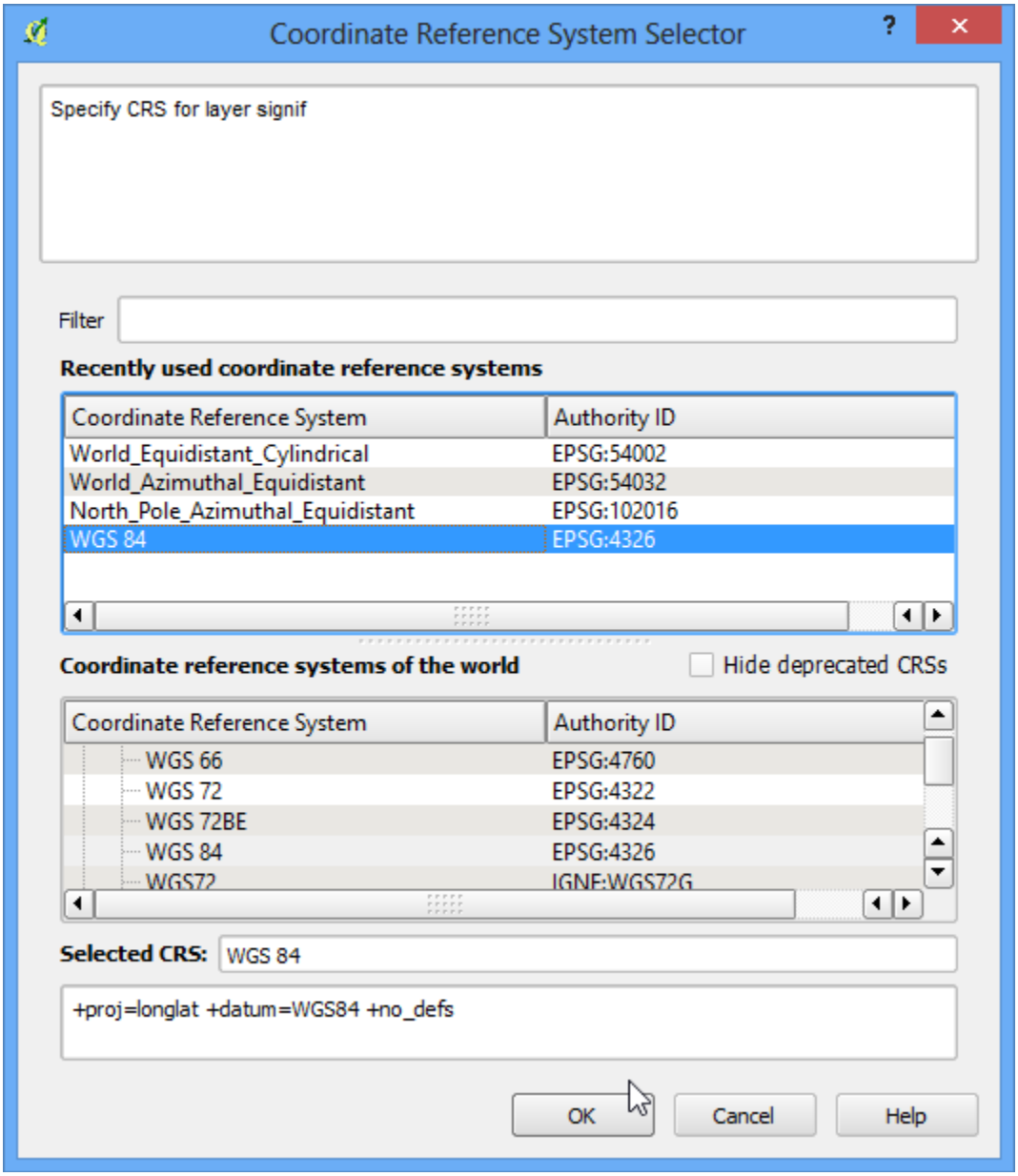
> Note
>
> It is easy to confuse X and Y coordinates. Latitude specifies the north-south position of a point and hence it is a **Y** coordinate. Similarly Longitude specifies the east-west position of a point and it is a **X** coordinate.



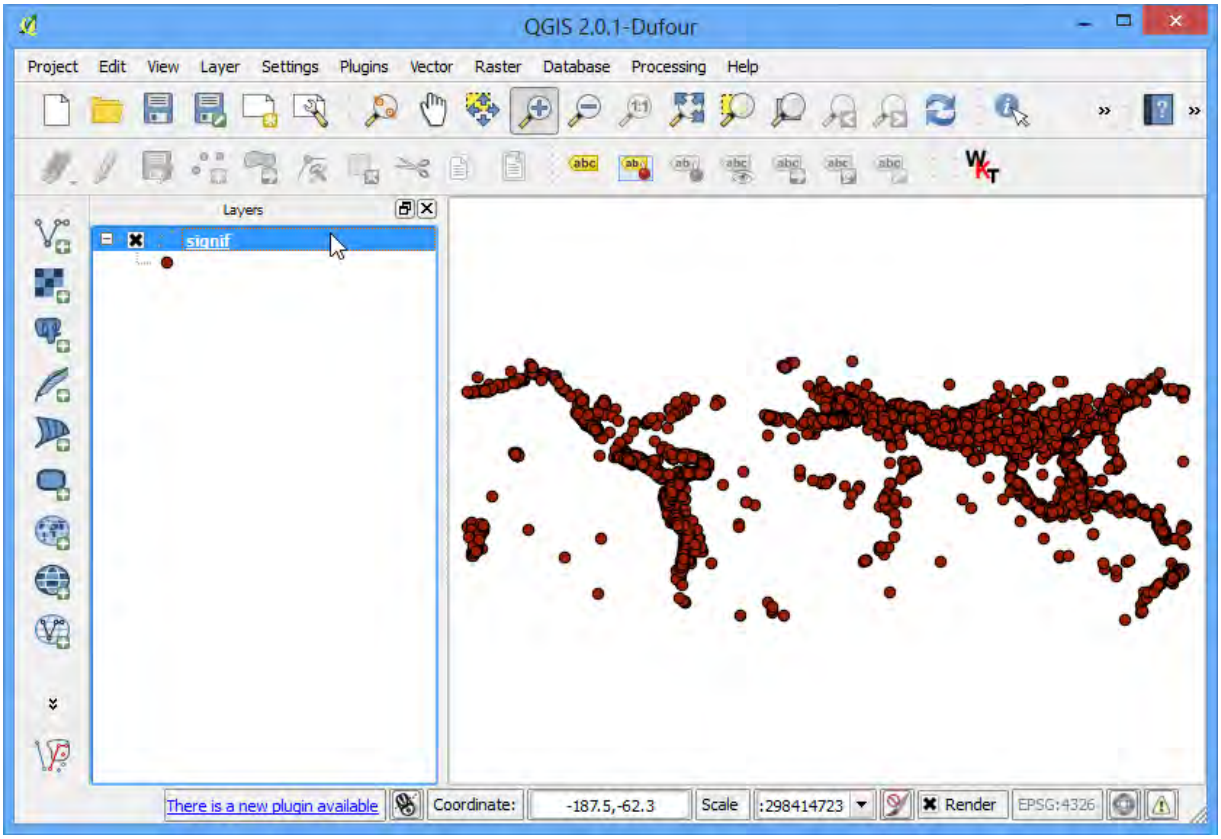
You may see some errors displayed in the next dialog. The errors in this file are mainly due to missing X or Y fields. You may examine these errors and fix the problems in your source file. For this tutorial, you may ignore these errors.



Next, a Coordinate Reference System Selector will ask you to select a coordinate reference system. Since the earthquake coordinates are in latitudes and longitudes, you should select WGS 84. Click OK.



You will now see that the data will be imported and displayed in the QGIS canvas.


QGIS 2.0.1-Dufour
Project
Edit
View
Layer
Settings
Plugins
Vector
Raster
Database
Processing
Help
Layers
signif
There is a new plugin available
Coordinate:
-187.5,-62.3
Scale
:298414723
Render
EPSG:4326

4 USING PLUG-IN

Plugins in QGIS add useful features to the software. Plugins are written by QGIS developers and other independent users who want to extend the core functionality of the software. These plugins are made available in QGIS for all the users.

4.1 Overview of the task

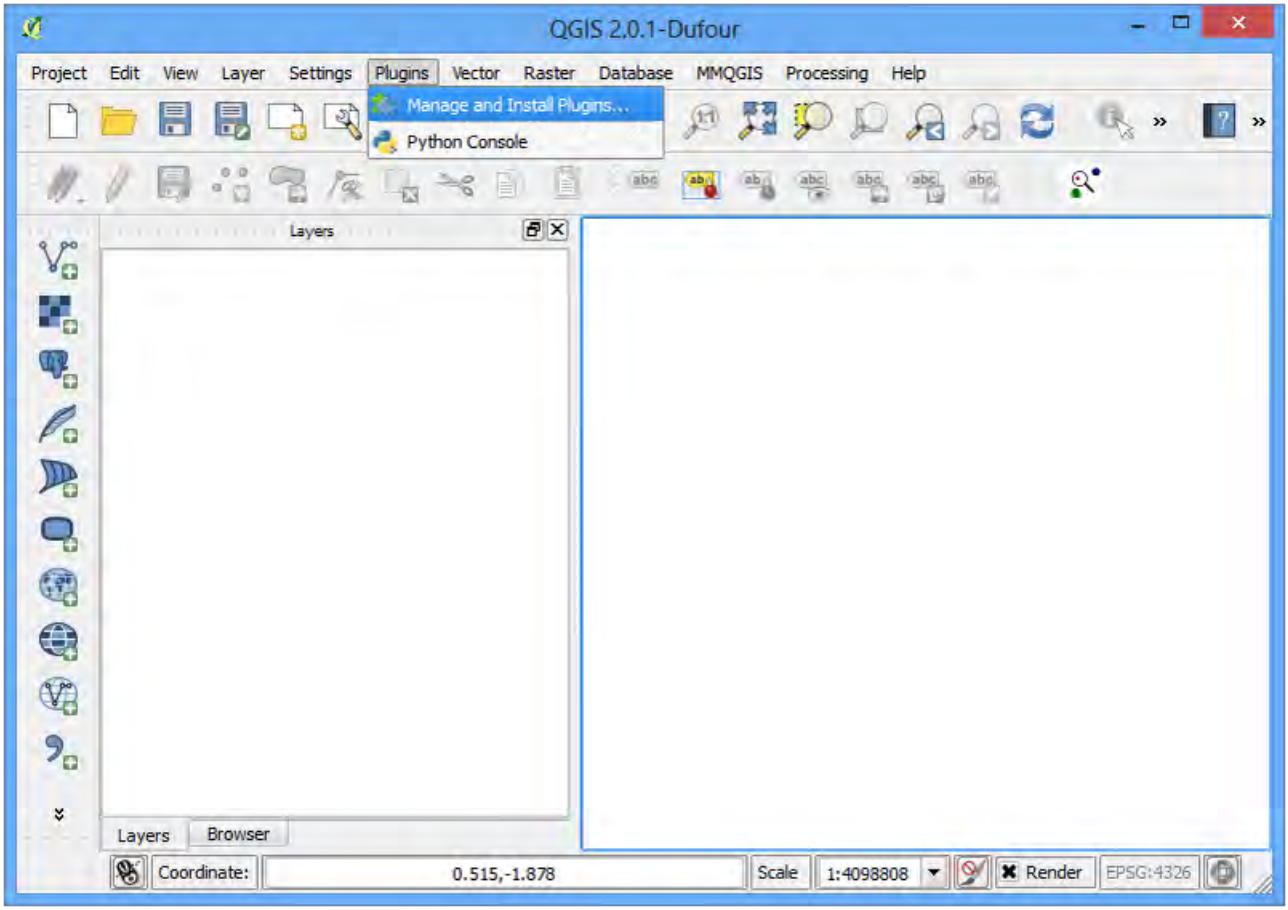
In this tutorial, you will learn how to enable *Core Plugins* as well as download and install *External Plugins*. You will also learn how to locate the plugin from the QGIS menu once they are installed.

4.2 Procedure

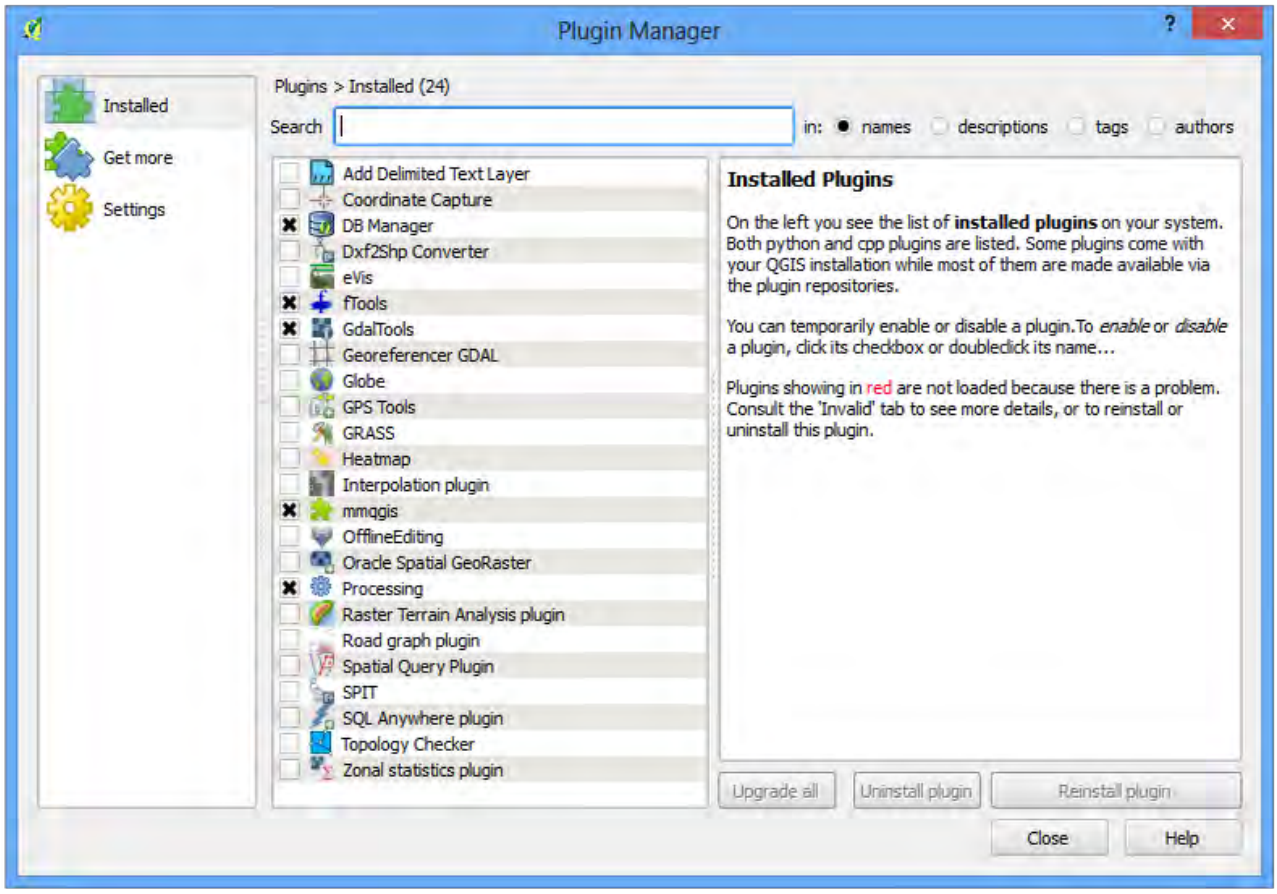
4.2.1 Core Plugins

Core plugins are already part of the standard QGIS installation. To use these, you just need to enable them.

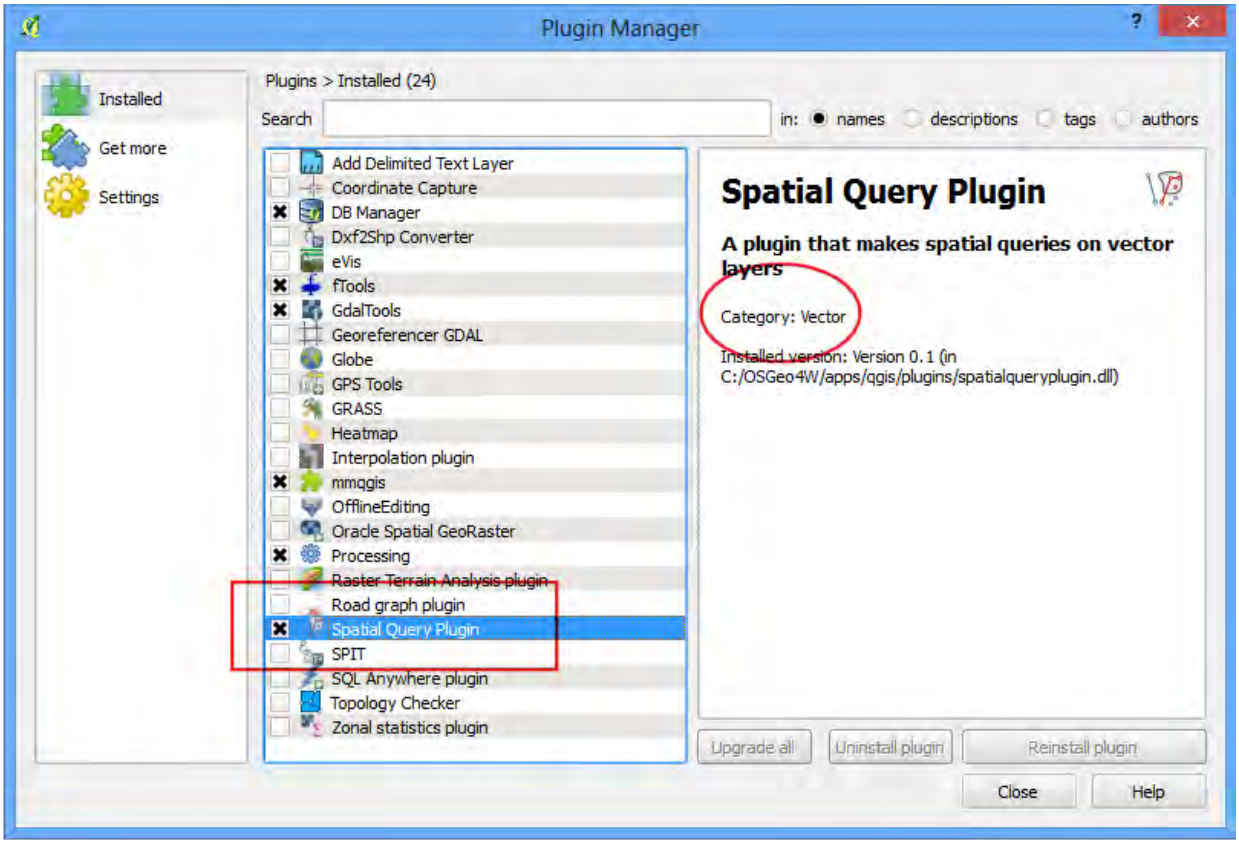
1. Open QGIS. Click on Plugins ▸ Manage and Install Plugins... . to open the Plugin Manager dialog.



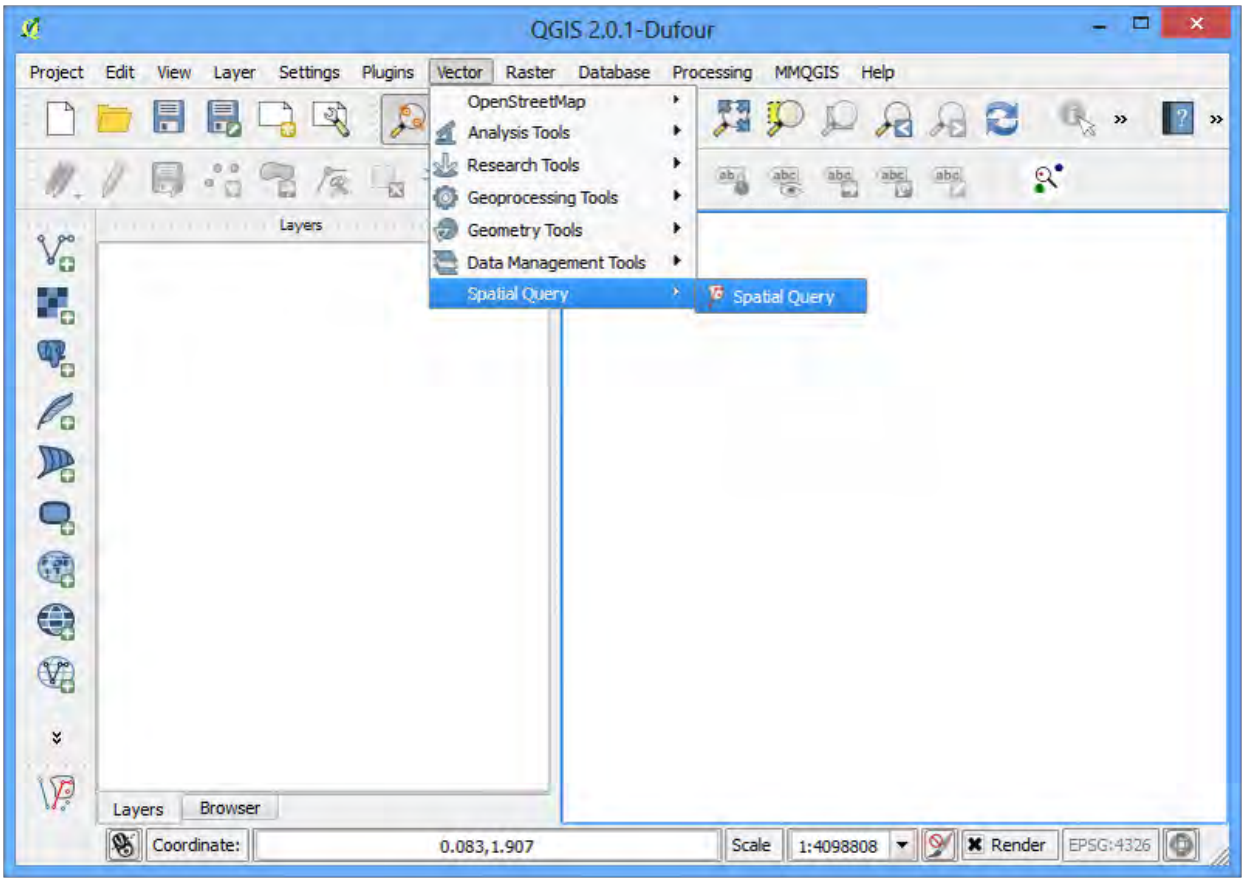
2. Even if this is your first time using QGIS, you will see a lot of plugins listed under the Installed tab. This is because they are *Core Plugins* and were installed during QGIS installation.



3. Let's enable one of the plugins. Check on the checkbox next to Spatial Query Plugin. This will enable the plugin and you will be able to use it. One thing to note is that plugins have the ability to insert menu items at various locations and create new panels and toolbars. Sometimes it is difficult to know how to find the newly enabled tools. Once clue is to look in the plugin discription. Here the description says *Category: Vector*. That indicates that the plugin would be found under the Vector menu once enabled. Click Close.



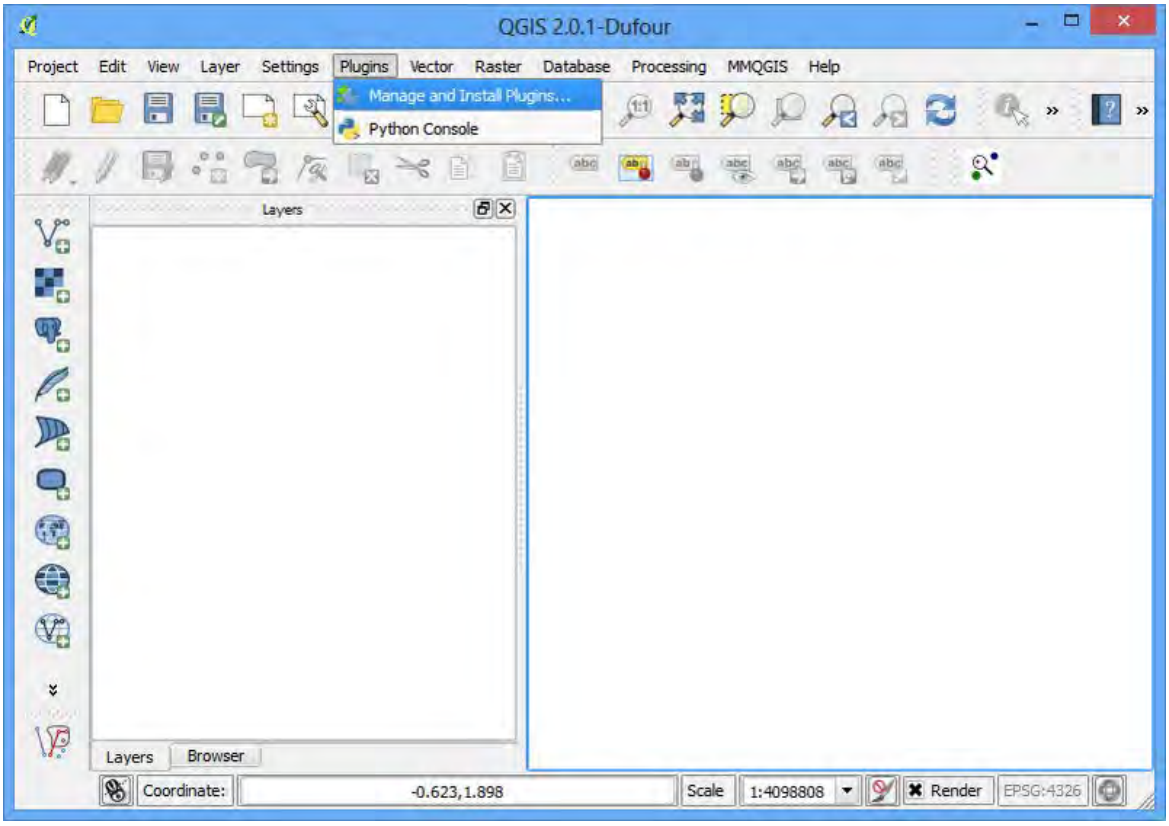
4. Now that the Spatial Query Plugin is enabled, you can go to the Vector ▸ Spatial Query to use the functionality added by the plugin.



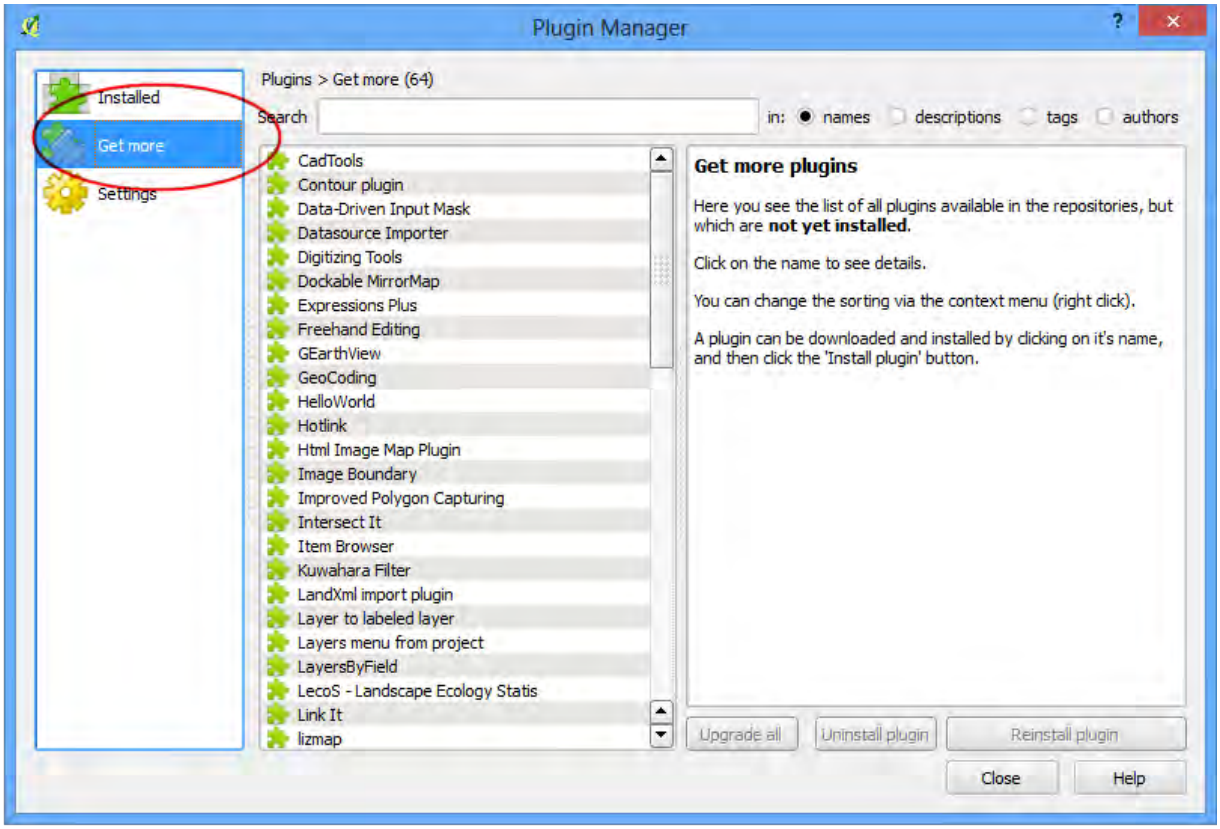
4.2.2 External Plugins

External plugins are available in the QGIS Plugins Repository and need to be installed by the users before using them. An easy way to browse and install these plugins is by using the Plugin Manager tool.

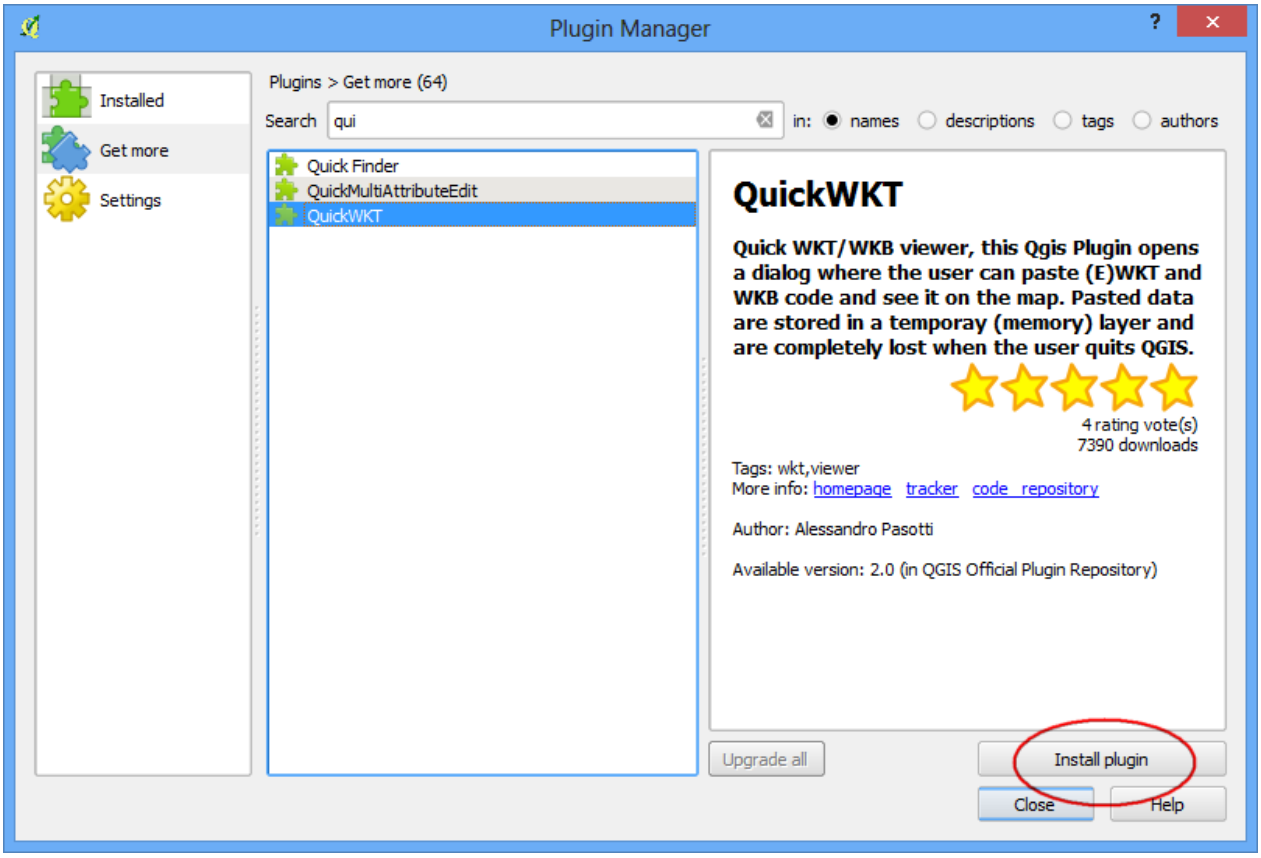
1. Open QGIS. Click on Plugins ▸ Manage and Install Plugins.... to open the Plugin Manager dialog.



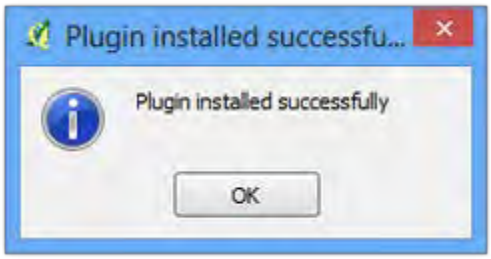
2. Click on Get more tab. Here you will see a list of plugins listed.



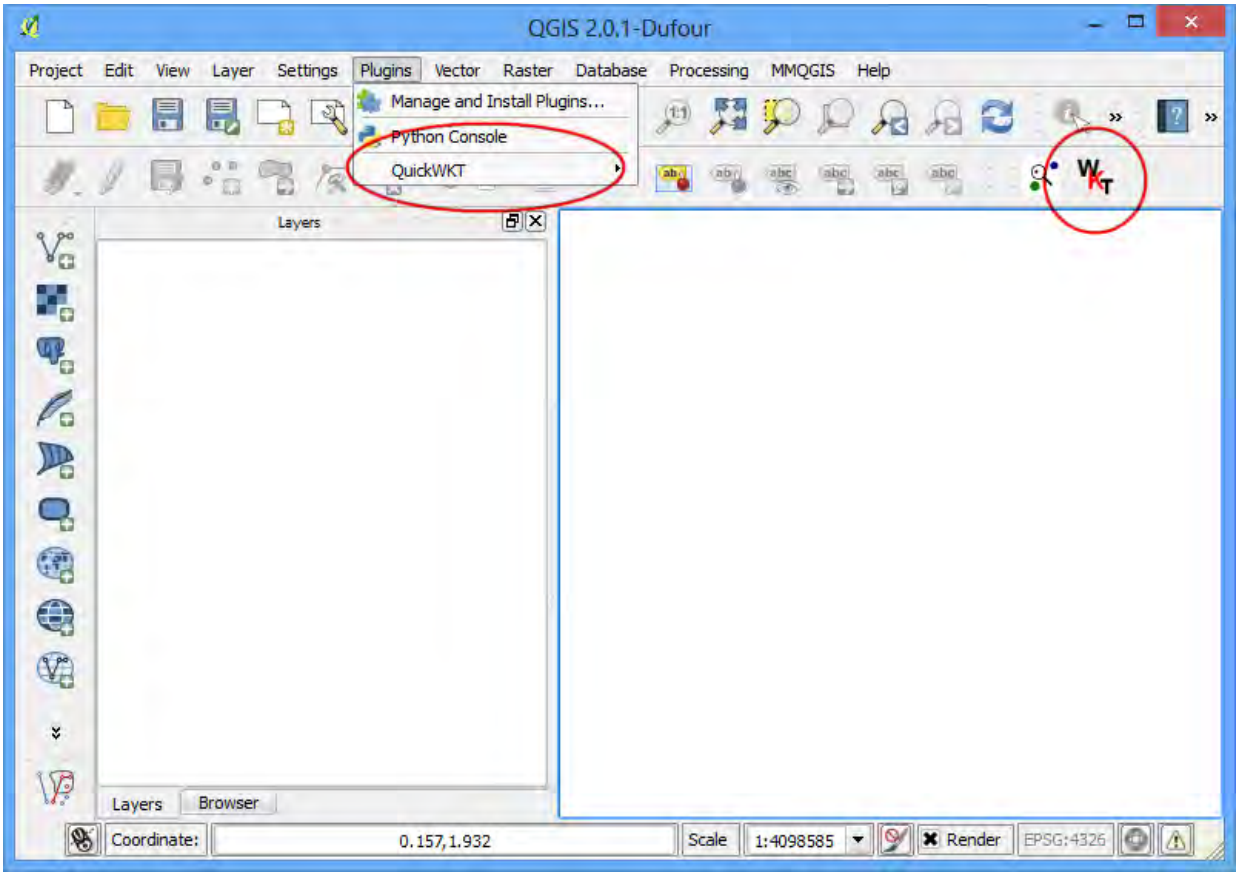
3. For this tutorial, let's find and install a plugin called 'QuickQKT'. As you start typing *qui* in the search box, you will see the search results below. Click on the QuickWKT. Next, click on Install plugin button to install it.



4. Once the plugin is downloaded and installed, you will see a confirmation dialog.



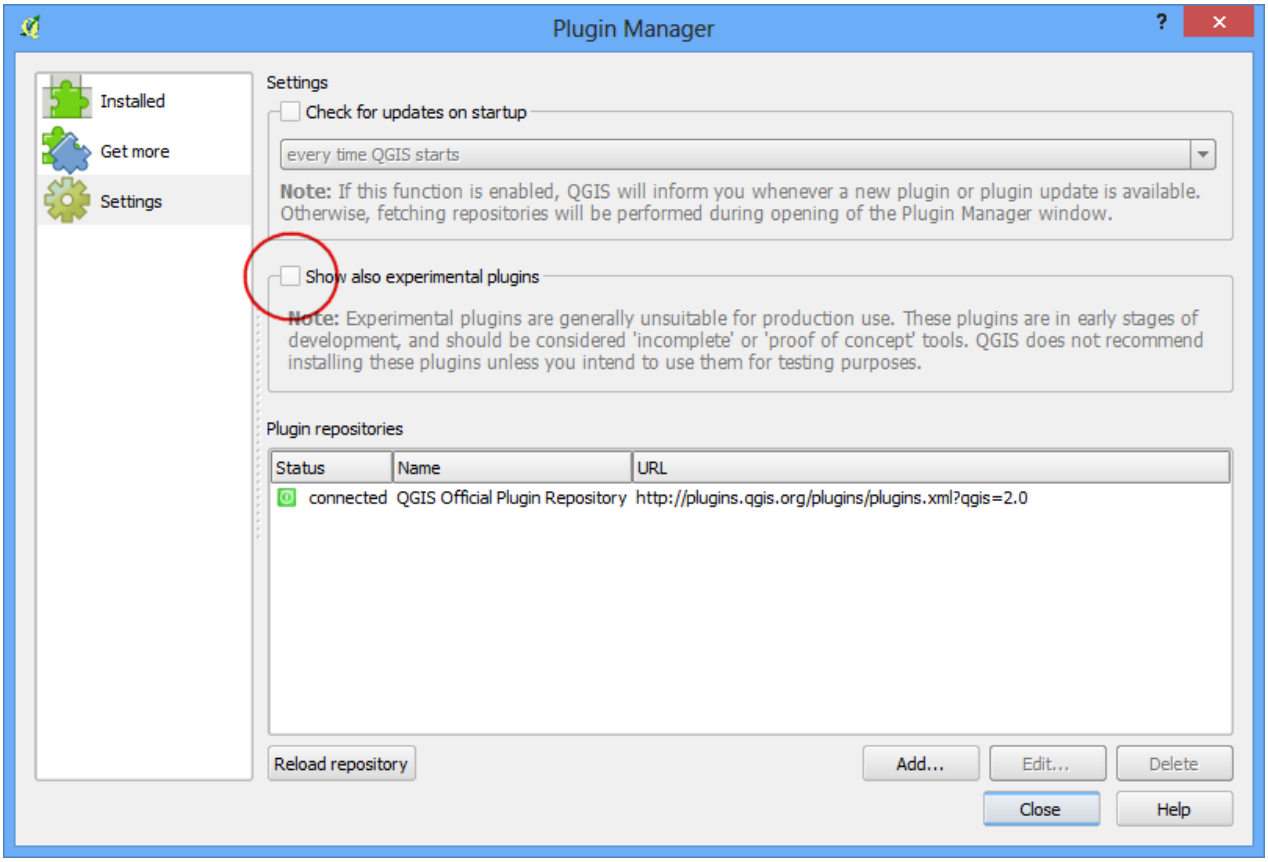
5. If you noticed, there was no mention of the plugin category in the description. That makes it hard to determine how to access the newly installed plugin. Most external plugins are installed under the Plugins menu itself in QGIS. Click on Plugins ▸ QuickWKT and you will see the newly installed plugin. Usually, external plugins also install a button in the Plugins toolbar also. You may also use that button to access the plugin.



4.2.3 Experimental Plugins

Now you know how to install and find an *External Plugin* in QGIS. Let's explore some advanced options. Sometimes you are looking for a specific plugin, but cannot find it in the Get more tab. It maybe because the plugin is marked *Experimental*. Here is how to install *experimental* plugins.

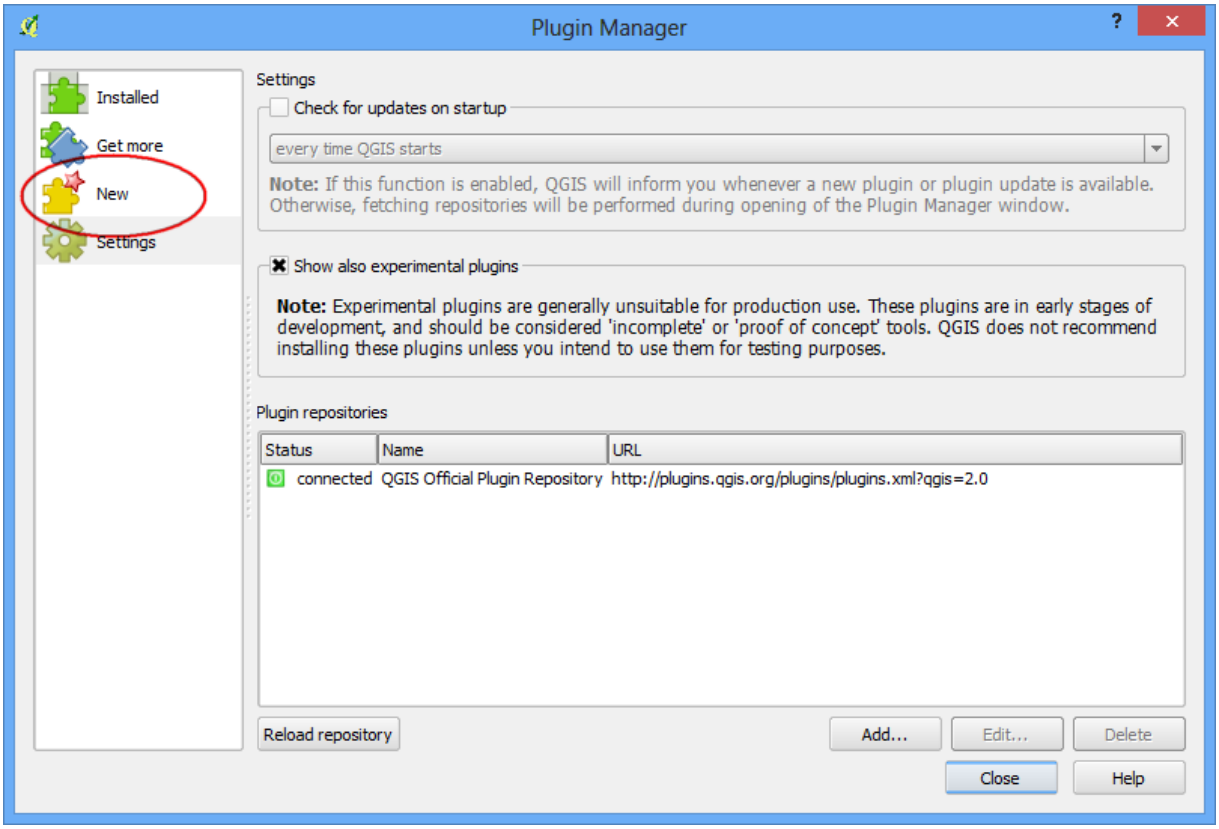
1. Open Plugin Manager by Plugins ▸ Manage and Install Plugins... . Click on the Settings tab. You will see an option called Show also experimental plugins. Click the checkbox next to it, to enable it.



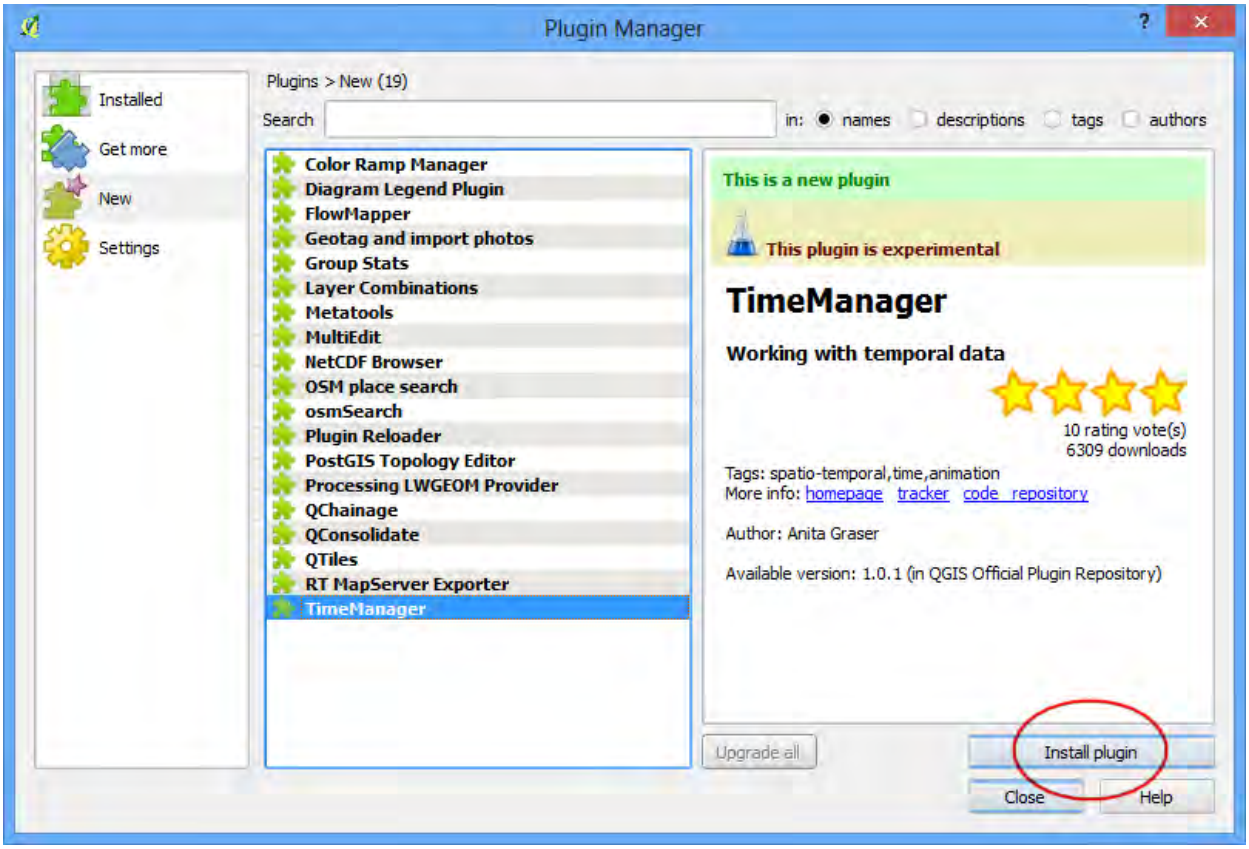
2. You will see a new tab called New. The newly enabled experimental plugins will show up here.

Note

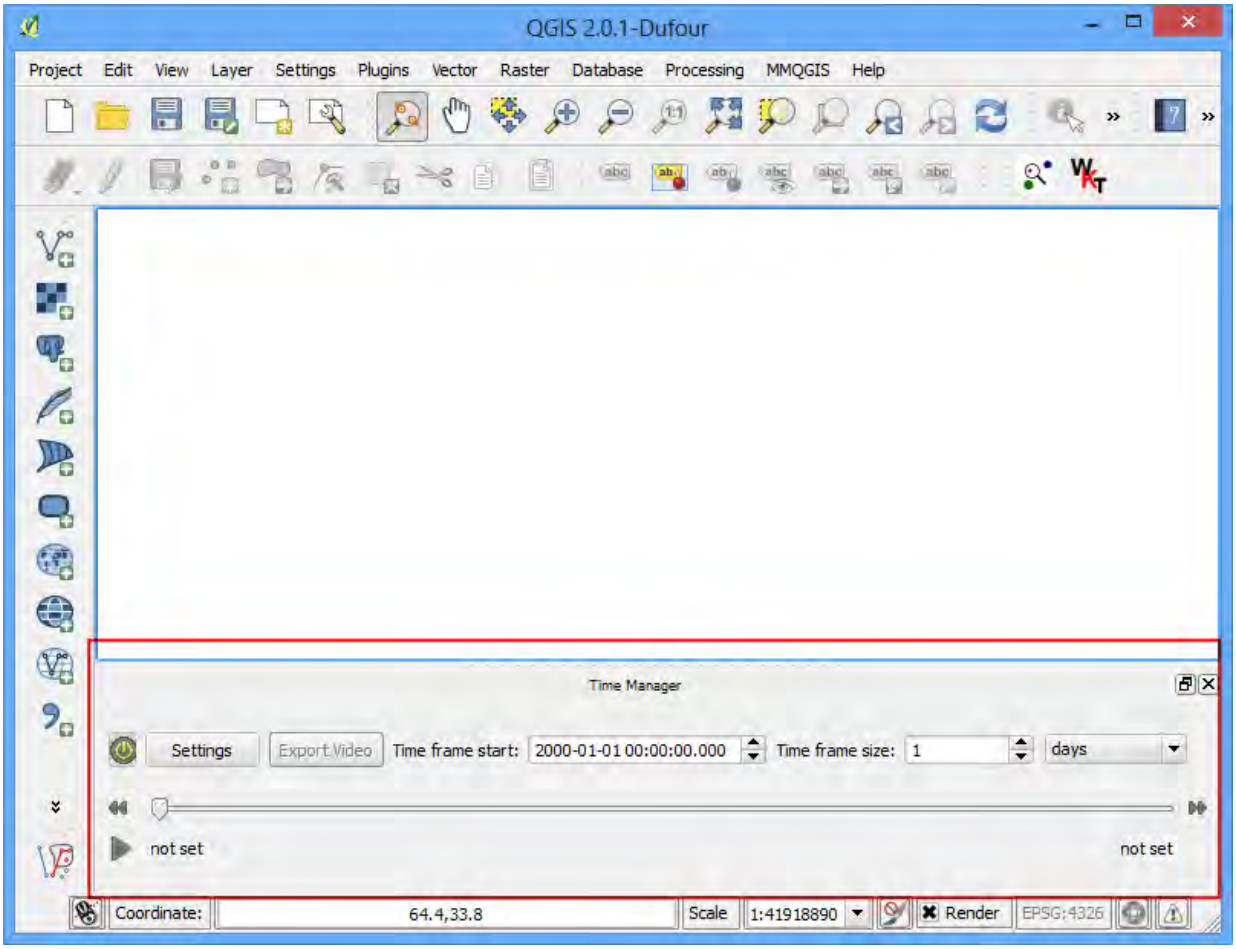
The New tab will appear only temporarily once you enable the experimental plugins. The next time you open Plugin Manager, the experimental plugins will show alongside regular plugins in the Get more tab.



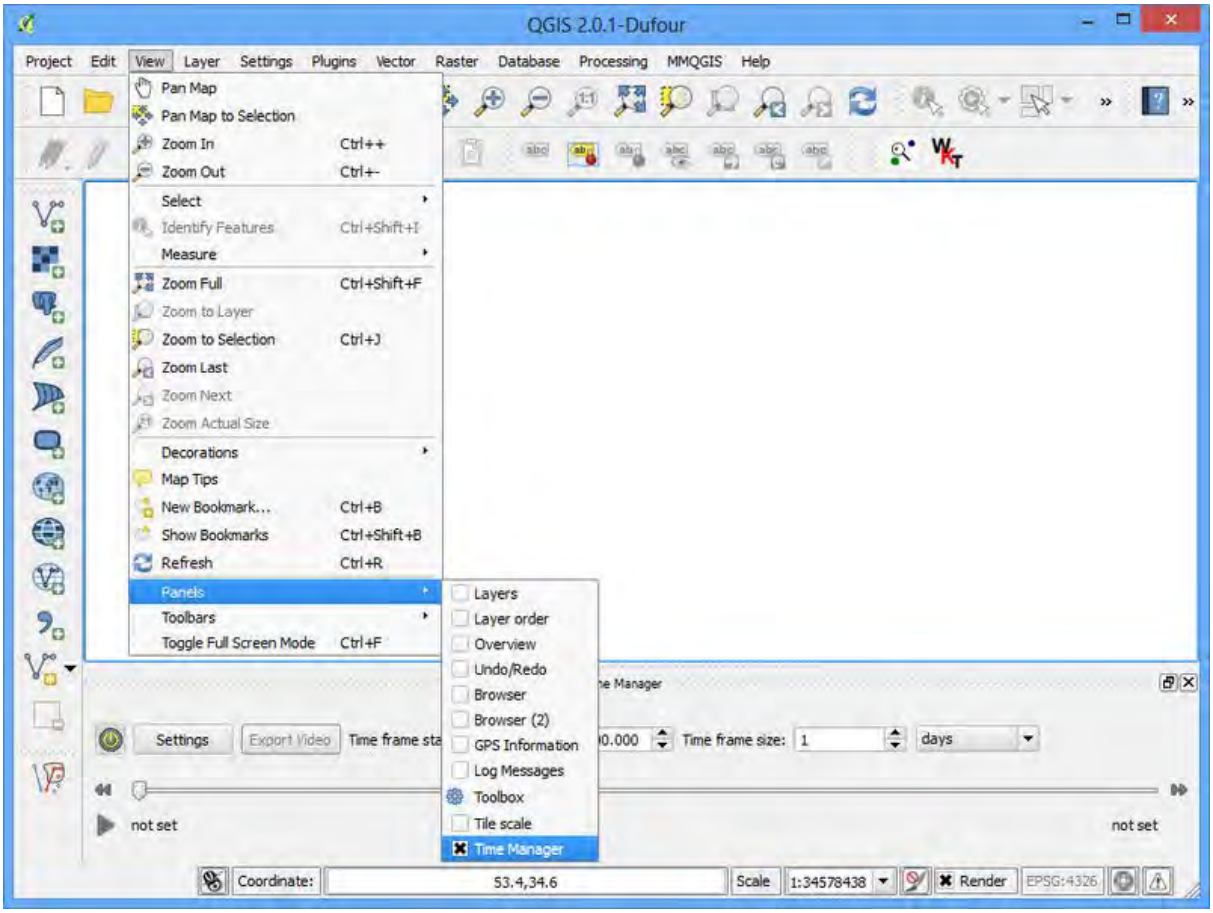
3. Let's install a plugin called TimeManager. Click on the plugin name and then Click Install.



4. Now when you come back to the main QGIS window, you will see a new *Panel* at the bottom of the canvas. This panel is created by the TimeManager plugin. This is yet another way of plugins to add useful functionality to the user interface.



5. You can enable/disable this panel from View ▸ Panels ▸ Time Manager .


QGIS 2.0.1-Dufour
Project
Edit
View
Layer
Settings
Plugins
Vector
Raster
Database
Processing
MMQGIS
Help
Pan Map
Pan Map to Selection
Zoom In Ctrl++
Zoom Out Ctrl+-
Select
Identify Features Ctrl+Shift+I
Measure
Zoom Full Ctrl+Shift+F
Zoom to Layer
Zoom to Selection Ctrl+J
Zoom Last
Zoom Next
Zoom Actual Size
Decorations
Map Tips
New Bookmark... Ctrl+B
Show Bookmarks Ctrl+Shift+B
Refresh Ctrl+R
Panels
Toolbars
Toggle Full Screen Mode Ctrl+F
Layers
Layer order
Overview
Undo/Redo
Browser
Browser (2)
GPS Information
Log Messages
Toolbox
Tile scale
Time Manager
Settings
Export Video
Time frame size:
days
not set
not set
Coordinate:
53.4,34.6
Scale
1:34578438
Render
EPSG:4326

5 Searching and Downloading OpenStreetMap Data

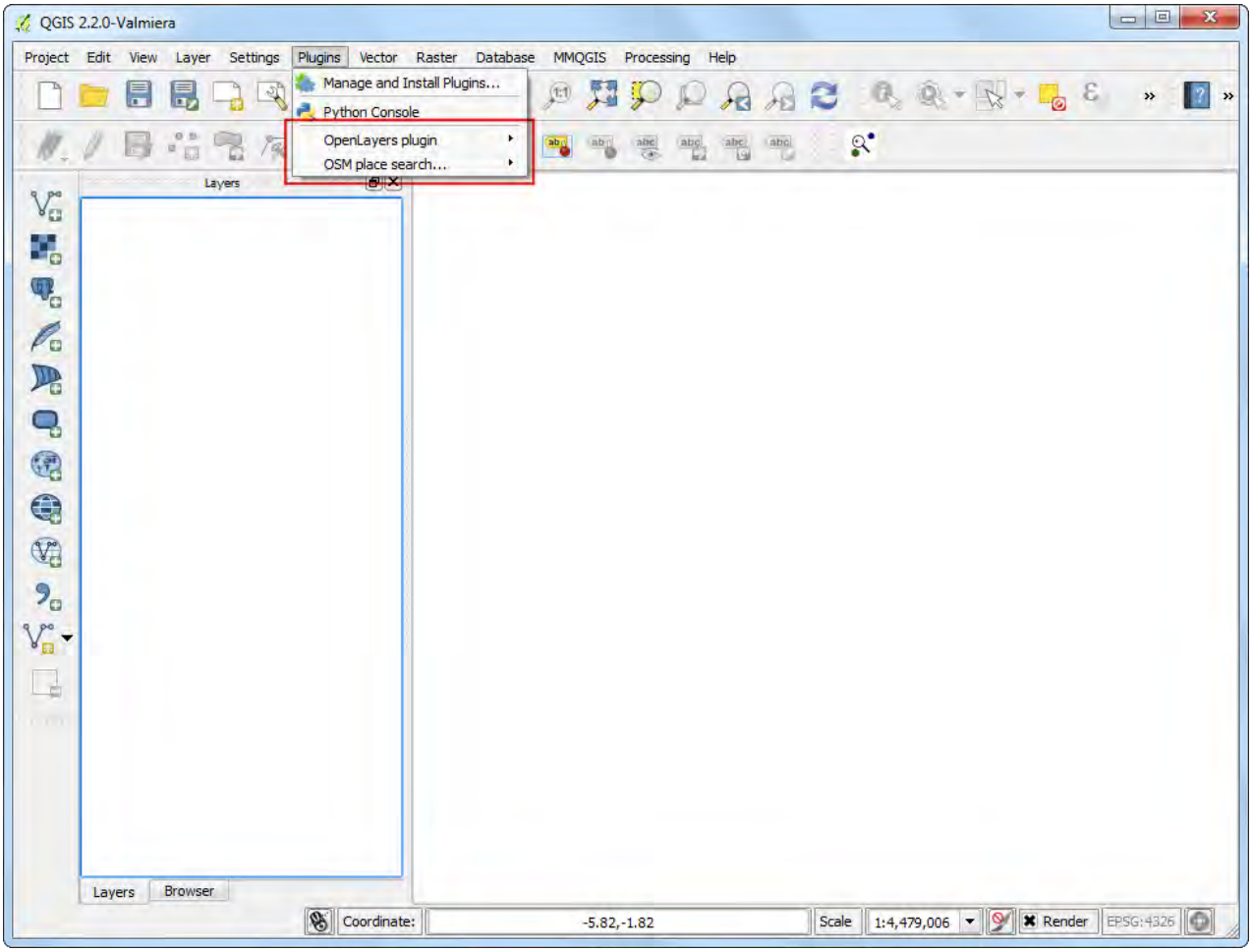
Getting high quality data is essential for any GIS task. One great resource for free and openly licensed data is OpenStreetMap(OSM) . The OSM database consits of streets, local data as well as building polygons. Getting access to OSM data in a GIS format is integrated in QGIS. This tutorial explains the process for searching, downloading and using OSM data in QGIS.

5.1 Overview of the task

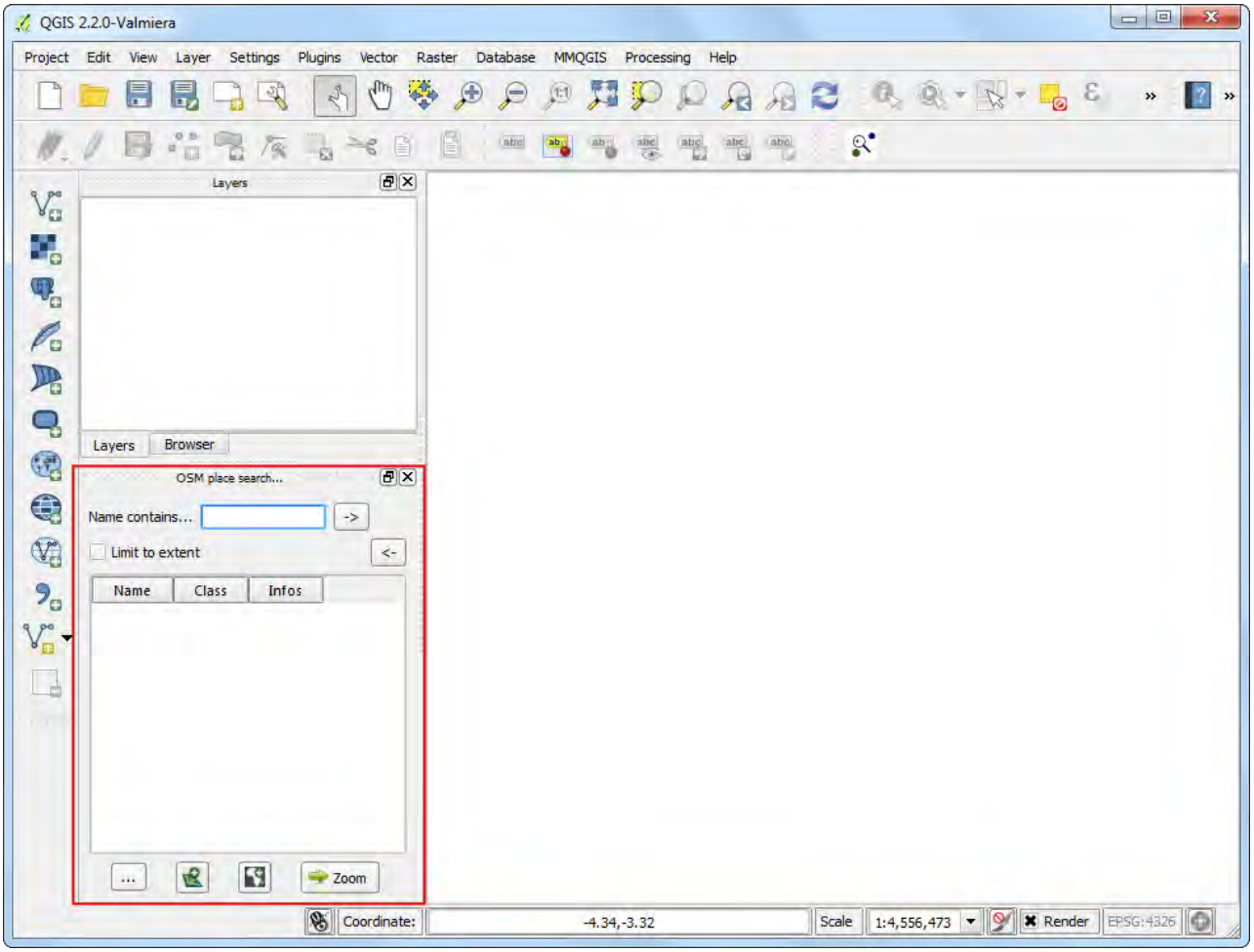
Search for *Naypyidaw* in OSM database, browse and select a part of the city, and extract all pub locations as a shapefile.

5.2 Procedure

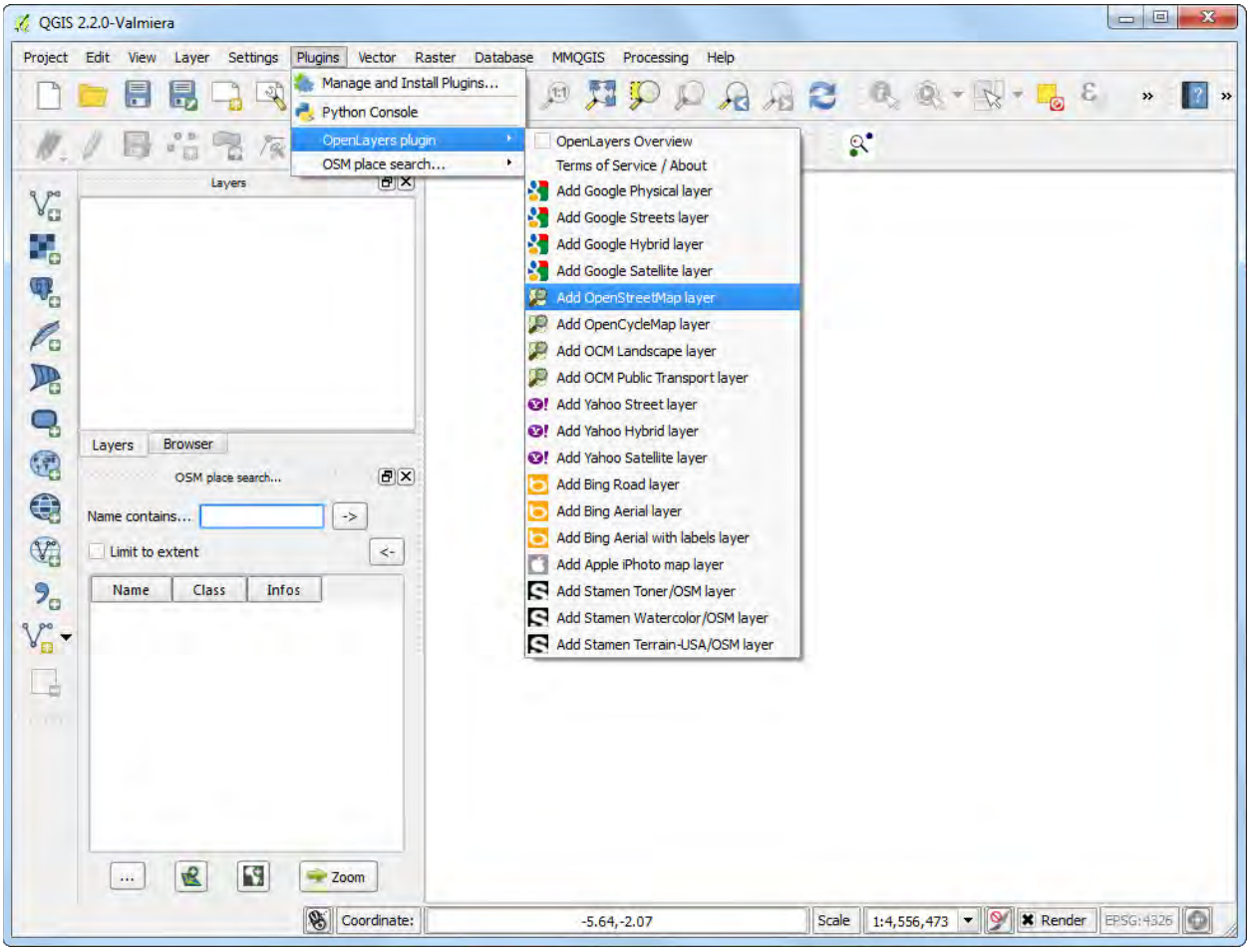
1. We will use 2 plugins to accomplish the task. Make sure you have installed **OSM Place Search** and **OpenLayers** plugins. See *Using Plugins* for instructions on downloading plugins.



2. The **OSM Place Search** plugin will install itself as a *Panel* in QGIS. You will see a new panel titled OSM place search... in QGIS.



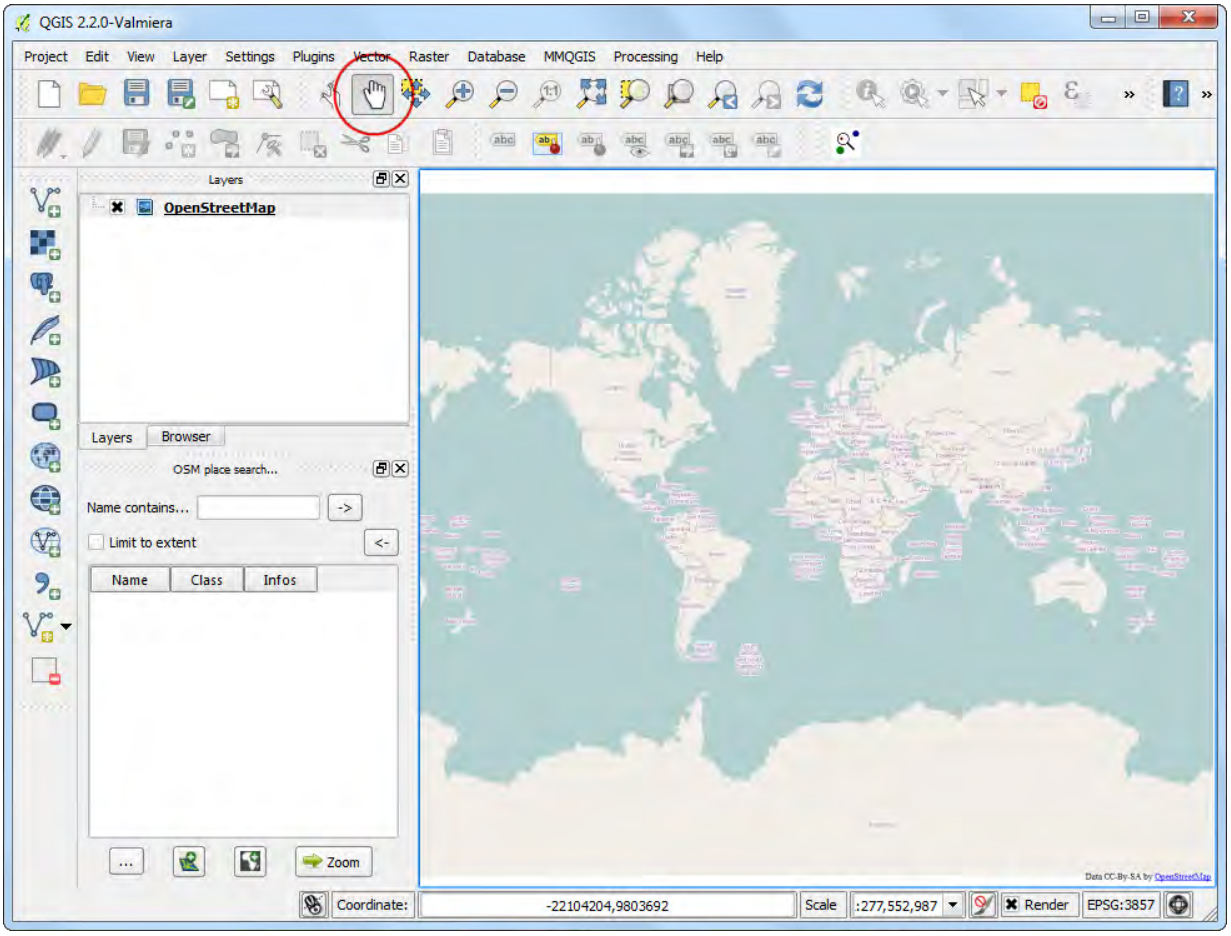
3. The **OpenLayers** plugin is installed under the *Plugin* menu. This plugin allows you to access basemaps from various providers in QGIS. Let's load the OpenStreetMap basemap in QGIS by going to Plugins ▸ OpenLayers plugin ▸ Add OpenS treetMap layer.



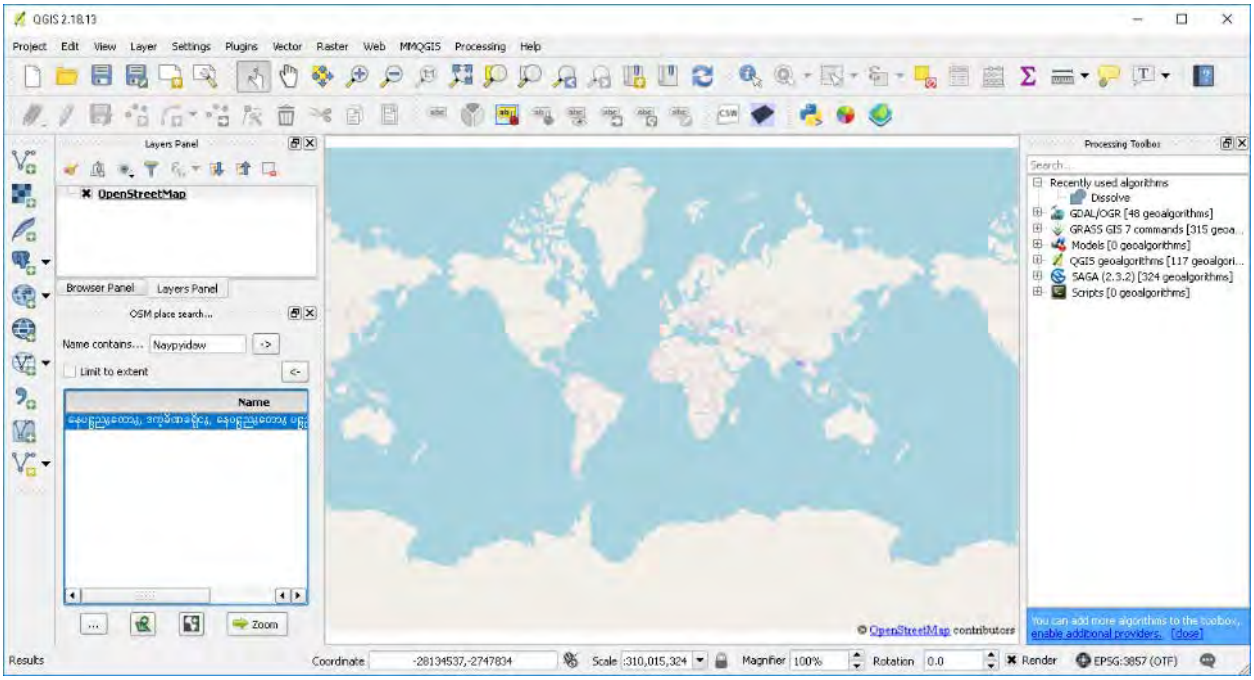
4. You will see a world map loaded in QGIS.

Note

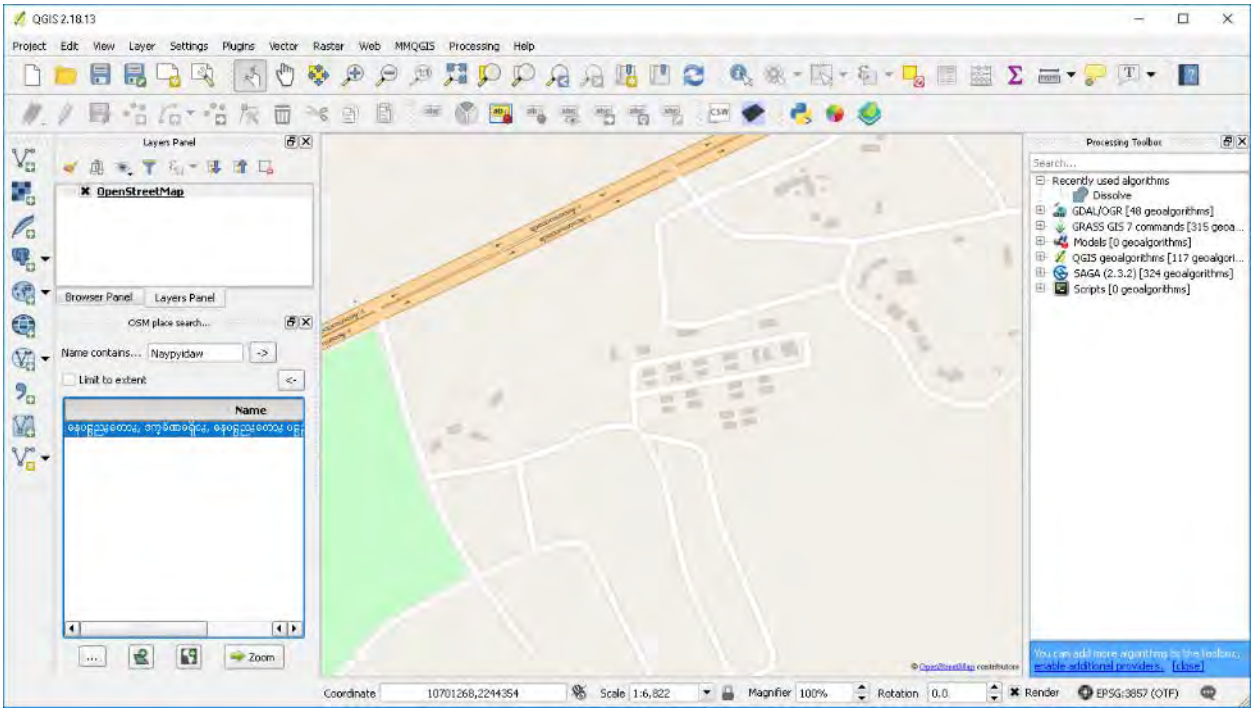
If you do not see any data - make sure you are online - as the basemap tiles are fetched from the internet. You can also use the *Pan* tool to move the map canvas slightly, which will trigger a refresh of the basemap.



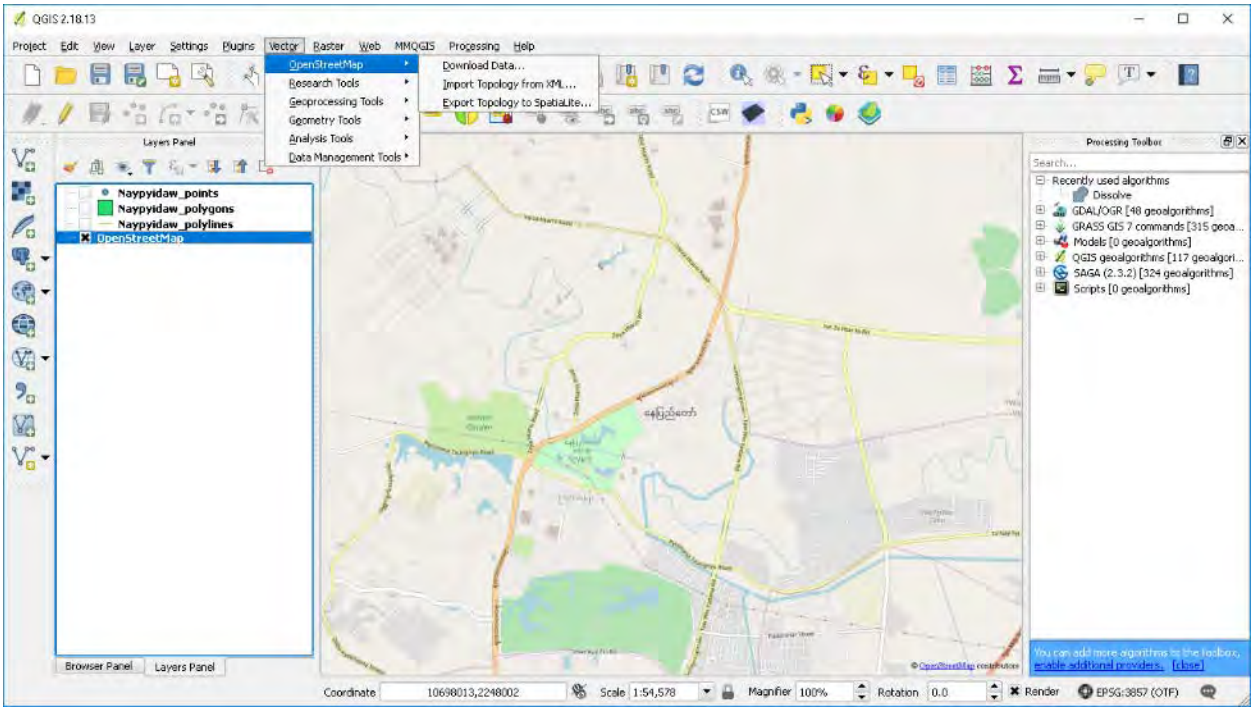
5. Now, let's search for **Naypyidaw**. Type the query in the Name contains... box in the **OSM Place Search** panel. You can hover over the results and the appropriate place will be highlighted on the map. Select the first result - which the city of Naypyidaw - and click the Zoom button.



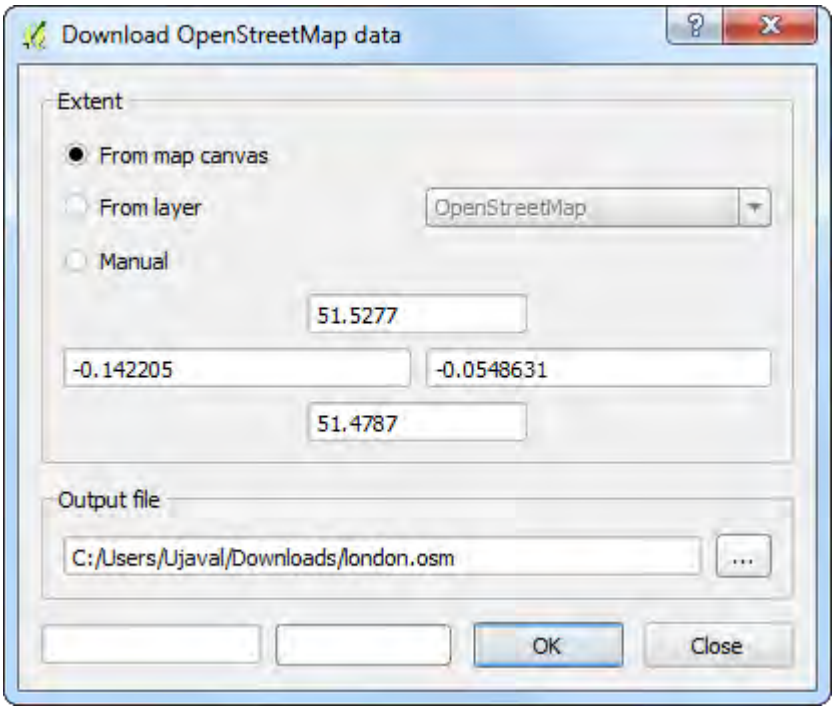
6. You will see the base layer move and center around the city of Naypyidaw. You can use the Zoom tool to zoom and select the exact area of your interest. For this tutorial, you can zoom in the center of the city as shown.



7. Now we can download the data displayed on the map canvas. Go to Vector ▸ OpenStreetMap ▸ Downlod data .



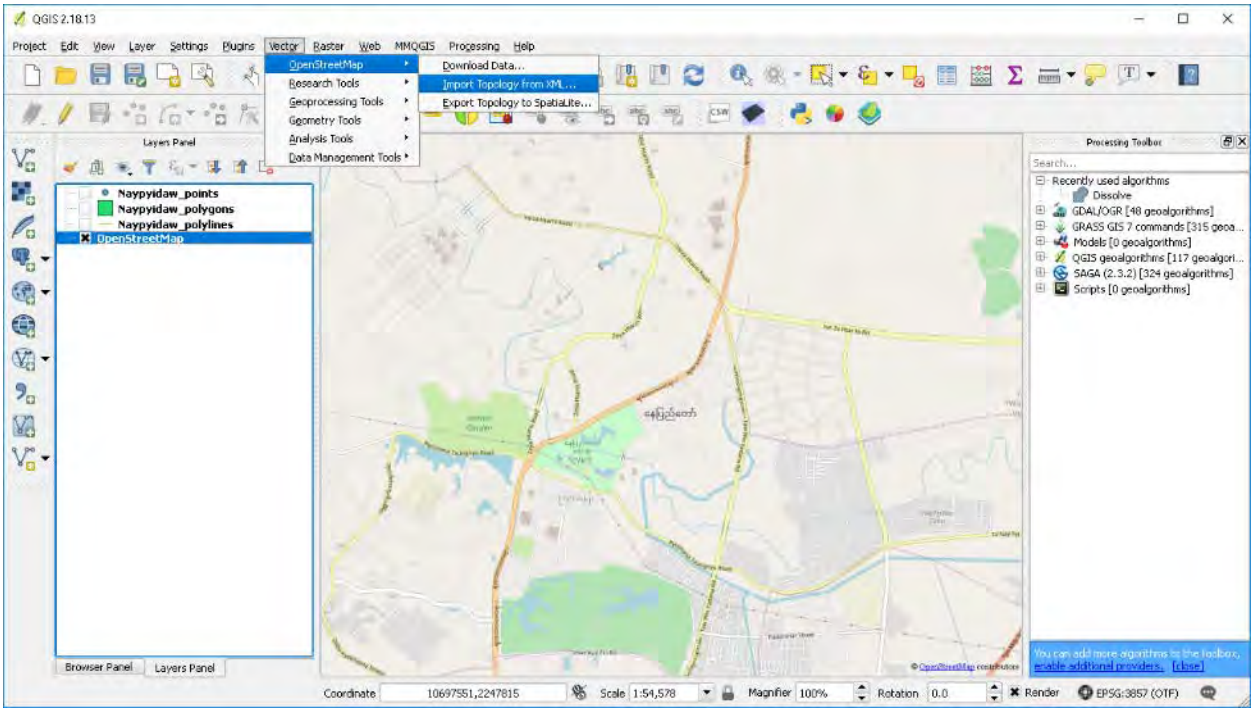
8. In the Download OpenStreetMap data dialog, choose From map canvas as the Extent. Choose the path and name the output file as `Naypidaw.osm`.



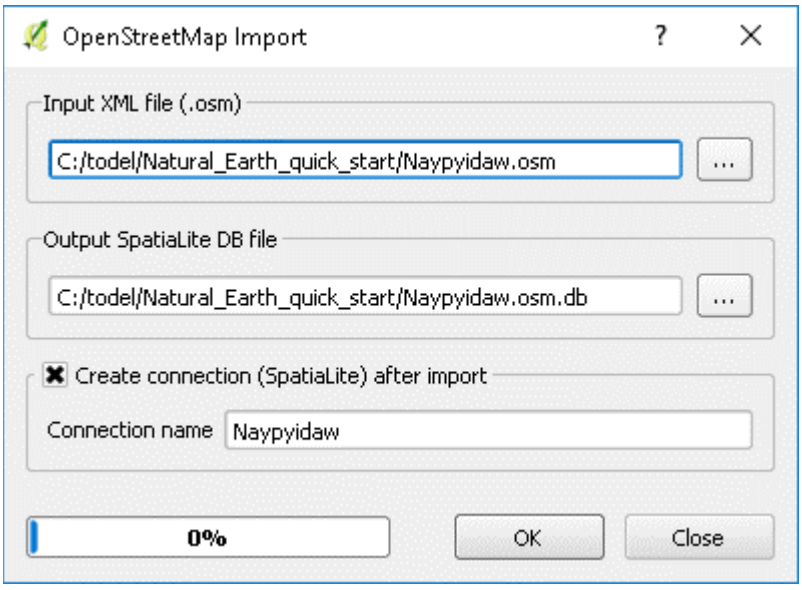
9. The downloaded file with the `.osm` extension is an text file in the OSM XML format. We first need to convert it into a suitable format that is easy to consume in QGIS. Go to Vector ▸ OpenStreetMap ▸ Import topology from XML .

Note

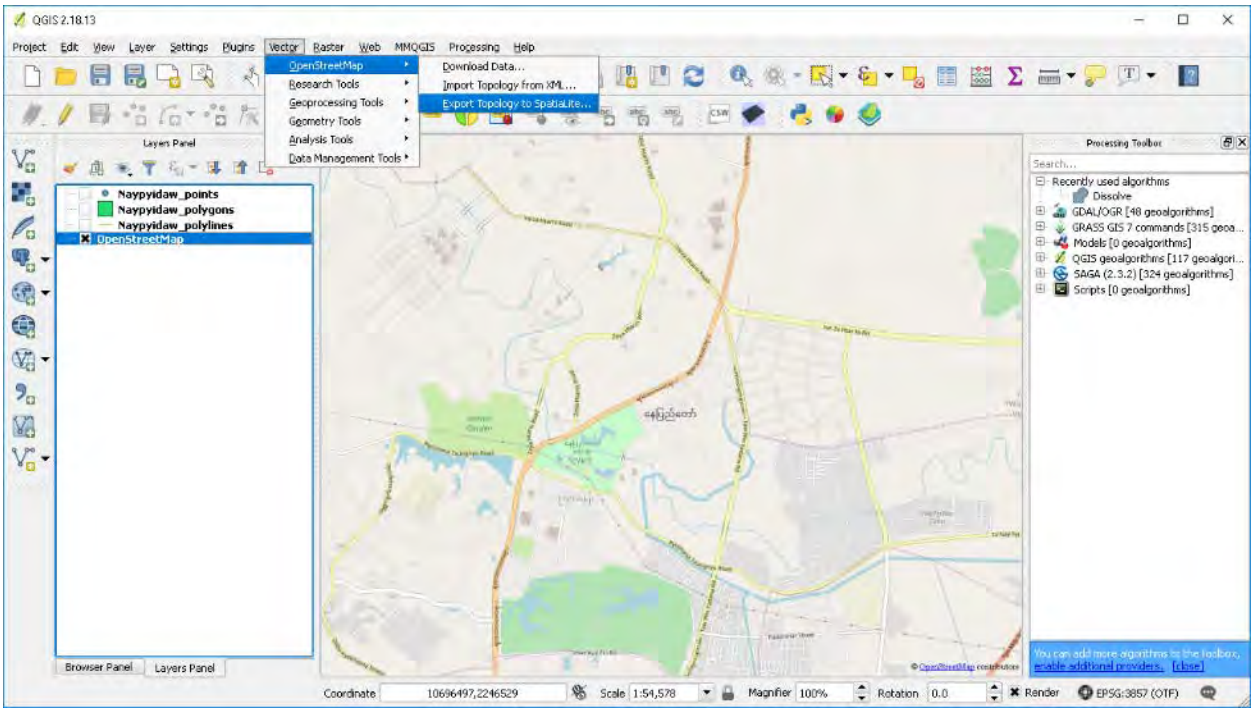
Now that we do not need the **OSM Place Search** functionality, you can click the close button to remove it from the main window. If you need to use it again, you can enable it from View ▸ Panels ▸ OSM place searc h... (Windows) or Settings ▸ Panels ▸ OSM place search... (Linux).



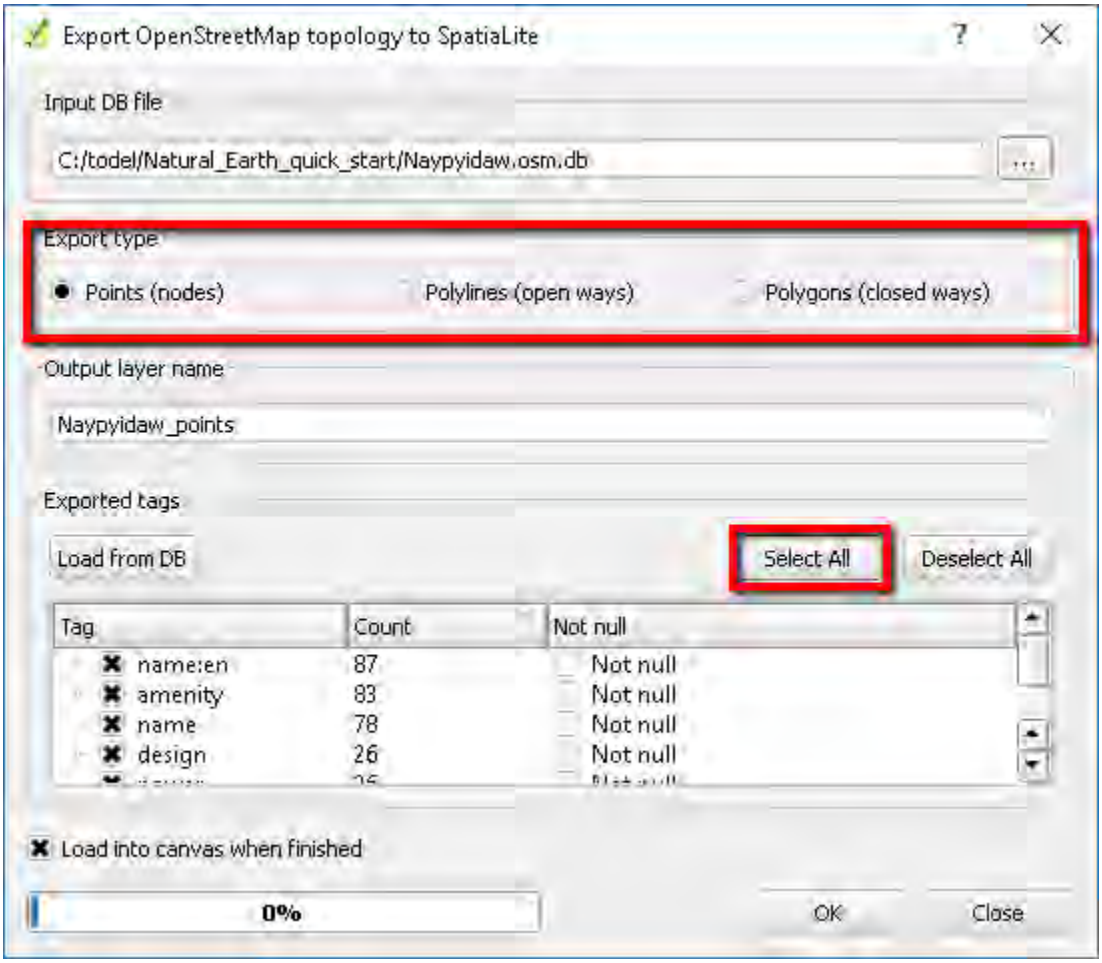
10. Choose the downloaded `Naypidaw.osm` as the Input XML file. Name the Output SpatiaLite DB file as `Naypidaw.osm.db`. Make sure the Create connection (SpatiaLite) after import button is checked.



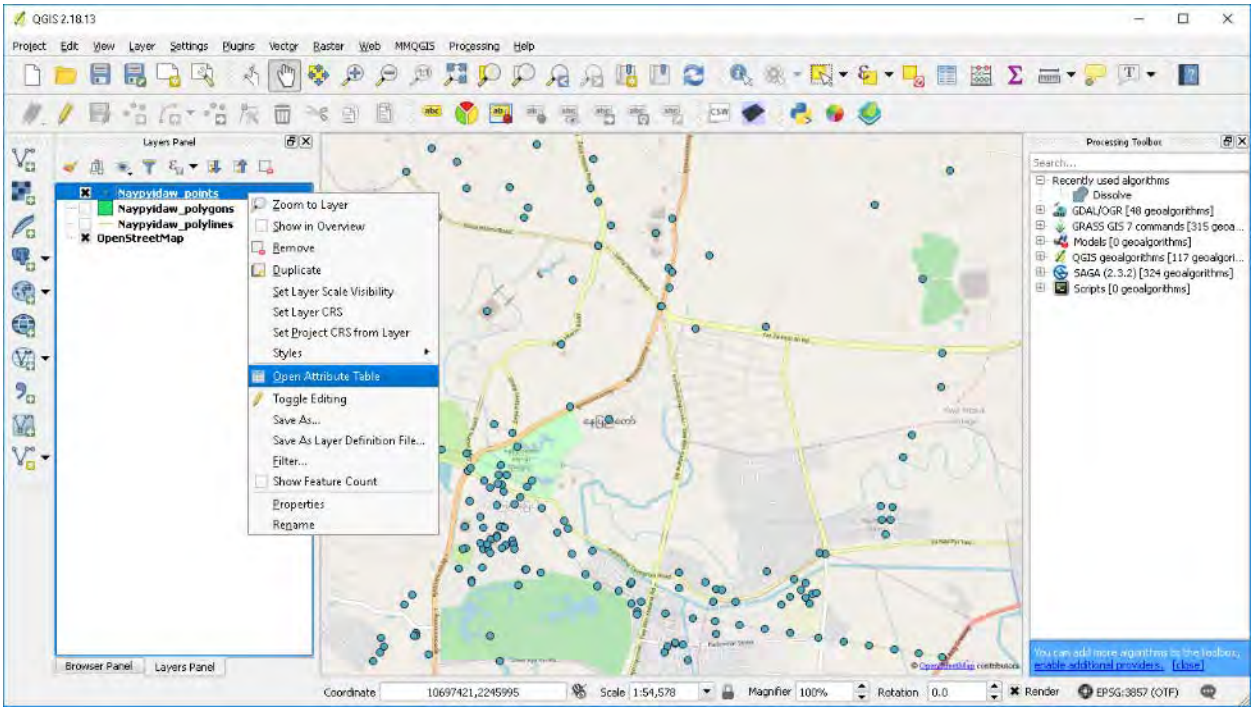
11. Now the last step. We need to create SpatialLite geometry layers that can be viewed and analyzed in QGIS. This is done using Vector ▸ OpenStreetMap ▸ Export topology to SpatialLite.



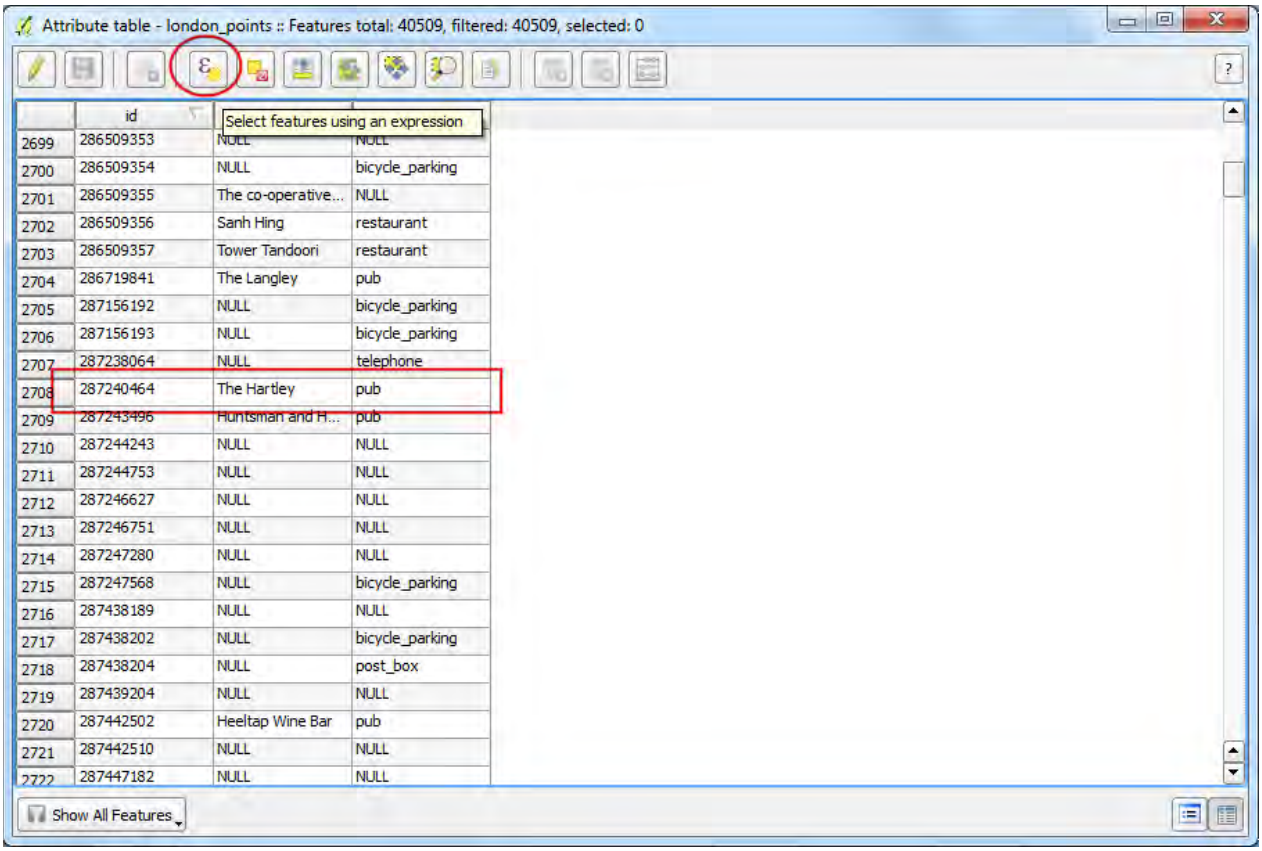
12. The `Naypyidaw.osm.db` file contains all feature types in the OSM database - Points, Lines and Polygons. GIS layers typically contain only one type of feature, so you need to choose one. Since we are interested in point locations of pubs, here you need to choose Point (nodes) as the Export type. You would choose Polylines (open ways) if you wanted to get the road network. Name the Output layer name as `Naypyidaw_points`. GIS data has 2 parts to it - location and attributes. We are also interested in the **name** of the pub - not just its location, so we need to export that information as well. Click on Load from DB under Exported tags section. This will fetch all attributes from the `Naypyidaw.osm.db` file.
Check name and amenity tags. See OSM Tags to learn more about what each attribute means. Make sure the Load into canvas when finished is checked, and click OK.



13. You will see a new point layer named `Naypyidaw_points` loaded in QGIS. Note that this contains **ALL** points in the OSM database for the viewport. Since we are interested only in pubs, we need to write a query to select only those. Right click on `Naypyidaw_points`layer and select Open Attribute Table.

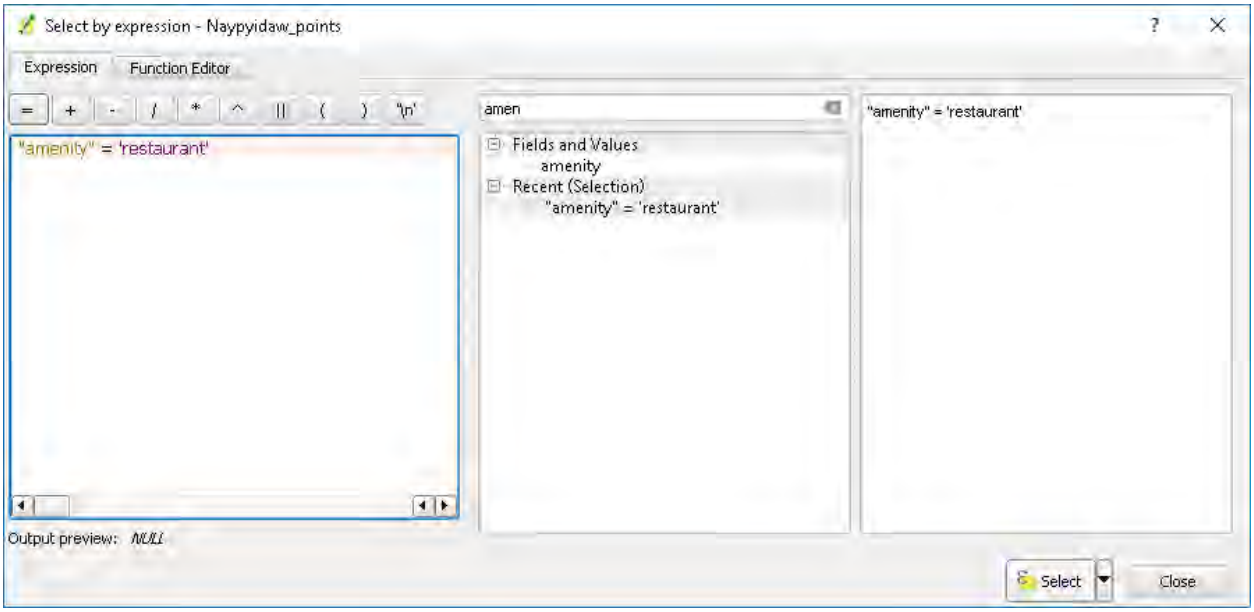


14. You will note that some features have the attribute value of **restaurant** listed under the amenity column. Click on Select features using an expression button.

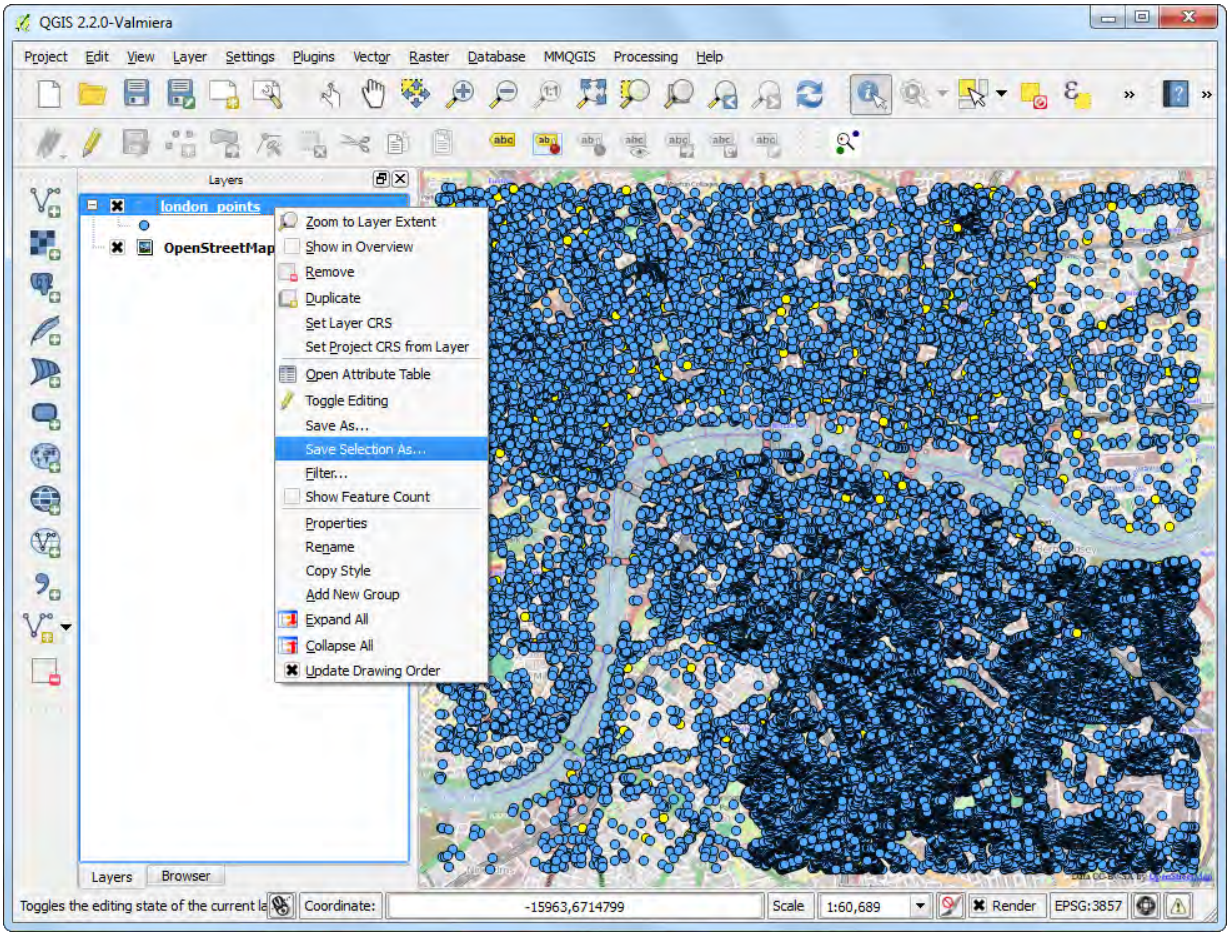


	id		
2699	286509353	NULL	NULL
2700	286509354	NULL	bicycle_parking
2701	286509355	The co-operative...	NULL
2702	286509356	Sanh Hing	restaurant
2703	286509357	Tower Tandoori	restaurant
2704	286719841	The Langley	pub
2705	287156192	NULL	bicycle_parking
2706	287156193	NULL	bicycle_parking
2707	287238064	NULL	telephone
2708	287240464	The Hartley	pub
2709	287243496	Huntsman and H...	pub
2710	287244243	NULL	NULL
2711	287244753	NULL	NULL
2712	287246627	NULL	NULL
2713	287246751	NULL	NULL
2714	287247280	NULL	NULL
2715	287247568	NULL	bicycle_parking
2716	287438189	NULL	NULL
2717	287438202	NULL	bicycle_parking
2718	287438204	NULL	post_box
2719	287439204	NULL	NULL
2720	287442502	Heeltap Wine Bar	pub
2721	287442510	NULL	NULL
2722	287447182	NULL	NULL

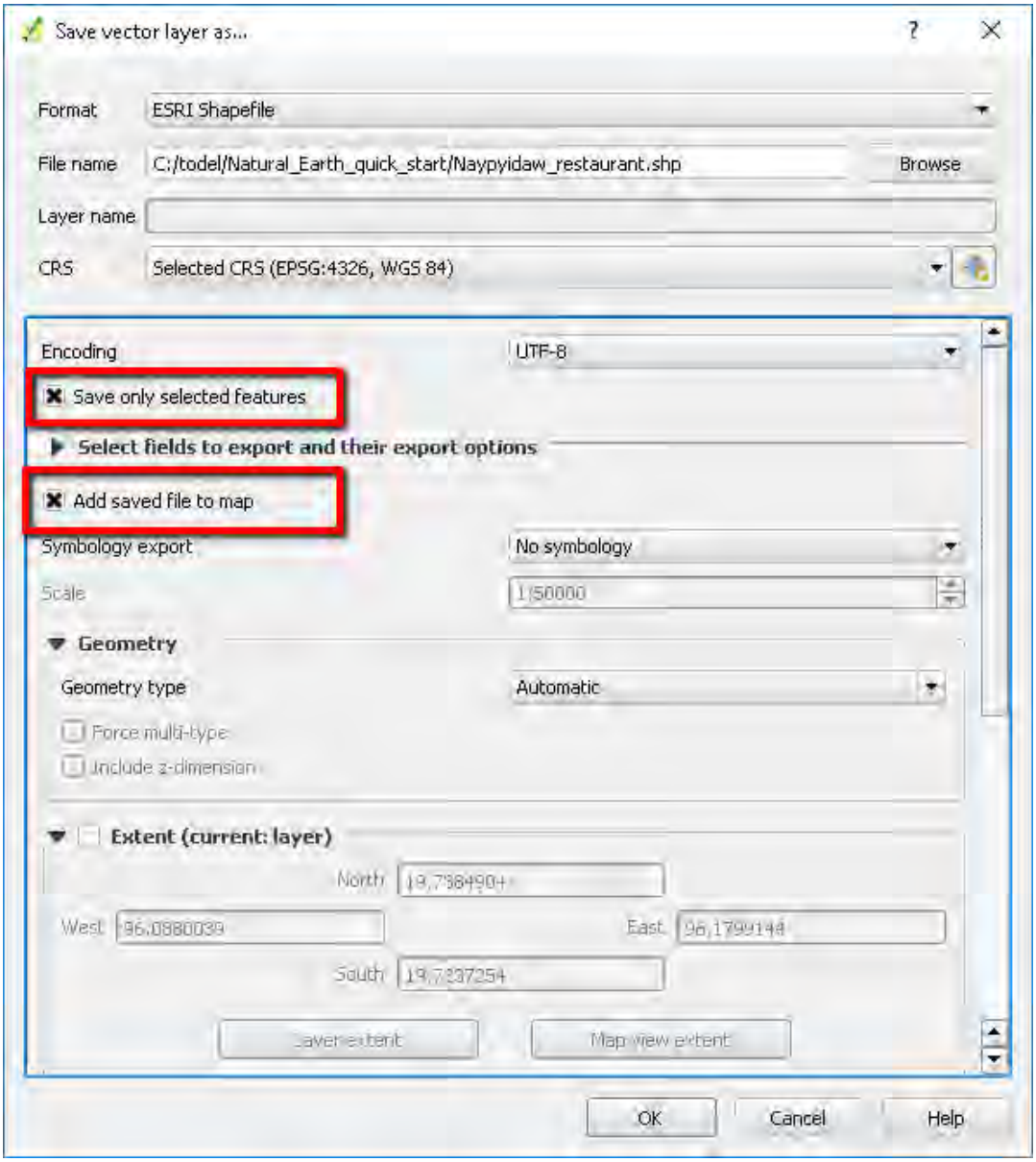
15. Enter the expression "amenity" = 'restaurants' and click Select.



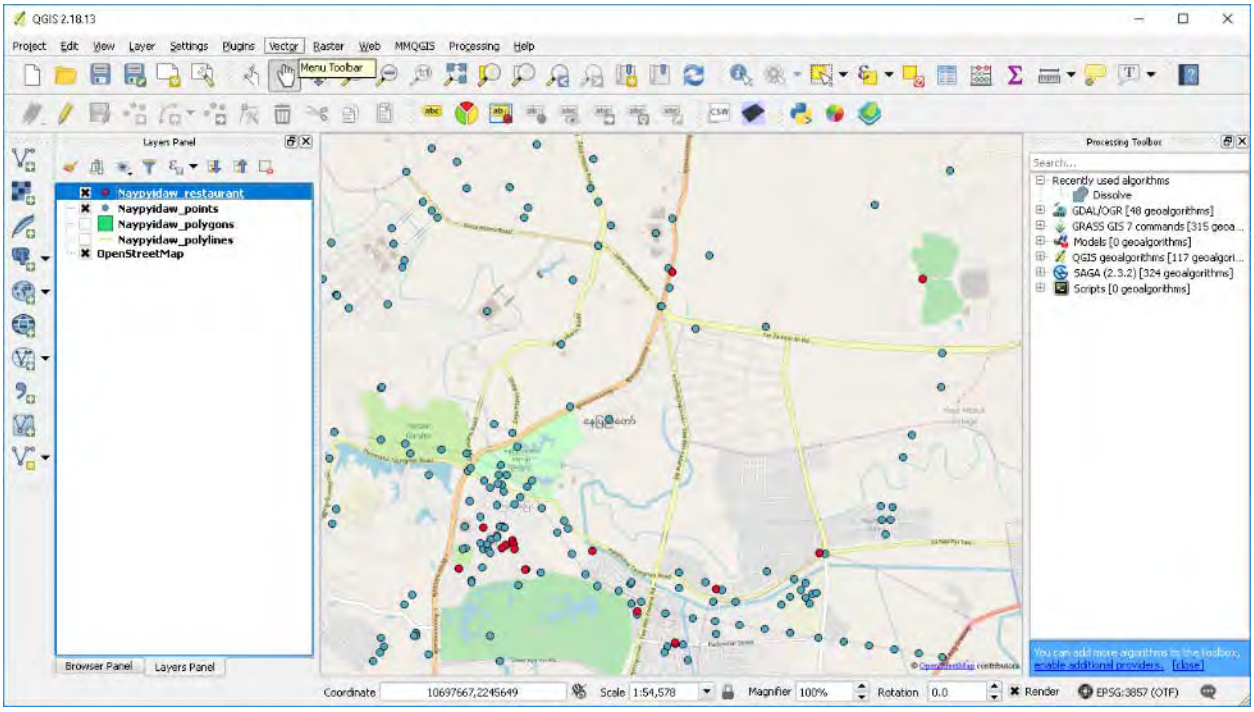
16. Back in the QGIS Canvas, you will see some points highlighted in yellow. These are the result of our query. Right-click the `Naypyidaw_points` layer and choose Save Selection As....



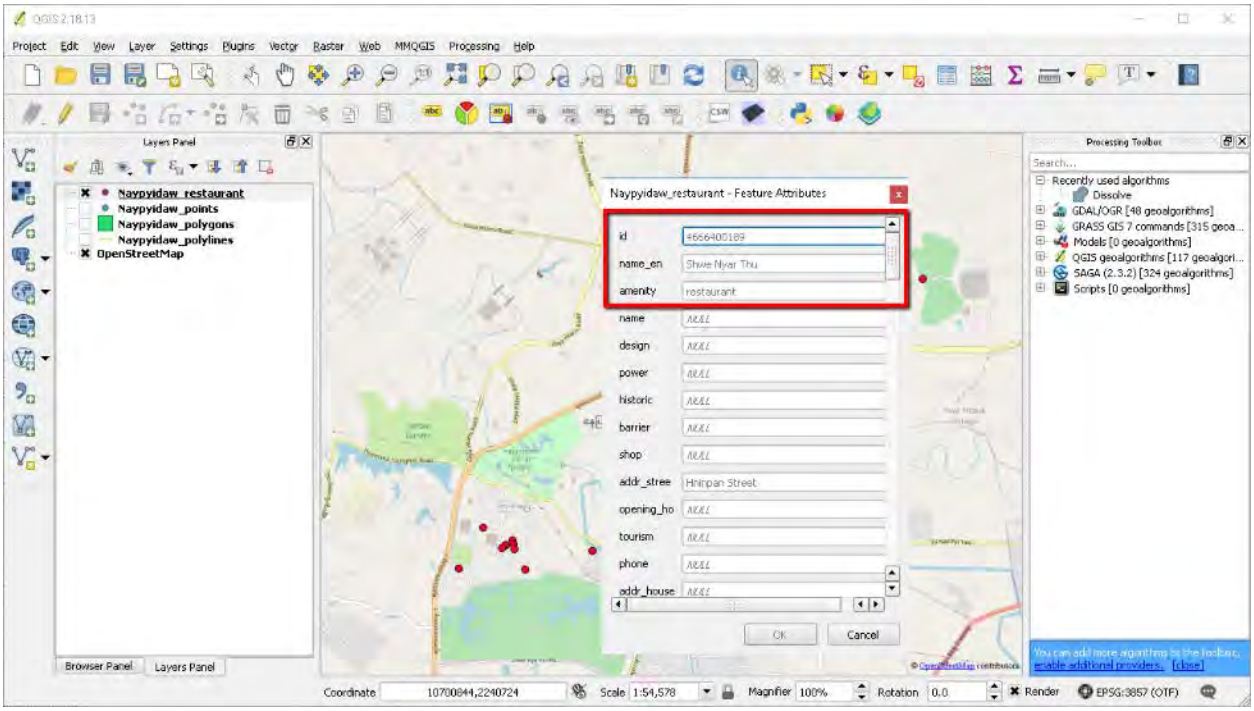
17. In the Save vector layer as... dialog, enter the name of the output file as `Naypyidaw_pubs.shp`. Leave all other options as they are and make sure the Add saved file to map option is checked. Click OK.



18. You will see a new layer named `Naypyidaw_pubs` in the QGIS canvas. Uncheck the `Naypyidaw_points` layer as we don't need that anymore.



19. The extraction of the pubs shapefile layer is now complete. You can use the Identify tool to click on any of the point as see its attributes.



6 Basic Vector Styling

To create a map, one has to style the GIS data and present it in a form that is visually informative. There are a large number of options available in QGIS to apply different types of symbology to the underlying data. In this tutorial, we will explore some basics of styling.

6.1 Overview of the task

We will style a vector layer to show life expectancy in different countries of the world.

Other skills you will learn

- View the attribute table of a vector layer.

6.2 Get the data

The data we will use is from Center for Sustainability and the Global Environment (SAGE) at the University of Wisconsin-Madison.

You can download the Life Expectancy GIS Grid data from the human impact dataset.

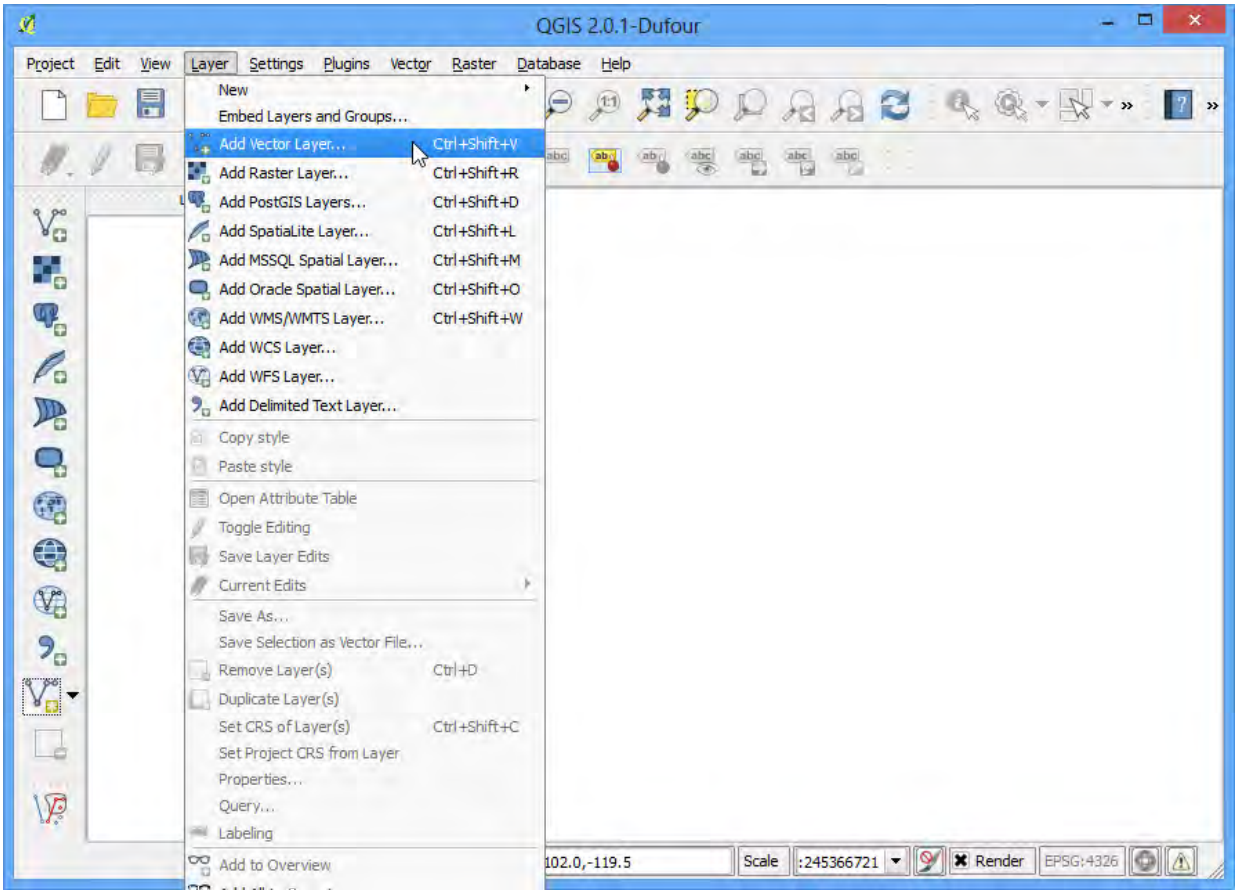
For convenience, you may directly download a copy of the dataset from the link below:

lifeexpectancy.zip

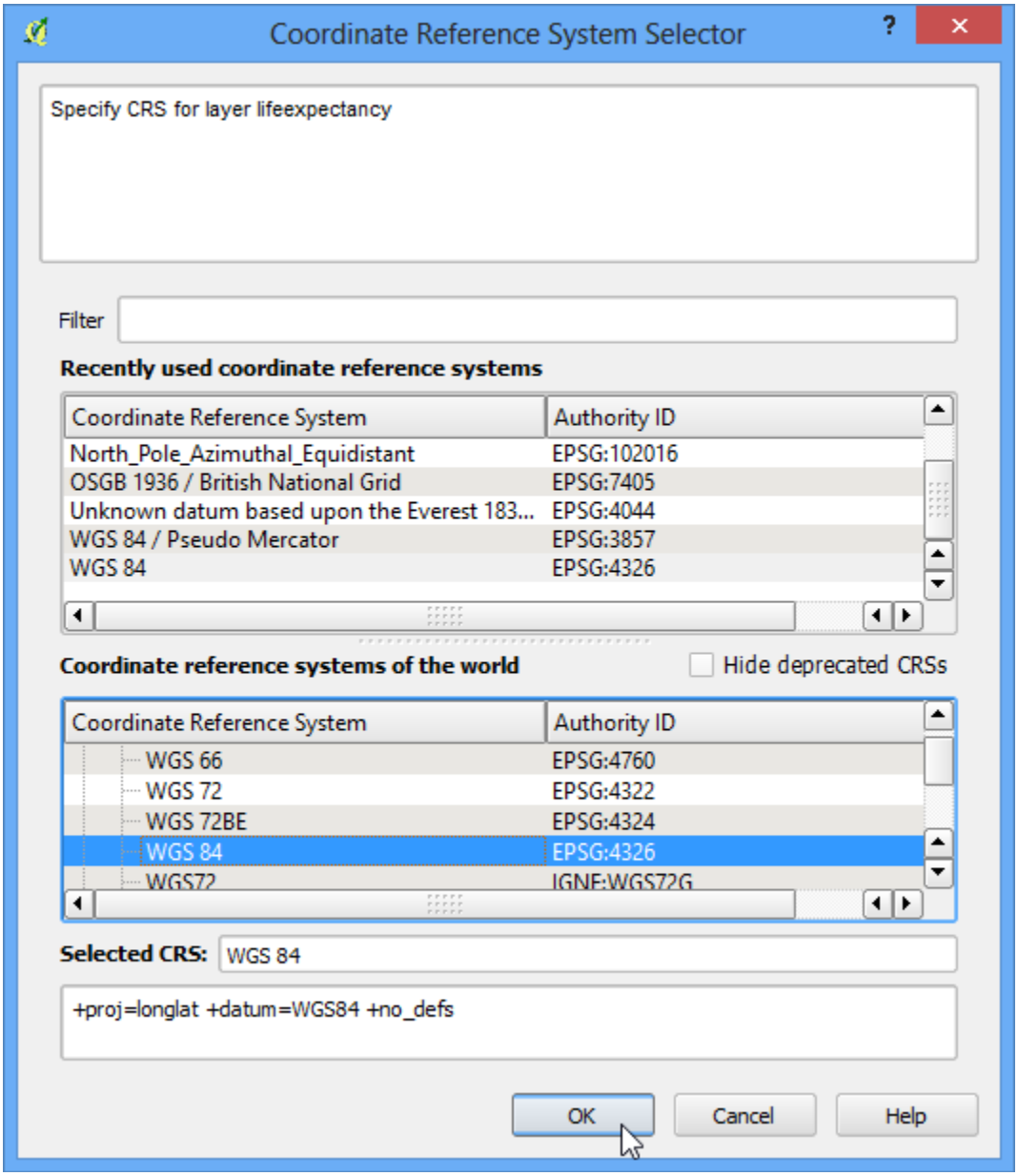
Data Source [SAGE]

6.2.1 Procedure

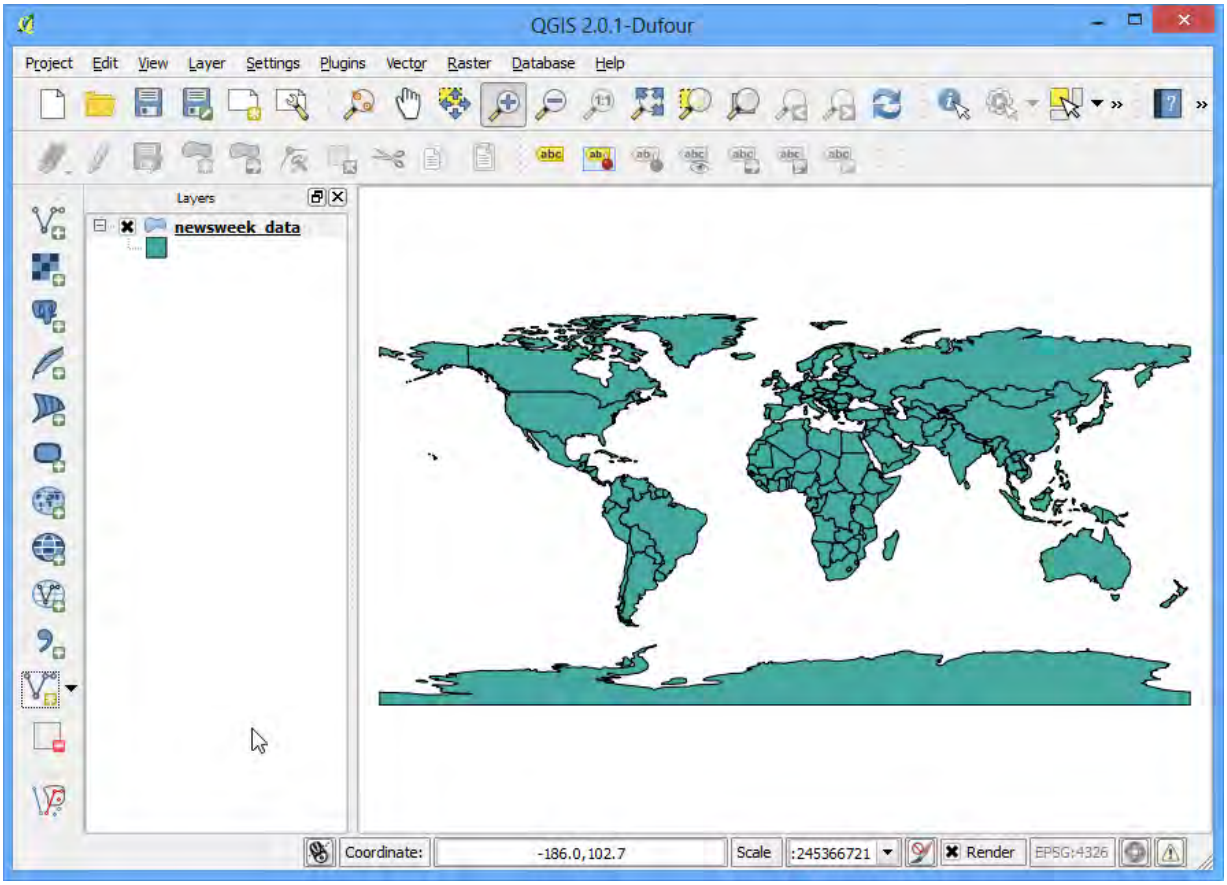
1. Open QGIS and go to Layer ‣ Add Vector Layer.. .



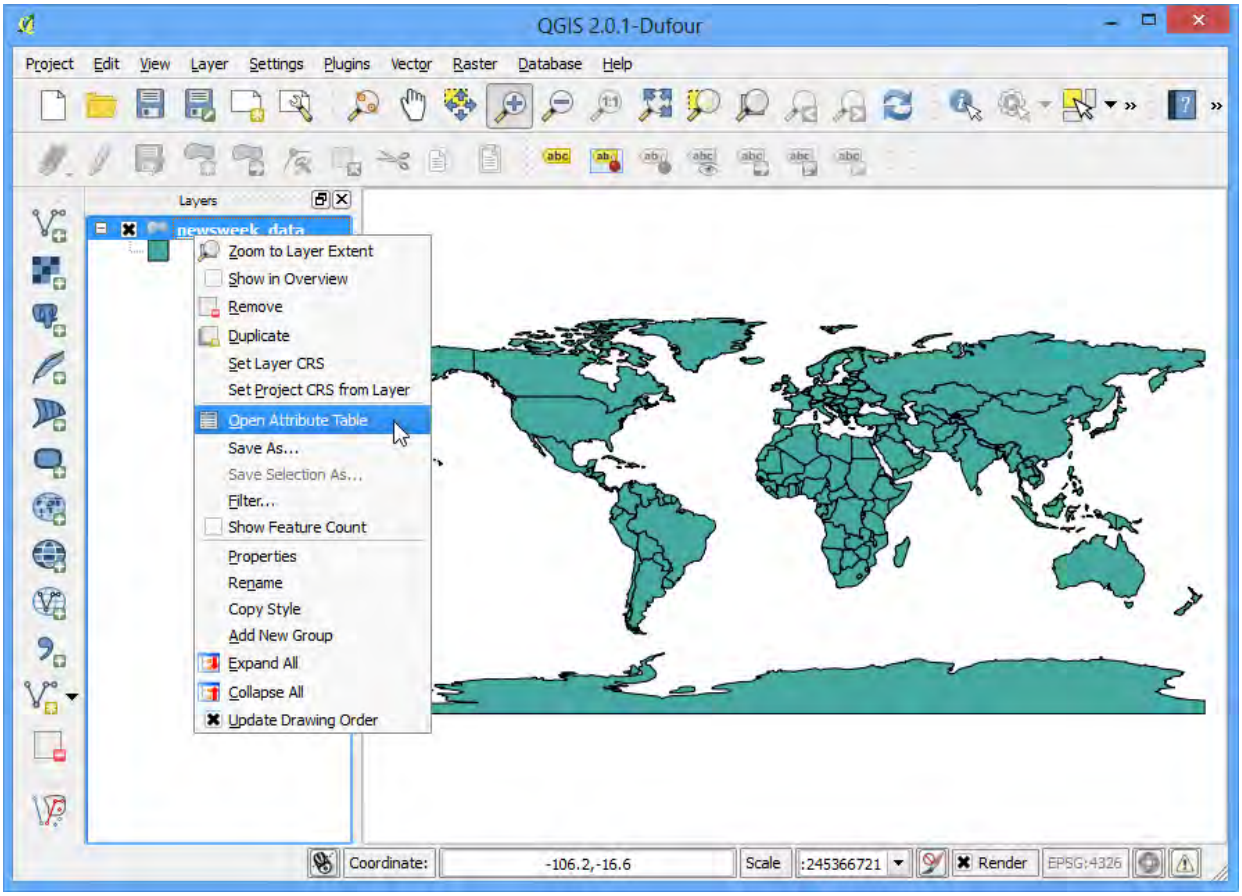
2. Browse to the downloaded `lifeexpectancy.zip` file and click Open.
   Select `newsweek_data.shp` and click Open. Next you will be prompted for choosing the CRS.
   Select WGS84 EPSG:4326 as the Coordinate Reference System (CRS).



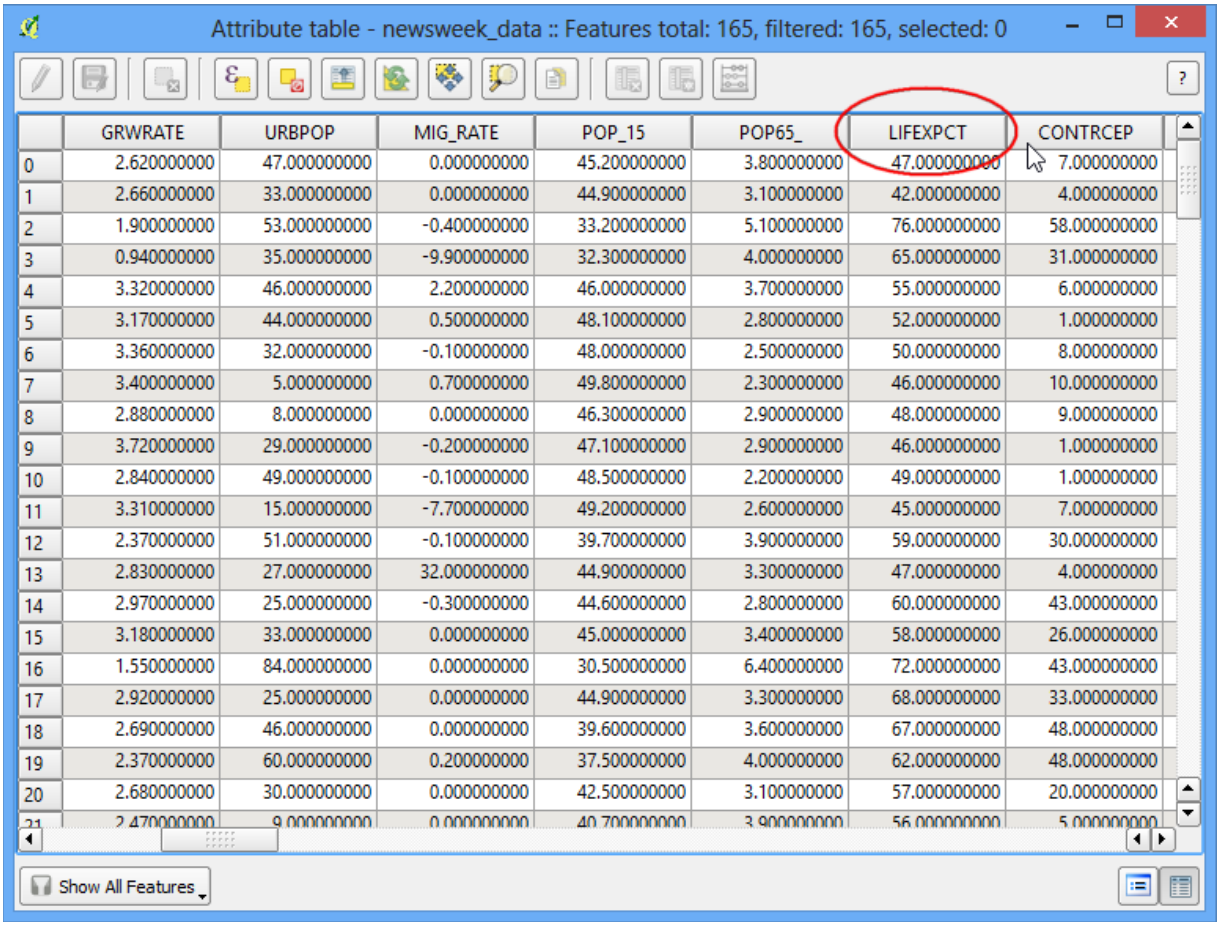
3. The shapefile contained within the zip file is now loaded and you can see the default style applied to it.



4. Right click on the layer name and select Open Attribute Table.

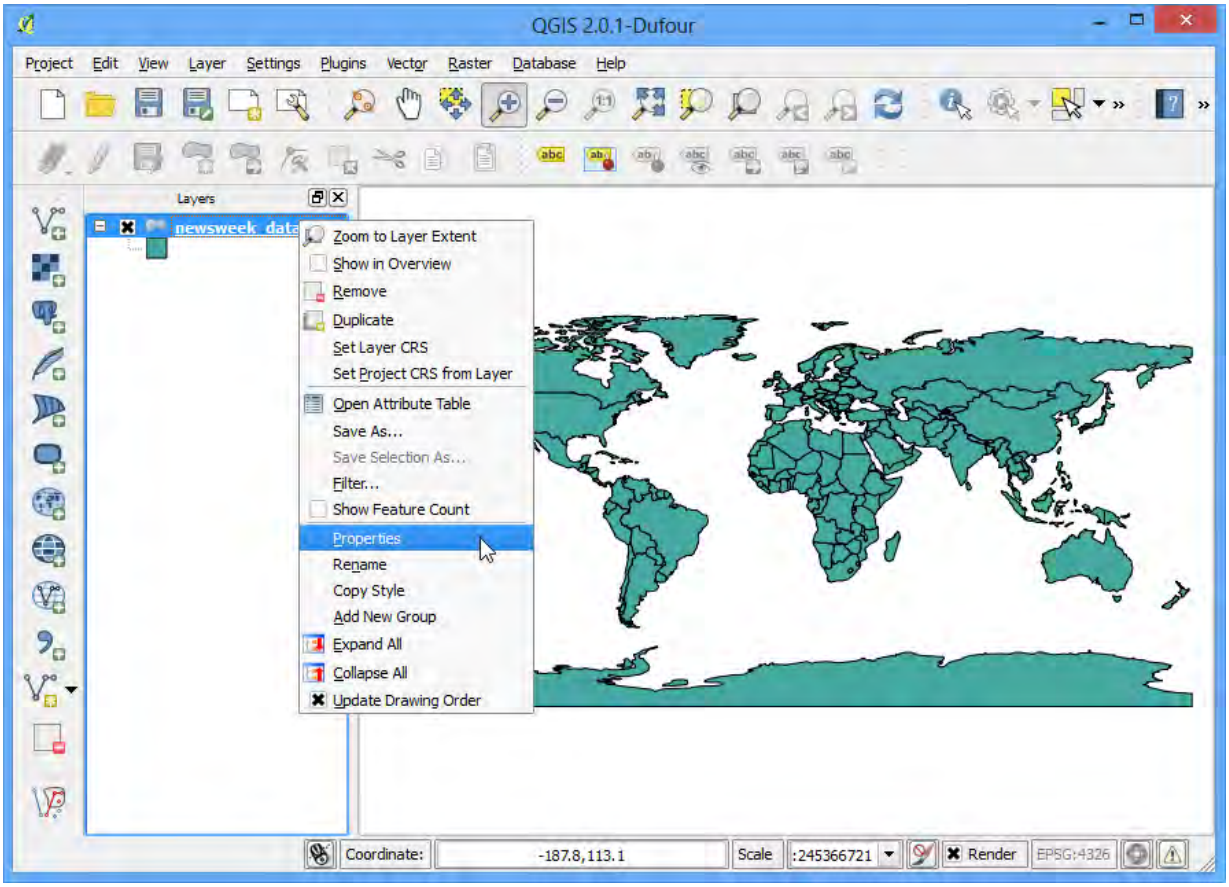


5. Explore the different attributes. To style a layer, we must pick an attribute or a column that would represent the map we are trying to create. Since we want to create a layer represting life expectancy, i.e. the average age till a person lives in a country, the field LIFEXPCT is the attribute we want to use in styling.

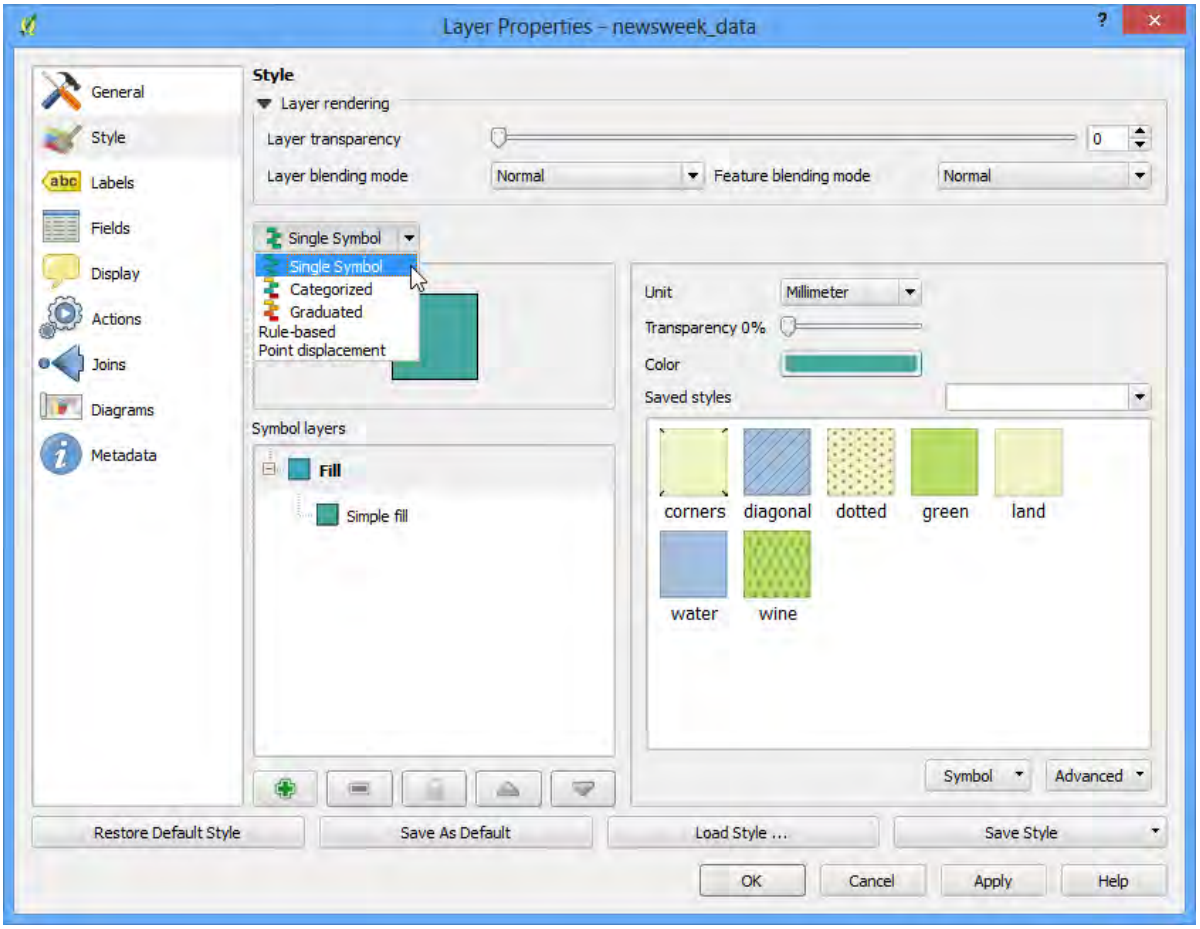


	GRWRATE	URBPOP	MIG_RATE	POP_15	POP65_	LIFEXPCT	CONTRCEP
0	2.620000000	47.000000000	0.000000000	45.200000000	3.800000000	47.000000000	7.000000000
1	2.660000000	33.000000000	0.000000000	44.900000000	3.100000000	42.000000000	4.000000000
2	1.900000000	53.000000000	-0.400000000	33.200000000	5.100000000	76.000000000	58.000000000
3	0.940000000	35.000000000	-9.900000000	32.300000000	4.000000000	65.000000000	31.000000000
4	3.320000000	46.000000000	2.200000000	46.000000000	3.700000000	55.000000000	6.000000000
5	3.170000000	44.000000000	0.500000000	48.100000000	2.800000000	52.000000000	1.000000000
6	3.360000000	32.000000000	-0.100000000	48.000000000	2.500000000	50.000000000	8.000000000
7	3.400000000	5.000000000	0.700000000	49.800000000	2.300000000	46.000000000	10.000000000
8	2.880000000	8.000000000	0.000000000	46.300000000	2.900000000	48.000000000	9.000000000
9	3.720000000	29.000000000	-0.200000000	47.100000000	2.900000000	46.000000000	1.000000000
10	2.840000000	49.000000000	-0.100000000	48.500000000	2.200000000	49.000000000	1.000000000
11	3.310000000	15.000000000	-7.700000000	49.200000000	2.600000000	45.000000000	7.000000000
12	2.370000000	51.000000000	-0.100000000	39.700000000	3.900000000	59.000000000	30.000000000
13	2.830000000	27.000000000	32.000000000	44.900000000	3.300000000	47.000000000	4.000000000
14	2.970000000	25.000000000	-0.300000000	44.600000000	2.800000000	60.000000000	43.000000000
15	3.180000000	33.000000000	0.000000000	45.000000000	3.400000000	58.000000000	26.000000000
16	1.550000000	84.000000000	0.000000000	30.500000000	6.400000000	72.000000000	43.000000000
17	2.920000000	25.000000000	0.000000000	44.900000000	3.300000000	68.000000000	33.000000000
18	2.690000000	46.000000000	0.000000000	39.600000000	3.600000000	67.000000000	48.000000000
19	2.370000000	60.000000000	0.200000000	37.500000000	4.000000000	62.000000000	48.000000000
20	2.680000000	30.000000000	0.000000000	42.500000000	3.100000000	57.000000000	20.000000000
21	2.470000000	9.000000000	0.000000000	40.700000000	3.900000000	56.000000000	5.000000000

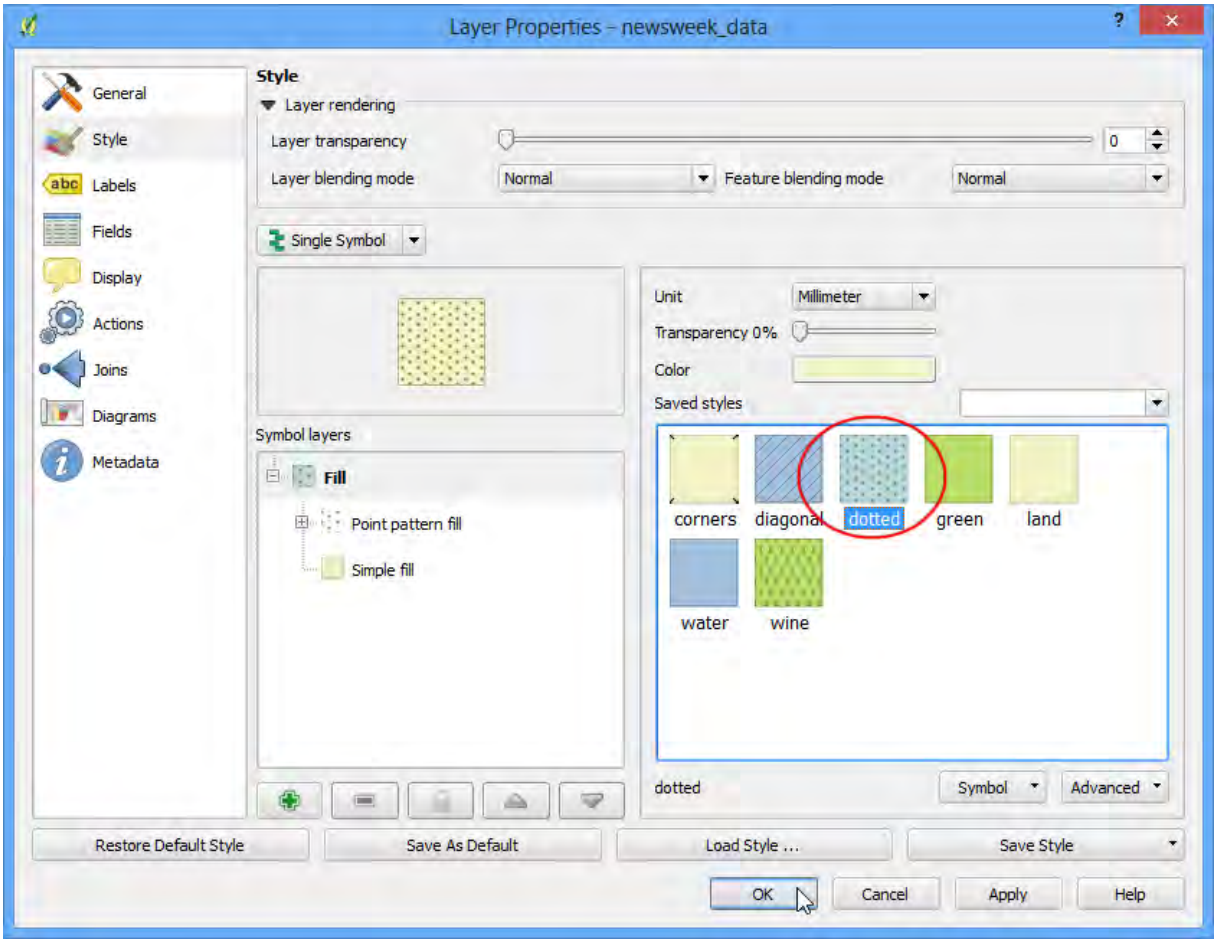
6. Close the attribute table. Right click on the layer again and choose Properties.



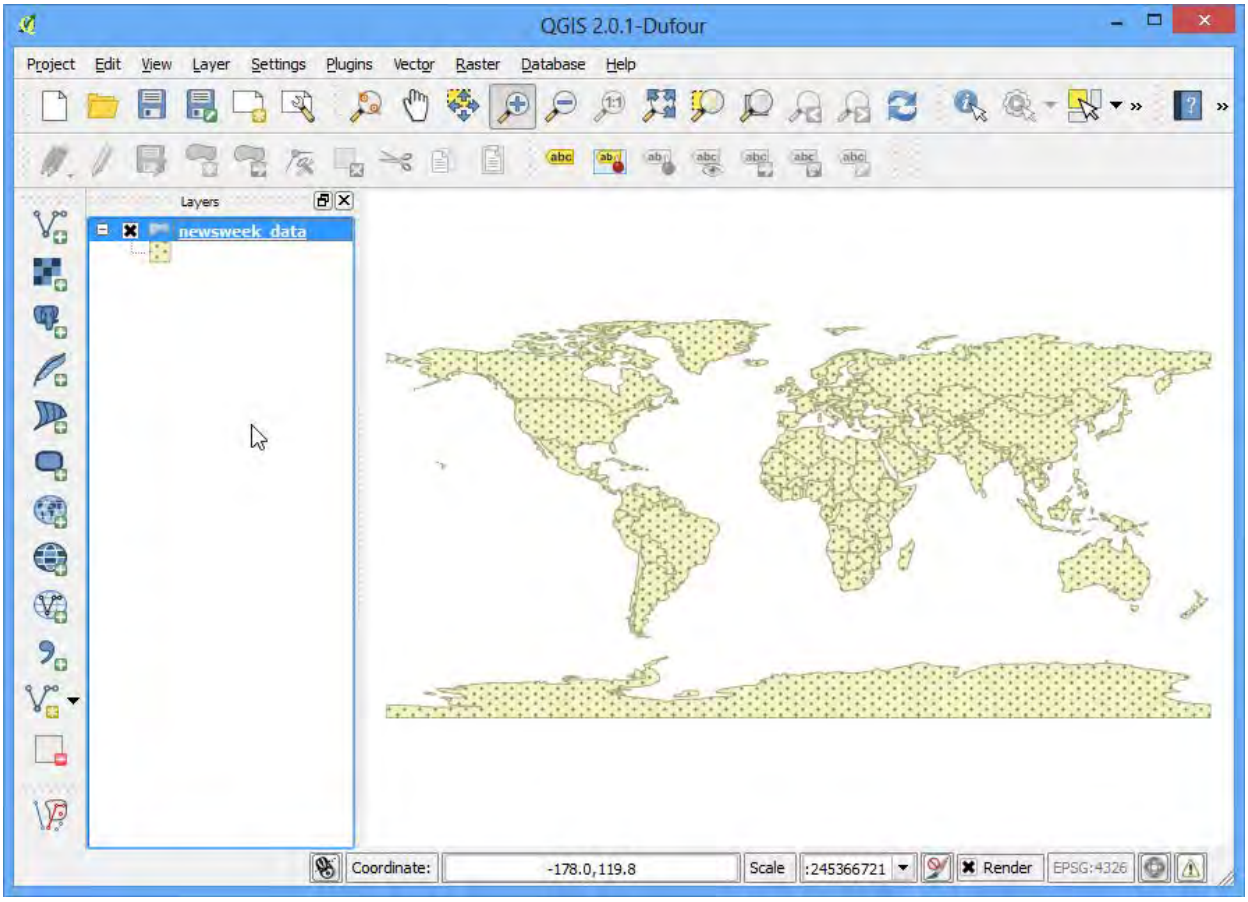
7. The various styling options are located in the Style tab of the Properties dialog. Clicking on the drop-down button inthe Style dialiog, you will see there are five options available - Single Symbol, Categorized, Graduated, Rule Based and Point displacement. We will explore the first three in this tutorial.



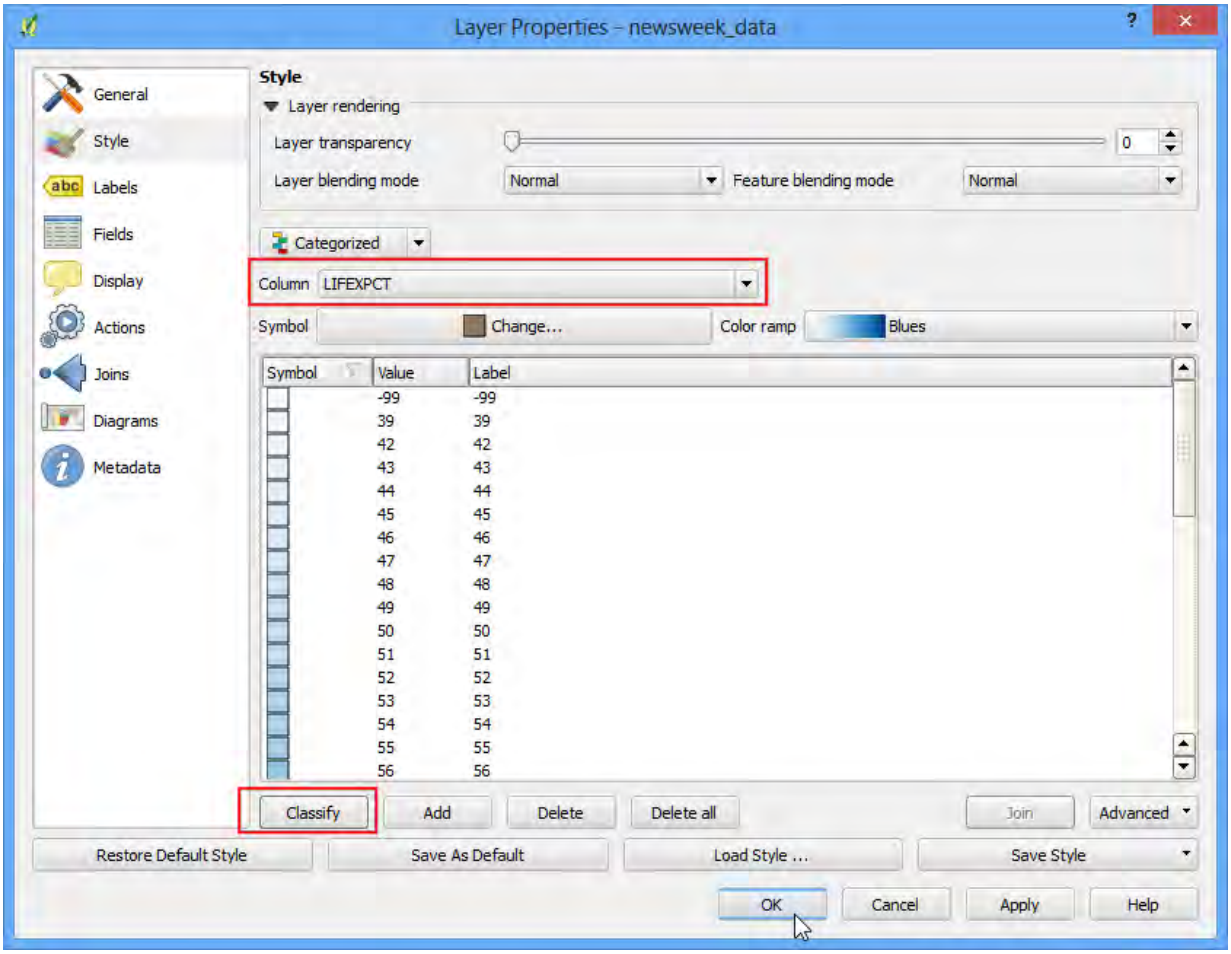
8. Select Single Symbol. This option allows you to choose a single style that will be applied to all the features in the layer. Since this is a polygon dataset, you have two basic choices. You can fill the polygon, or you can style with only outline. You can choose the dotted pattern fill and click OK.



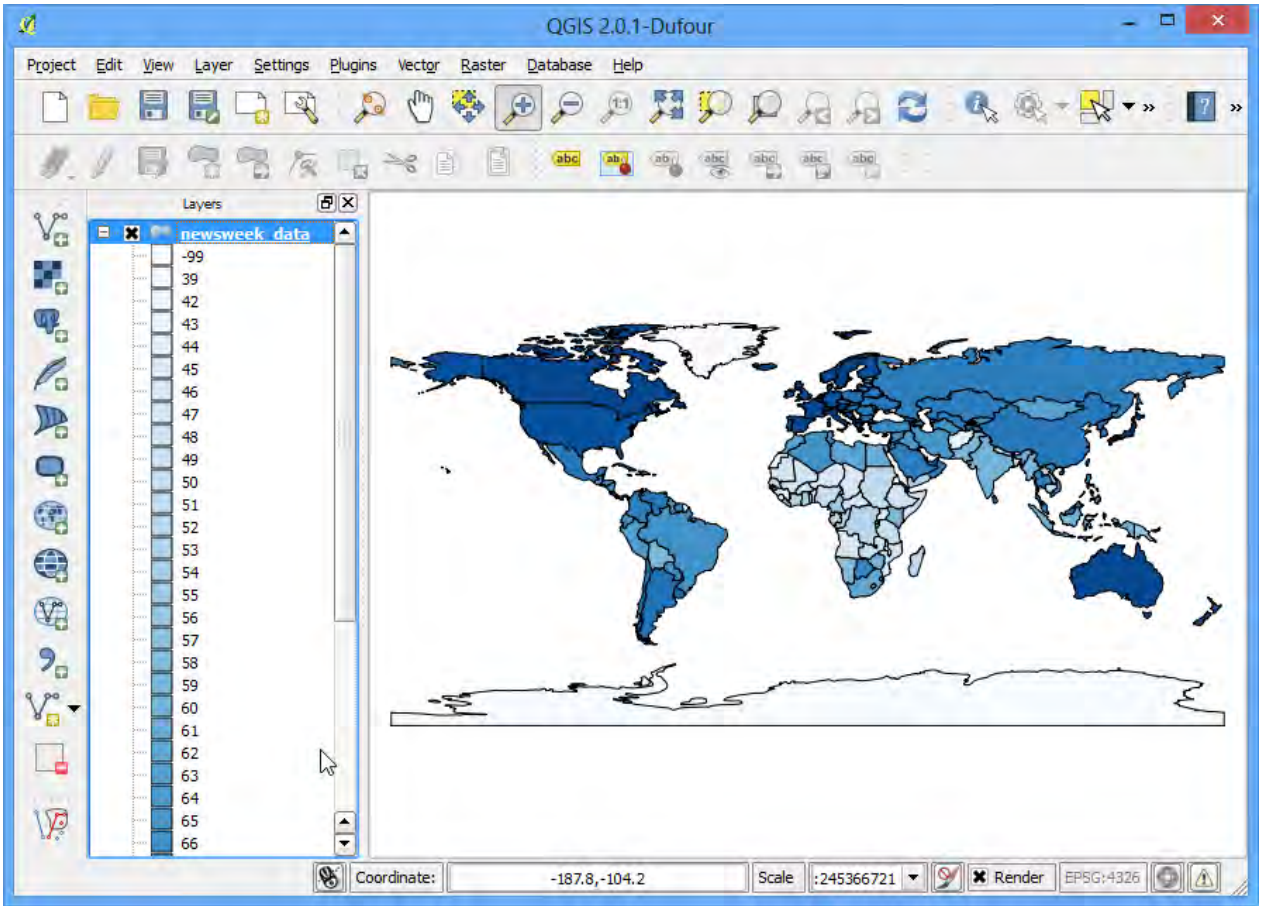
9. You will see a new style applied to the layer with the fill pattern you chose.



10. You will see that this Single Symbol style isn't useful in communicating the life expectancy data we are trying to map. Let us explore another styling option. Right-click the layer again and choose Properties. This time choose Categorized from the Styletab. Categorized means the features in the layer will be shown in different shades of a color based on unique values in an attribute field. Choose LIFEXPCT value as the Column. Choose a color ramp of your choice and click Classify at the bottom. Click OK.



11. You will see different countries appearing in shades of blue. Lighter shades meaning lower life expectancy and darker shades meaning higher life expectancy. This representation of the data is more useful and clearly show how life expectancy in developed countries vs. developing countries. This would be the type of style we set out to create.



12. Let us explore the Graduated symbology type in the Style dialog now. Graduated symbology type allows you to break down the data in a column in unique *classes* and choose a different style for each of the classes. We can think of classifying our life expectancy data into 3 classes, `LOW`, `MEDIUM` and `HIGH`. Choose LIFEXPCT as the Column and choose 3 as the classes. You will see there are many Mode optionsa vailable. Let us see the logic behind each of these modes. There are 5 modes available. Equal Interval, Quantile, Natural Breaks (Jenks), Standard Deviation and Pretty Breaks. These modes use different statistical algorithms to break down the data into separate classes.

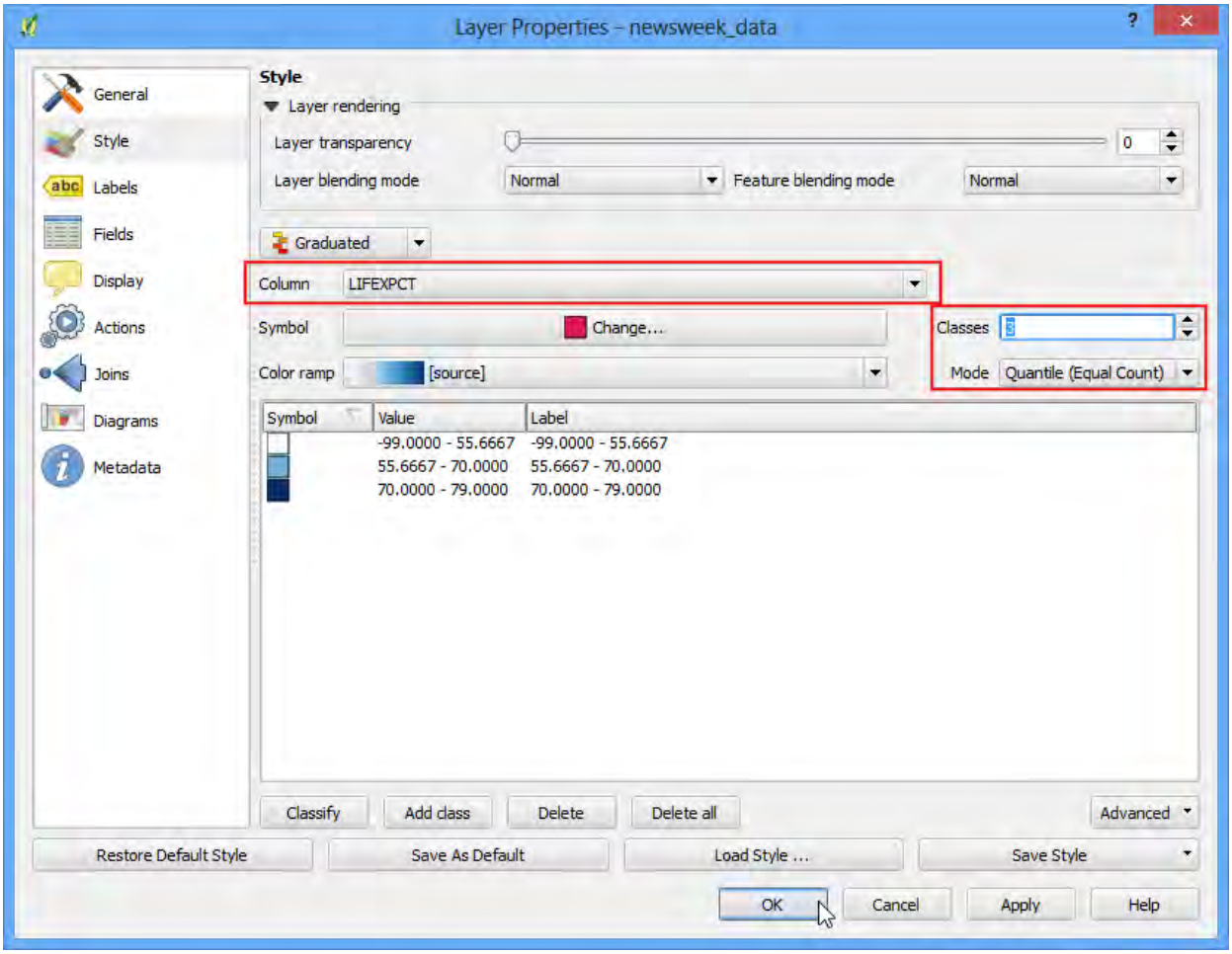
    - Equal Interval: As the name suggests, this method will will create classes which are at the same size. If our data ranges from 0-100 and we want 10 classes, this method would create a class from 0-10, 10-20, 20-30 and so on , keeping each class the same size of 10 units.
    - Quantile - This method will decide the classes such that number of values in each class are the same. If there are 100 values and we want 4 classes, quantile method will decide the classes such that each class will have 25 values.
    - Natural Breaks (Jenks) - This algorithm tries to find natural groupings of data to create classes. The resulting classes will be such that there will be maximum variance between individual classes and least variance within each class.
    - Standard Deviation - This method will calculate the mean of the data, and create classes based on standard deviation from the mean.

- Pretty Breaks - This is based on the statistical package R's pretty algorithm. It is a bit complex, but the pretty in the name means it creates class boundaries that are round numbers.

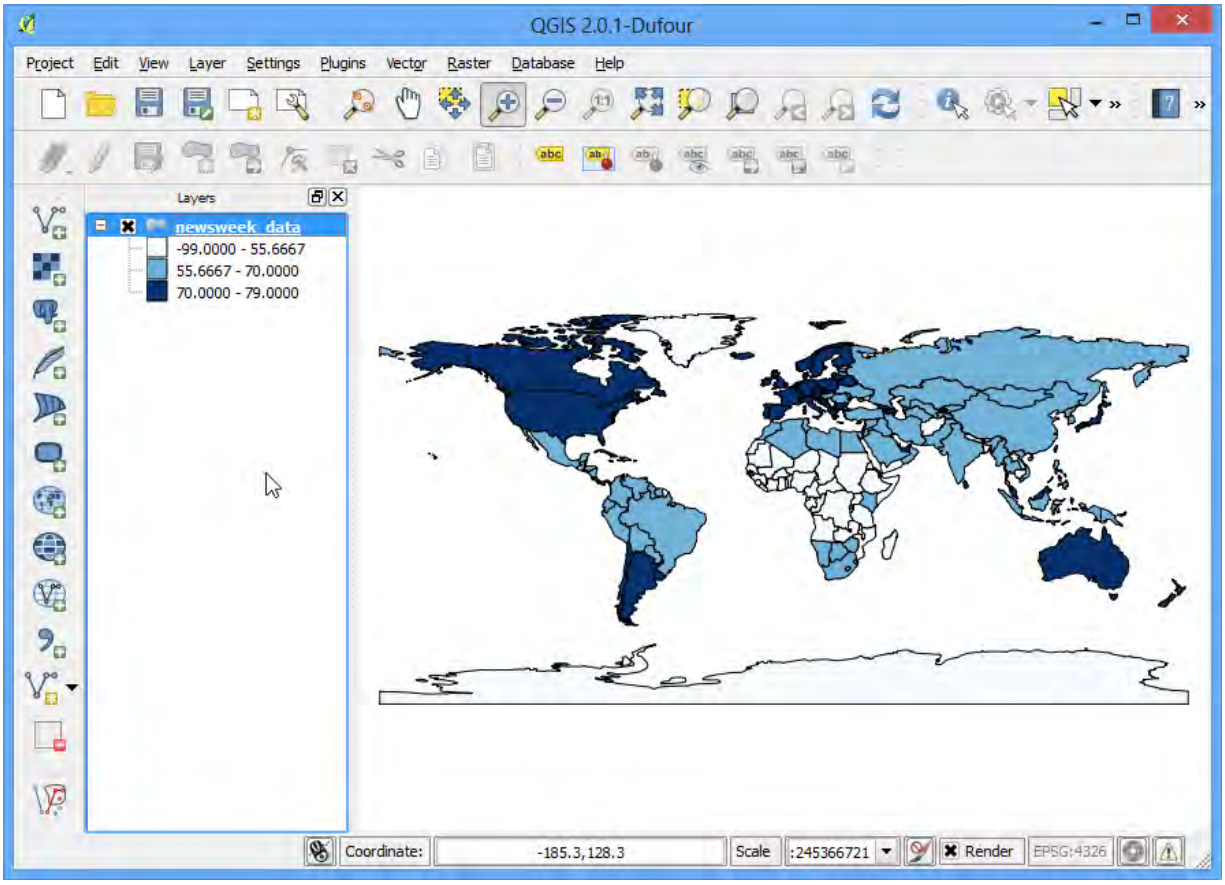
To keep things simple, let's use the Quantile method. Click Classify at the bottom and you will see 3 classes show up with their corresponding values. Click OK.

Note

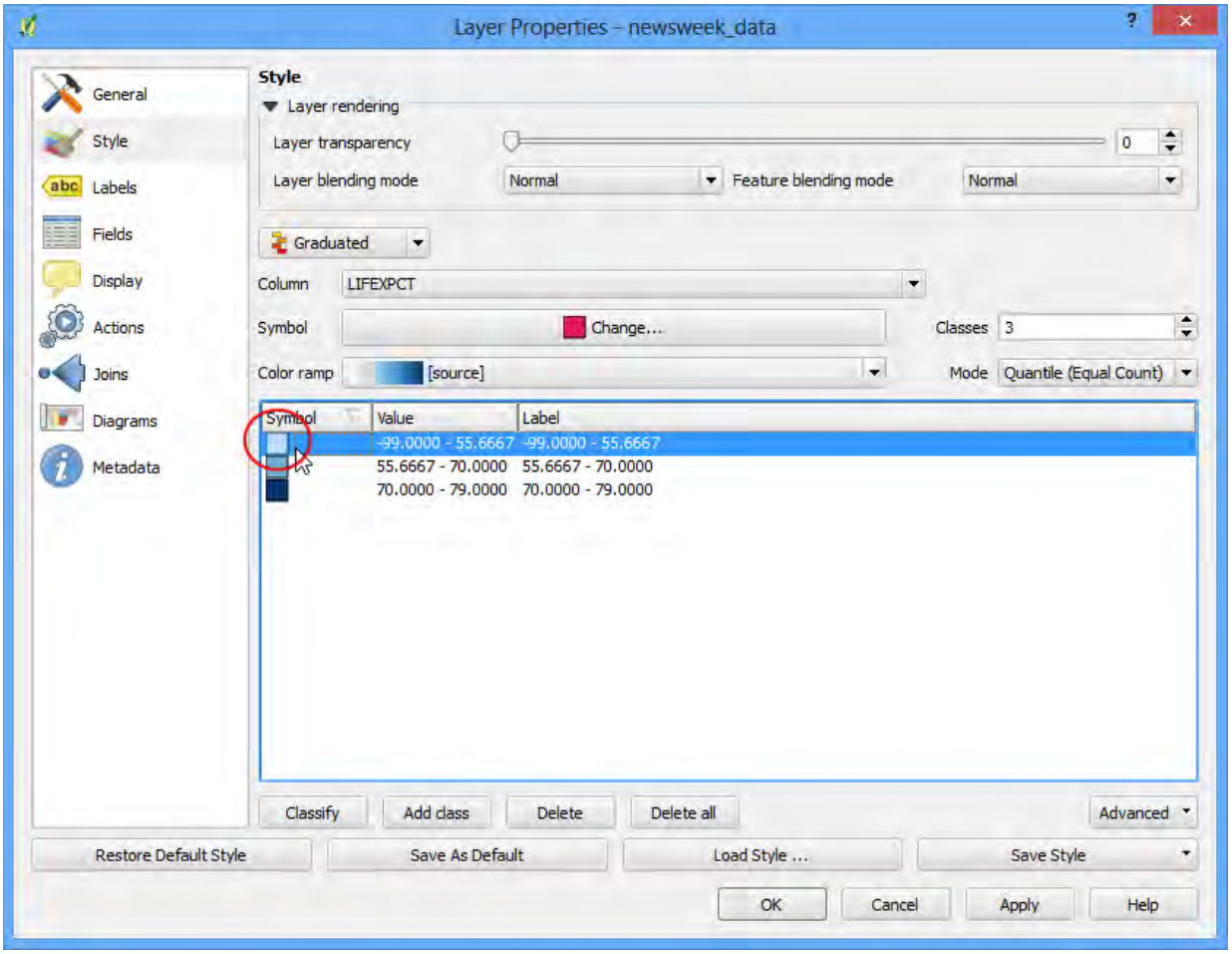
For an attribute to be used in Graduated style, it must be a numeric field. Integer and Real values are fine, but if the attribute field type is String, it cannot be used with this styling option.



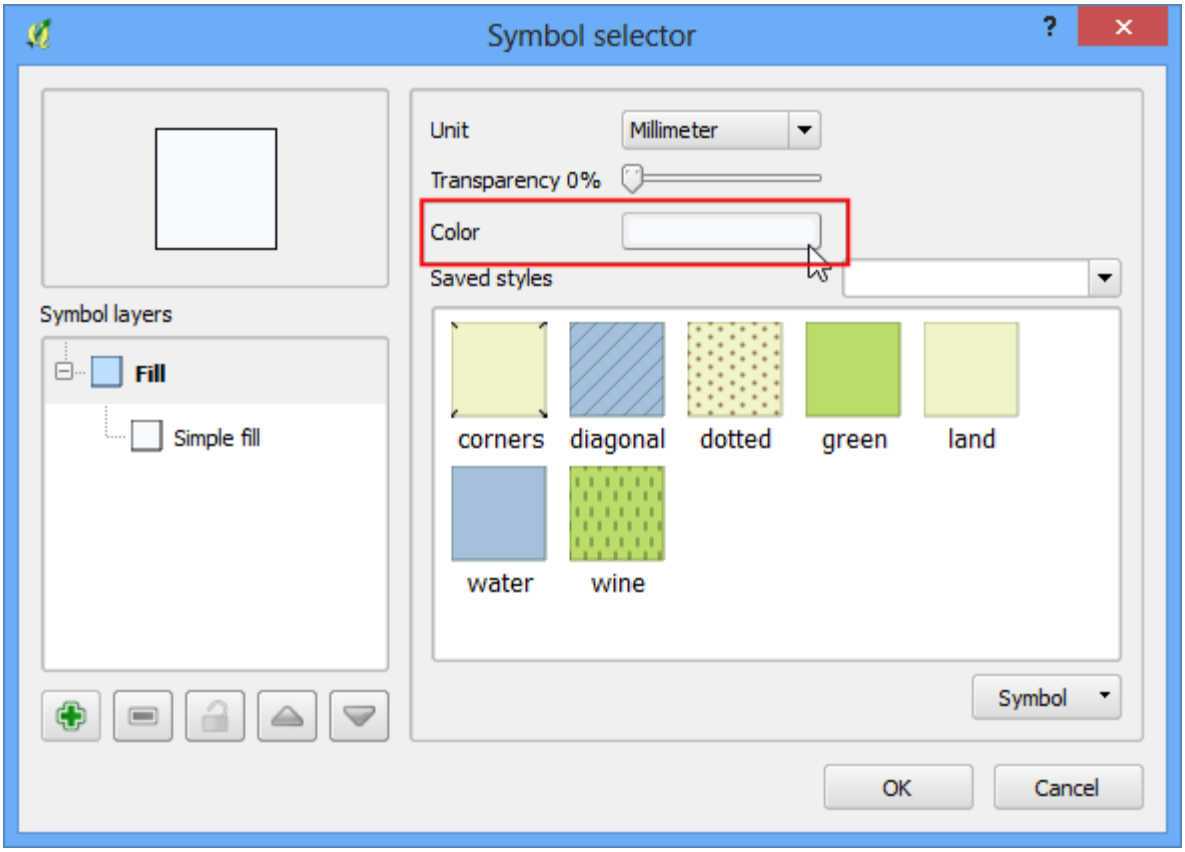
13. You will see a map showing countries in either of 3 colors representing average life expectancy in the country.



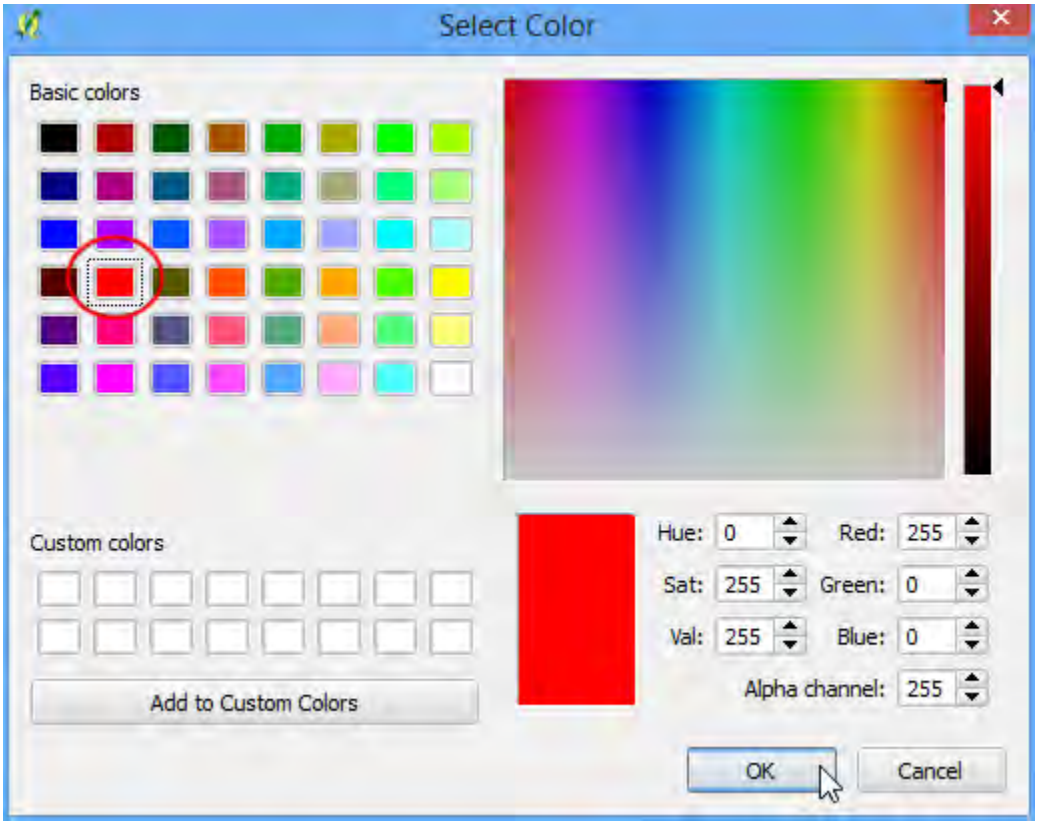
14. Now go back to the Style dialog by right clicking the layer and choosing Properties. There are some more styling options available. You can click on the Symbol for each of the classes and choose a different style. We will choose Red, Yellow and Green fill colors to indicate low, medium and high life expectancy.



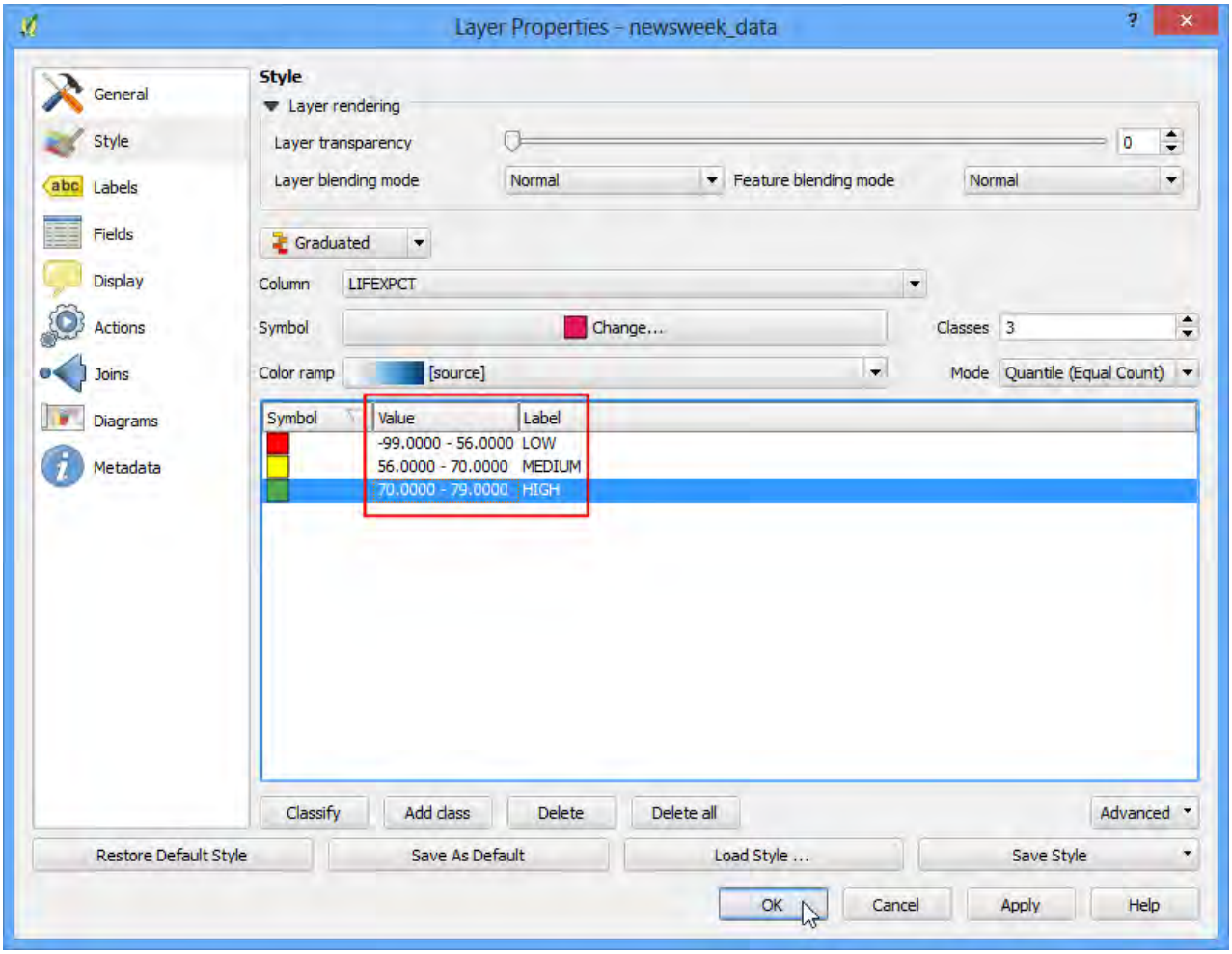
15. In the Symbol Selector dialog, click on Color selector.



16. Click on a color fom the Select Color dialog.



17. Back in the Layer Properties dialog, you can double-click on the Label column next to each value and enter the text that you want to display. Similarly, you may double-click on the Value column to edit the selected ranges. Click OK once you are satisfied with the classes.



18. This style definitely conveys a lot more useful map than the previous two attempts. There are clearly marked class names and colors to represent our interpretation of the life expectancy values.

7 Basic Raster Styling and Analysis

A lot of scientific observations and research produces raster datasets. Rasters are essentially grids of pixels that have a specific value assigned to them. By doing mathematical operations on these values, one can do some interesting analysis. QGIS has some basic analysis capabilities built-in via Raster Calculator. In this tutorial, we will explore basics on using Raster Calculator and options available for styling rasters.

7.1 Overview of the task

We will use population density grid data to find and visualize areas of the world that have seen dramatic population density change between year 1990 and 2000.

7.1.1 Other skills you will learn

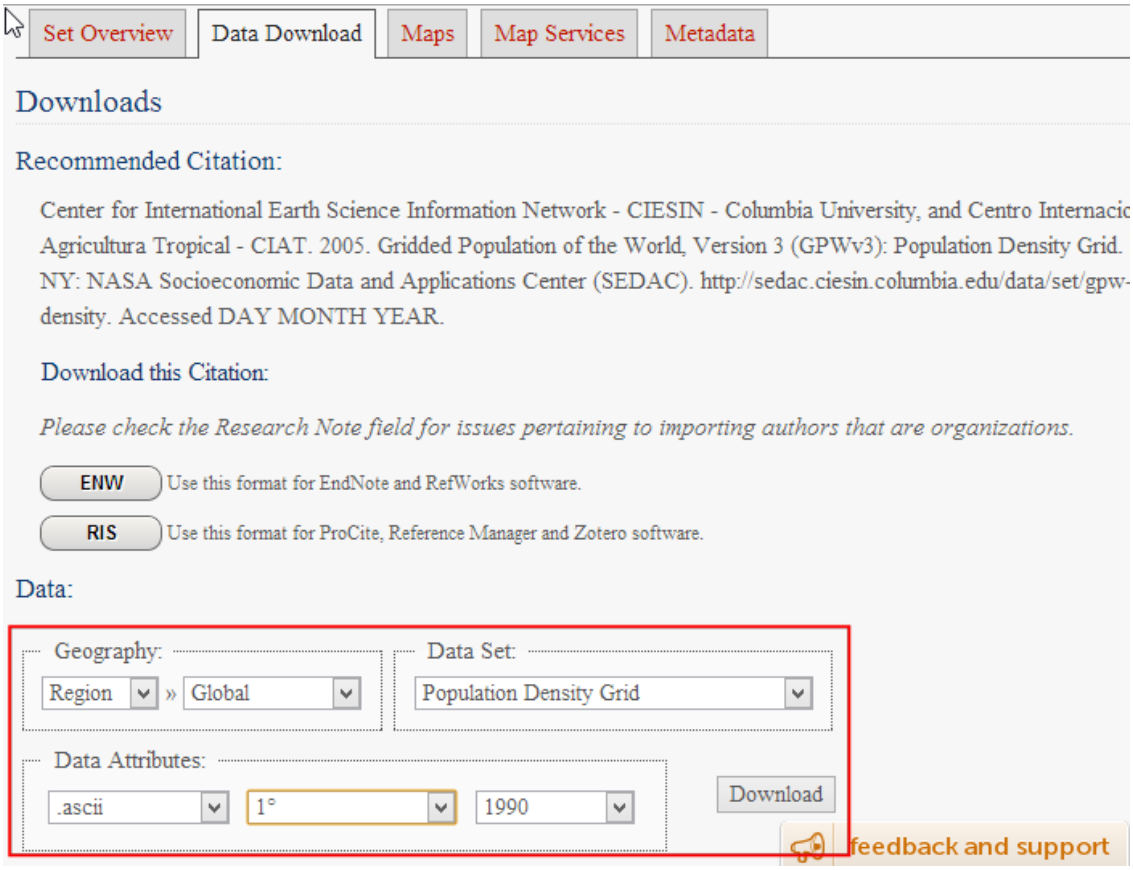
- Selecting and loading multiple datasets in a single step in QGIS.

7.2 Get the data

We will use the Gridded Population of the World (GPW) v3 dataset from Columbia University. Specifically, we need the Population Density Grid for the entire globe in ASCII format and for the year 1990 and 2000.

Here is how to search and download the relevant data.

1. Go to the Population Density Grid, v3 download page. Select the Data Attributes as .ascii format, 1° resolution and 1990 year. Click Download. At this point, you may create a free account and login, or use the Guest Download button at the bottom to immediately download the data. Repeat the process for 2000 year data.



You will now have 2 zip files downloaded.

For convenience, you may directly download a copy of the datasets from the links below:

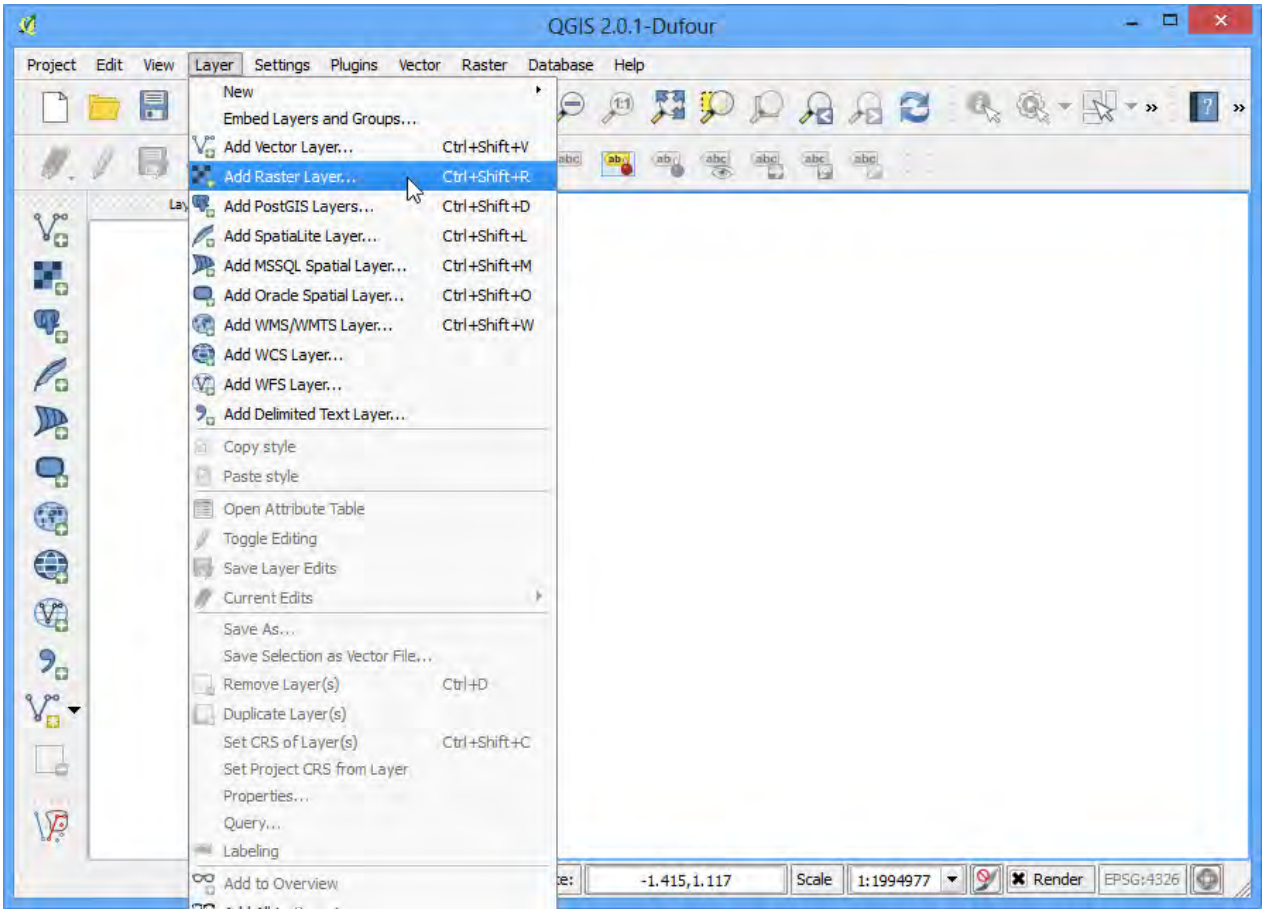
gl_gpwv3_pdens_90_ascii_one.zip

gl_gpwv3_pdens_00_ascii_one.zip

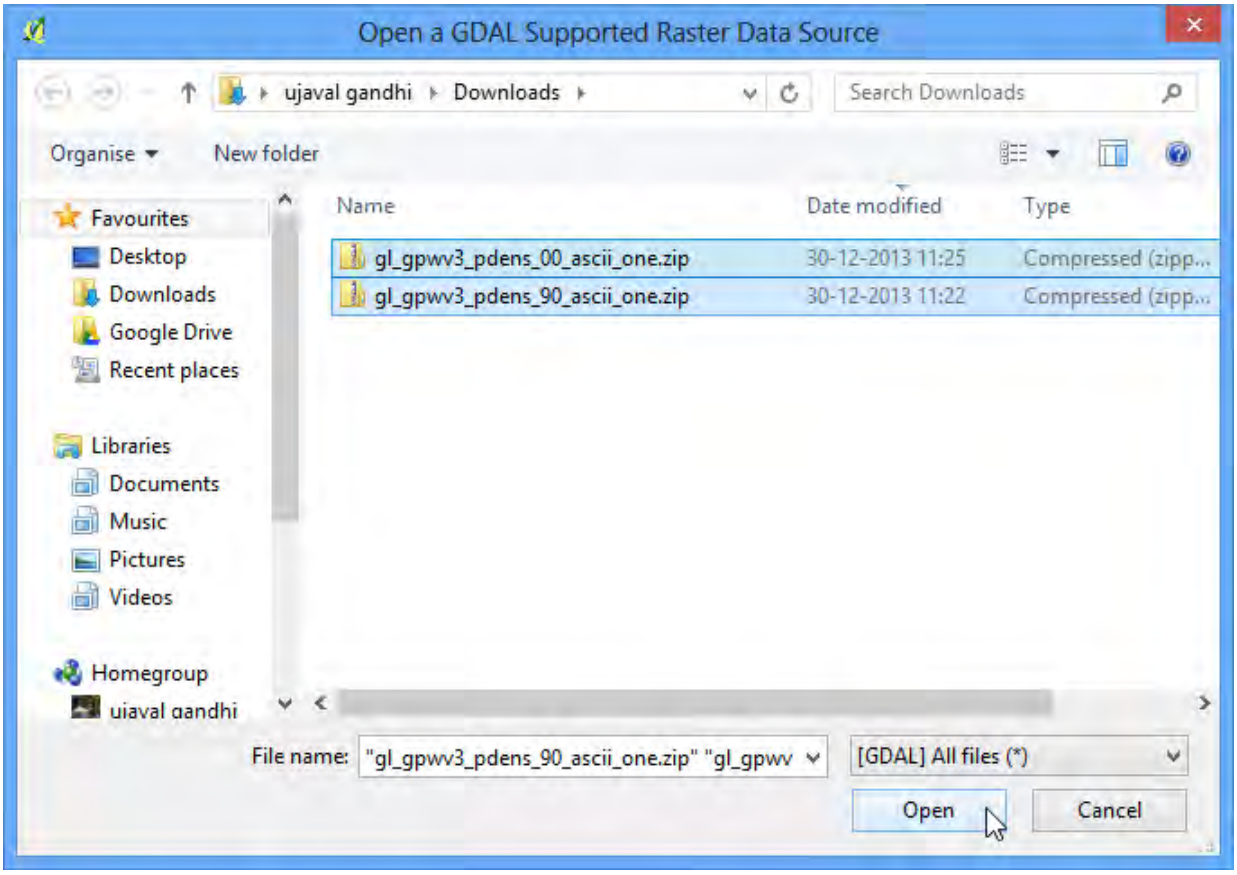
Data Source [GPW3]

7.3 Procedure

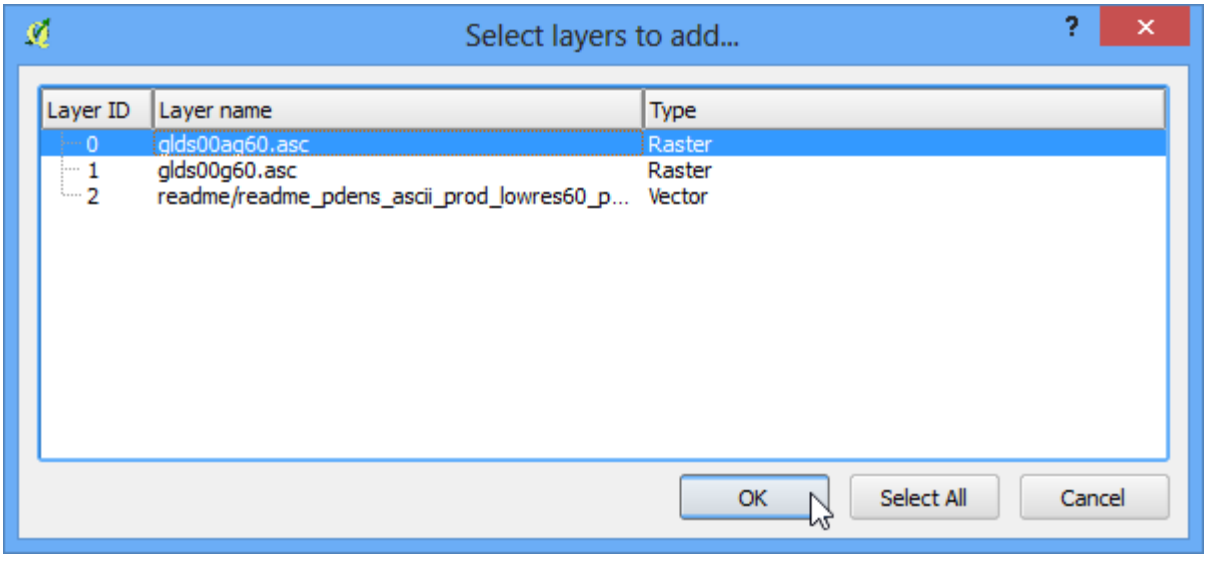
2. Open QGIS and go to Layer ‣ Add Raster Layer...



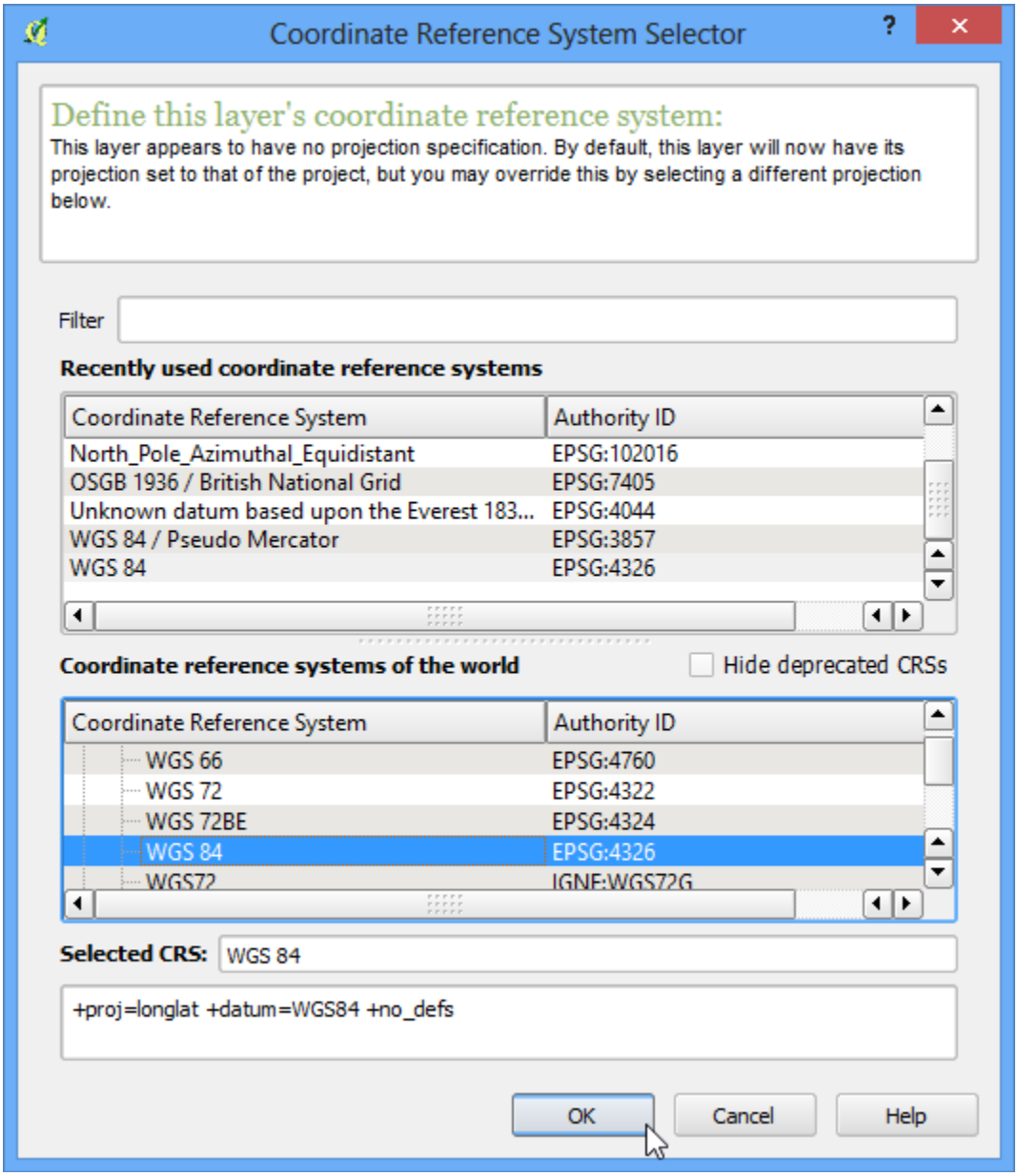
3. Locate the downloaded zip files. Hold down the `Ctrl` key and click on both the zip files to select them. This way you are able to load both the files in a single step.



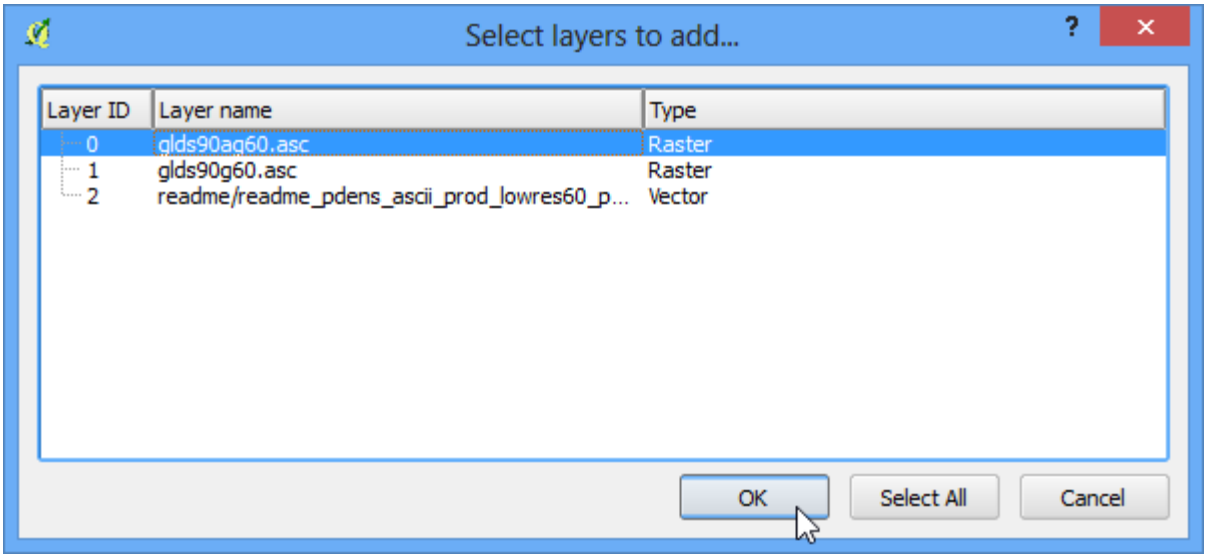
4. Each zip file contain 2 grid files. The `a` in the filename suggests that the population counts were adjusted to match the UN totals. We will use the adjusted grids for this tutorial. Select `glds00ag60.asc` as the layer to add. Click OK.



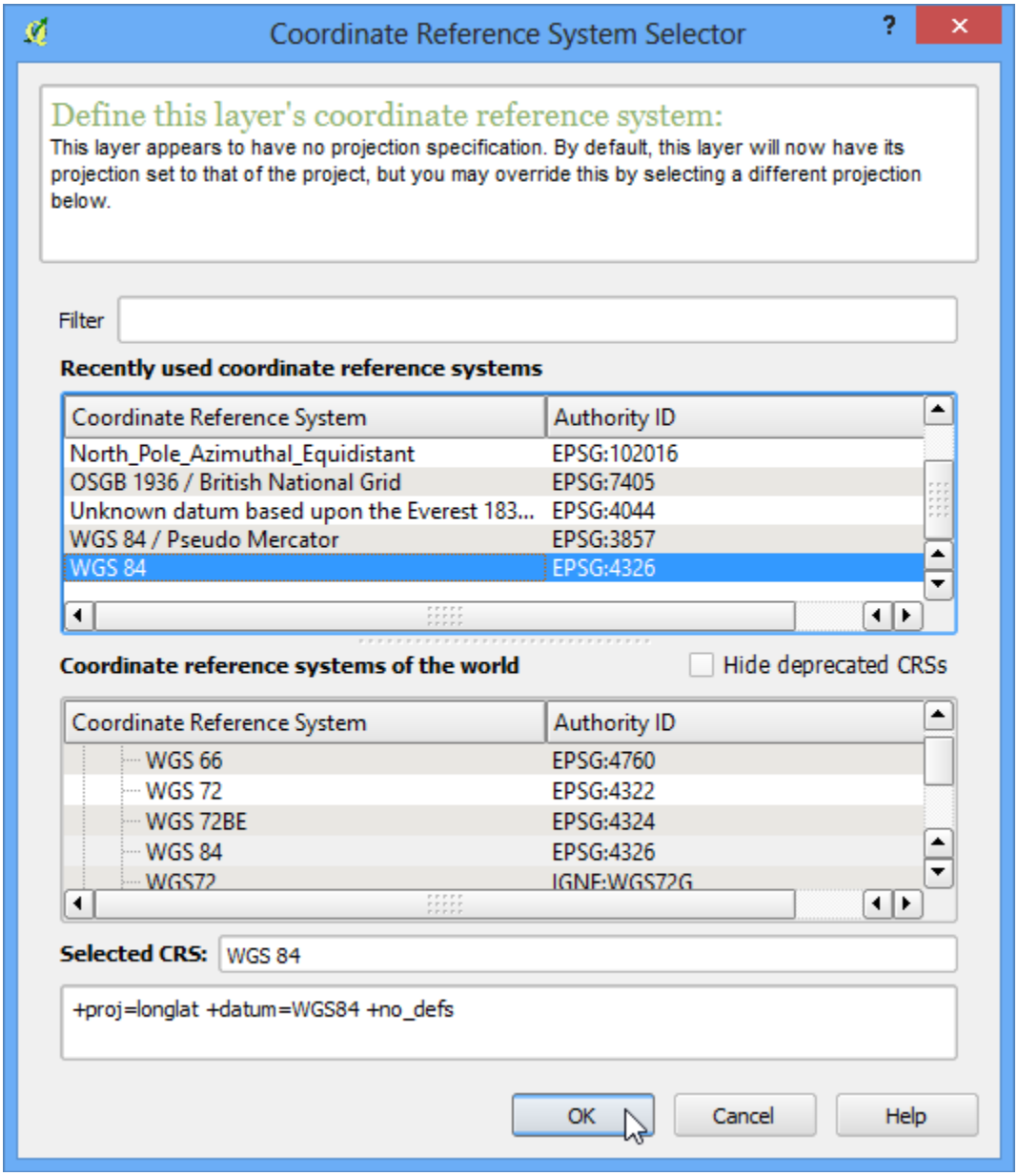
5. The layer doesn't have a CRS defined, and since the grids are in lat/long, choose EPSG:4326 as the coordinate reference system.



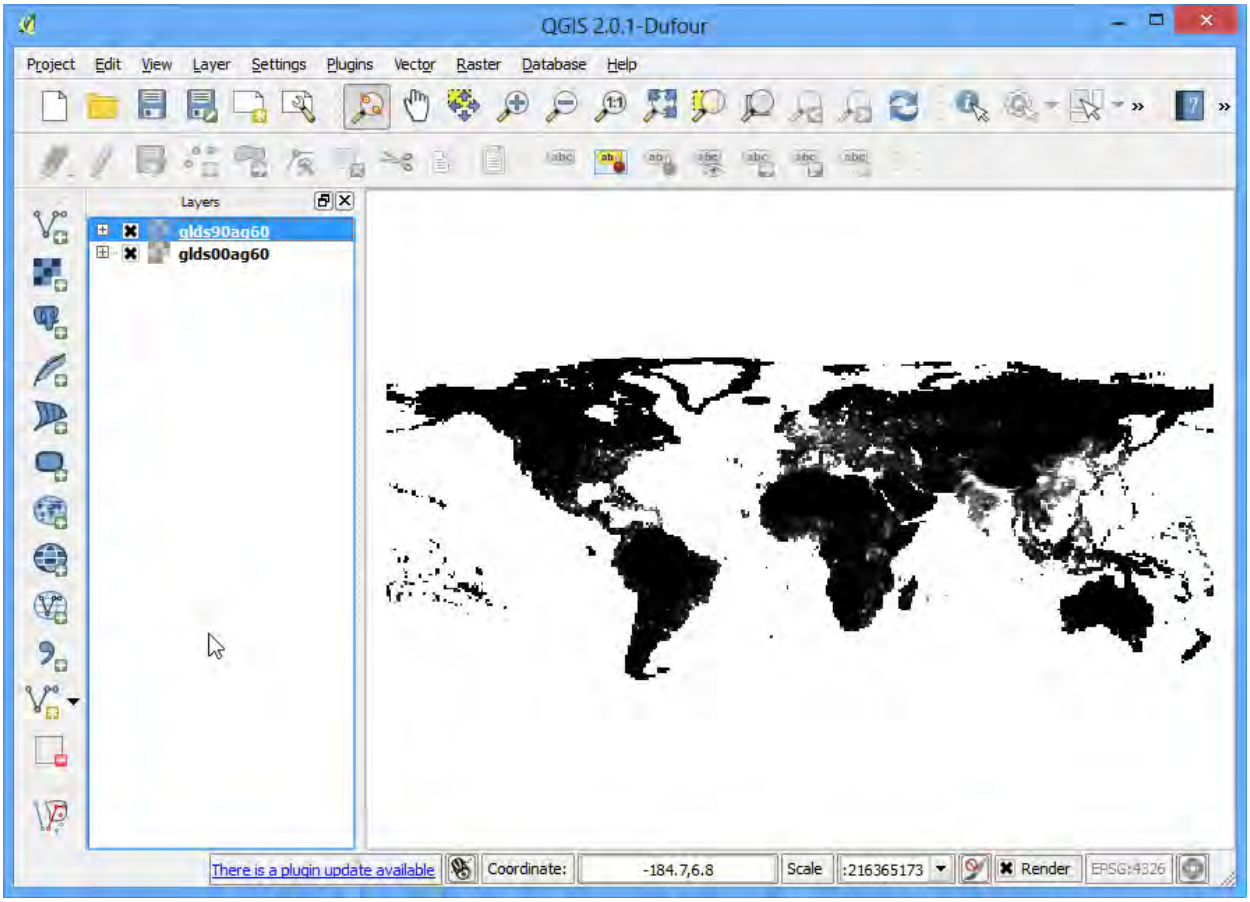
6. Since we selected both the zip files, you will see similar dialogs once again. Repeat the process and select `glds90ag60.asc` grid as the layer to add.



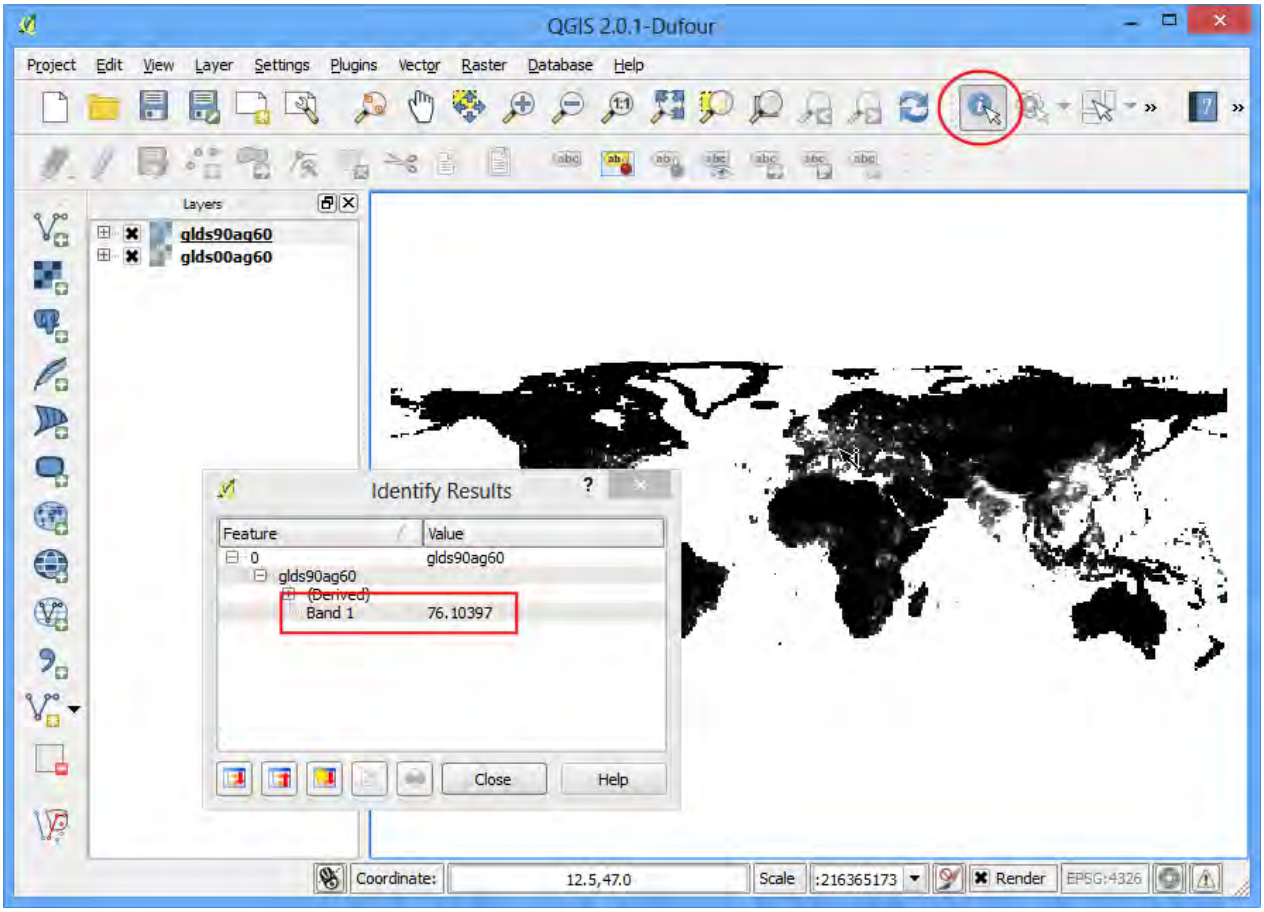
7. Once again, choose EPSG:4326 as the CRS.



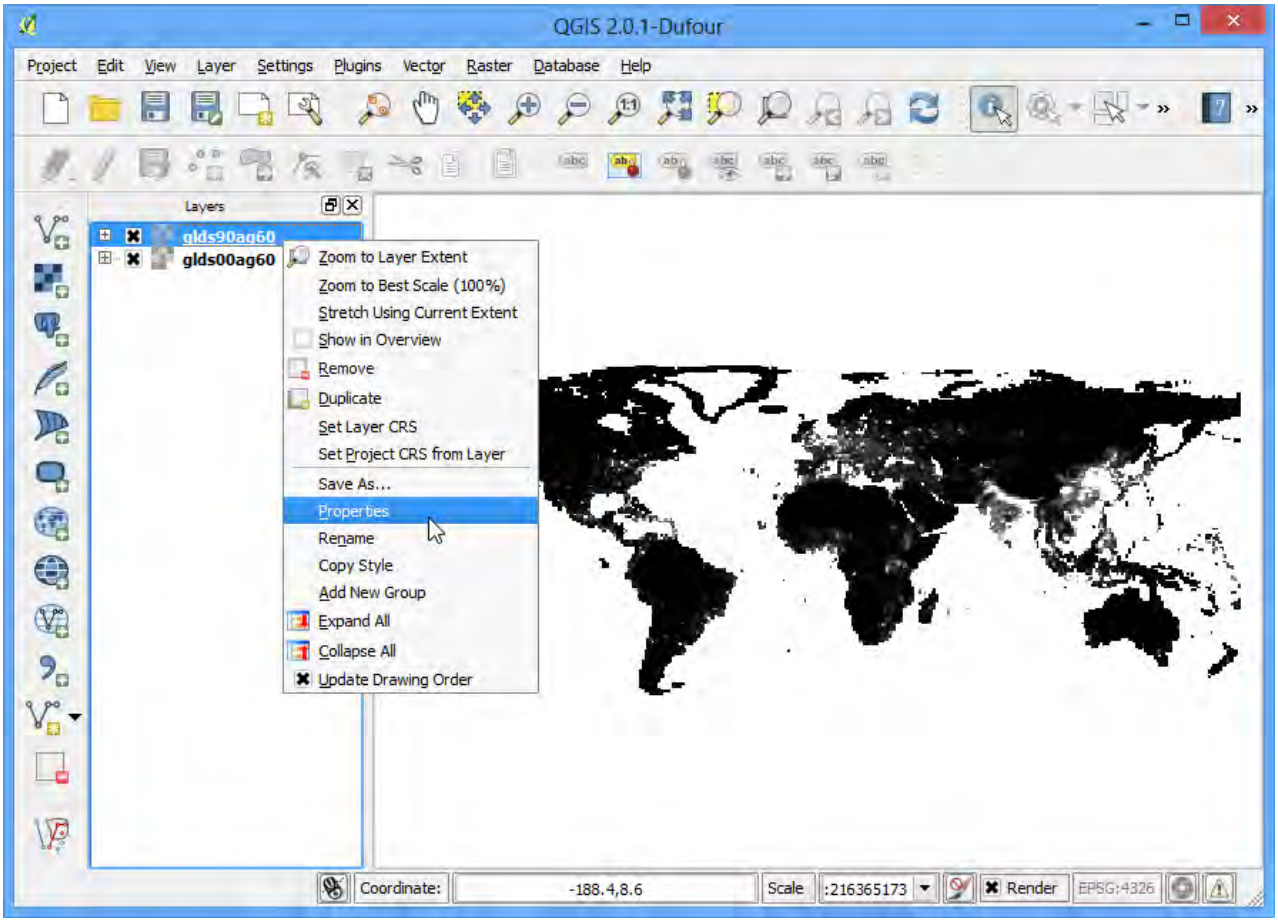
8. Now you will see both the rasters loaded in QGIS. The raster is rendered as in grayscale, where darker pixels indicate lower values and lighter pixels indicate higher values.



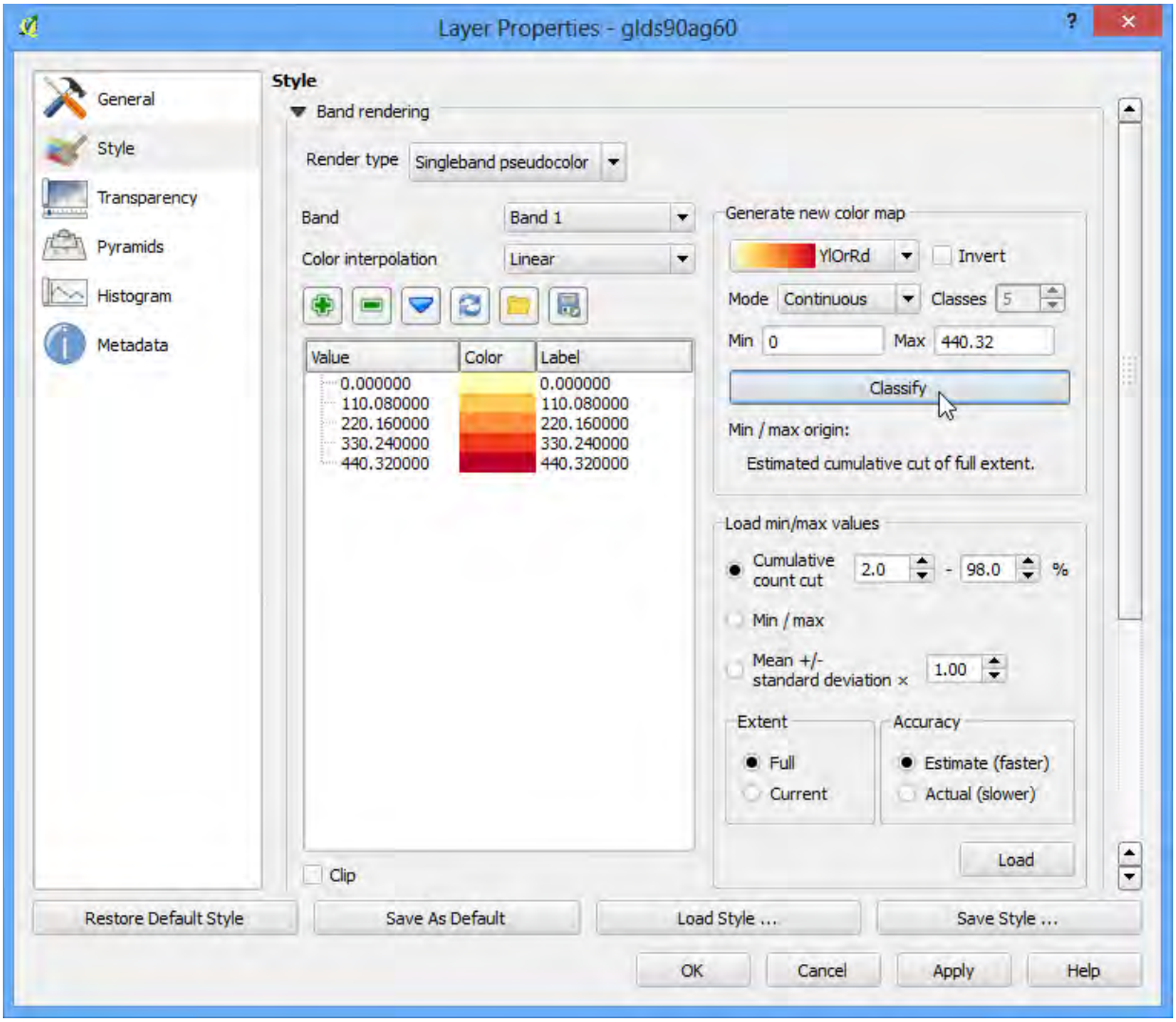
9. Each pixel in the raster has a value assigned. This value is the population density for that grid. Click on Identify Features button to select the tool and click anywhere on the raster to see the value of that pixel.



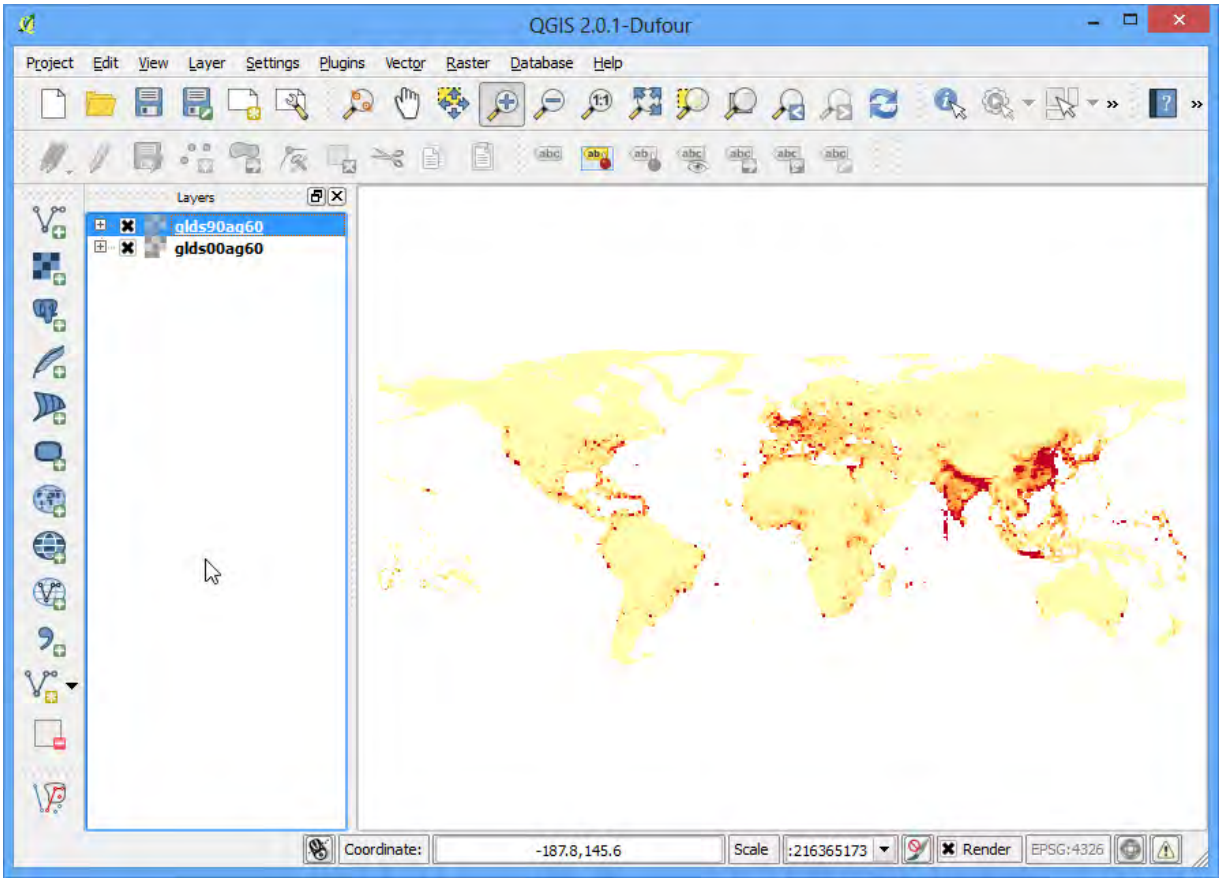
10. To better visualize the pattern of population density, we would need to style it. Right-click on the layer name and select Properties. You can also double-click on the layer name in the TOC to bring up the Layer Properties dialog.



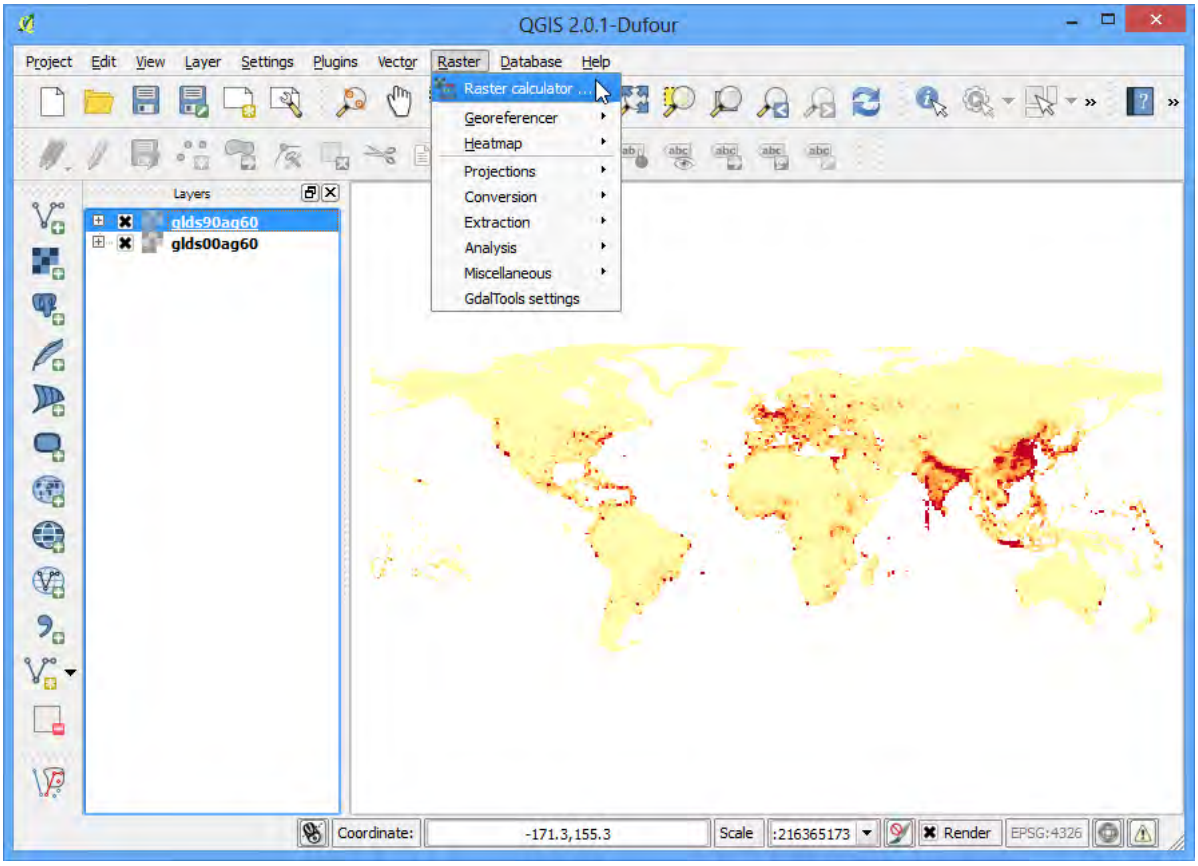
11. Under the Style tab, change the Render type to Singleband pseudocolor. Next, click Classify under Generate a new color map. You will see 5 new color values created. Click OK.



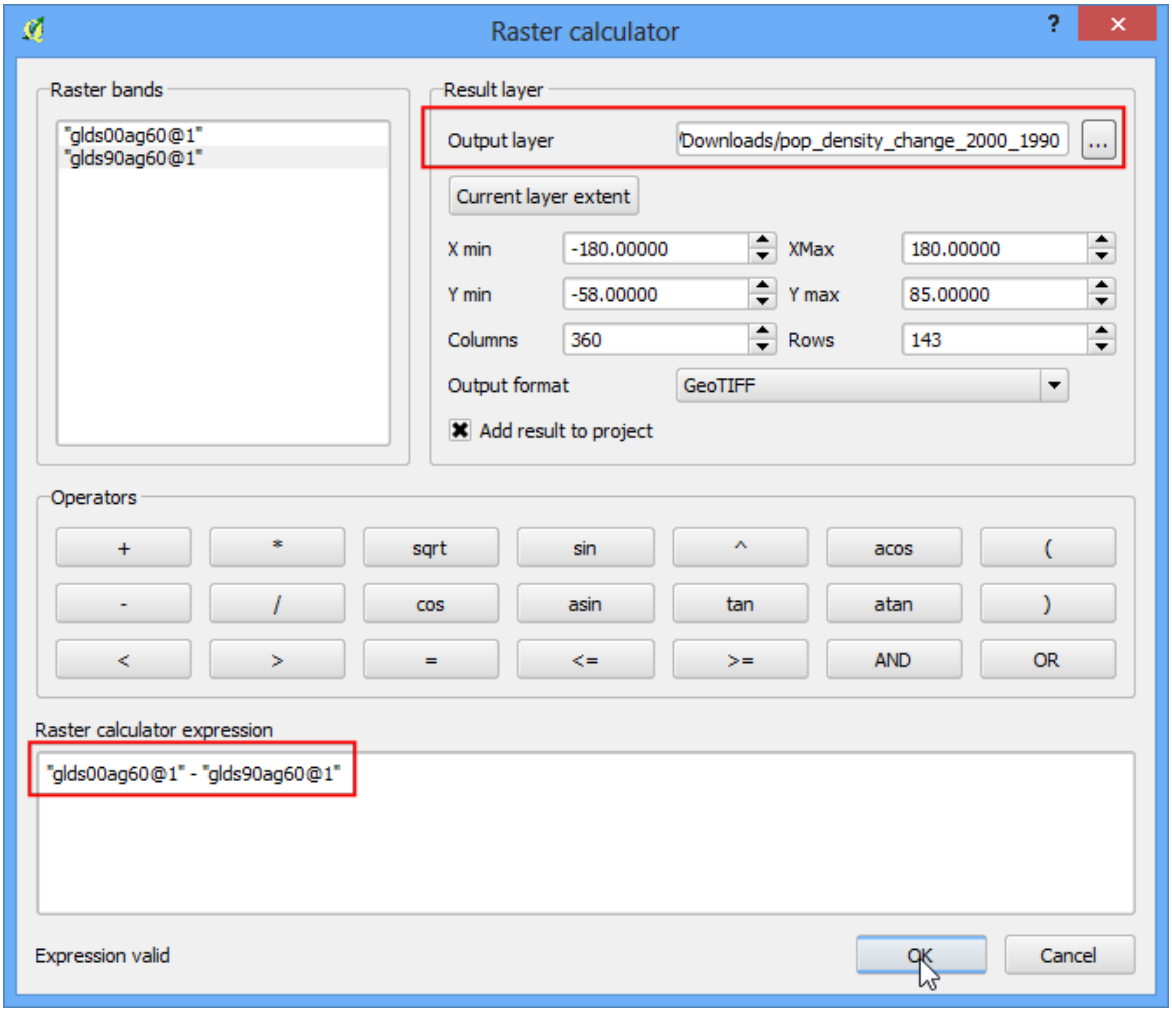
12. Back in the QGIS Canvas, you will see a heatmap-like rendering of the raster. Repeat the same process for the other raster as well.



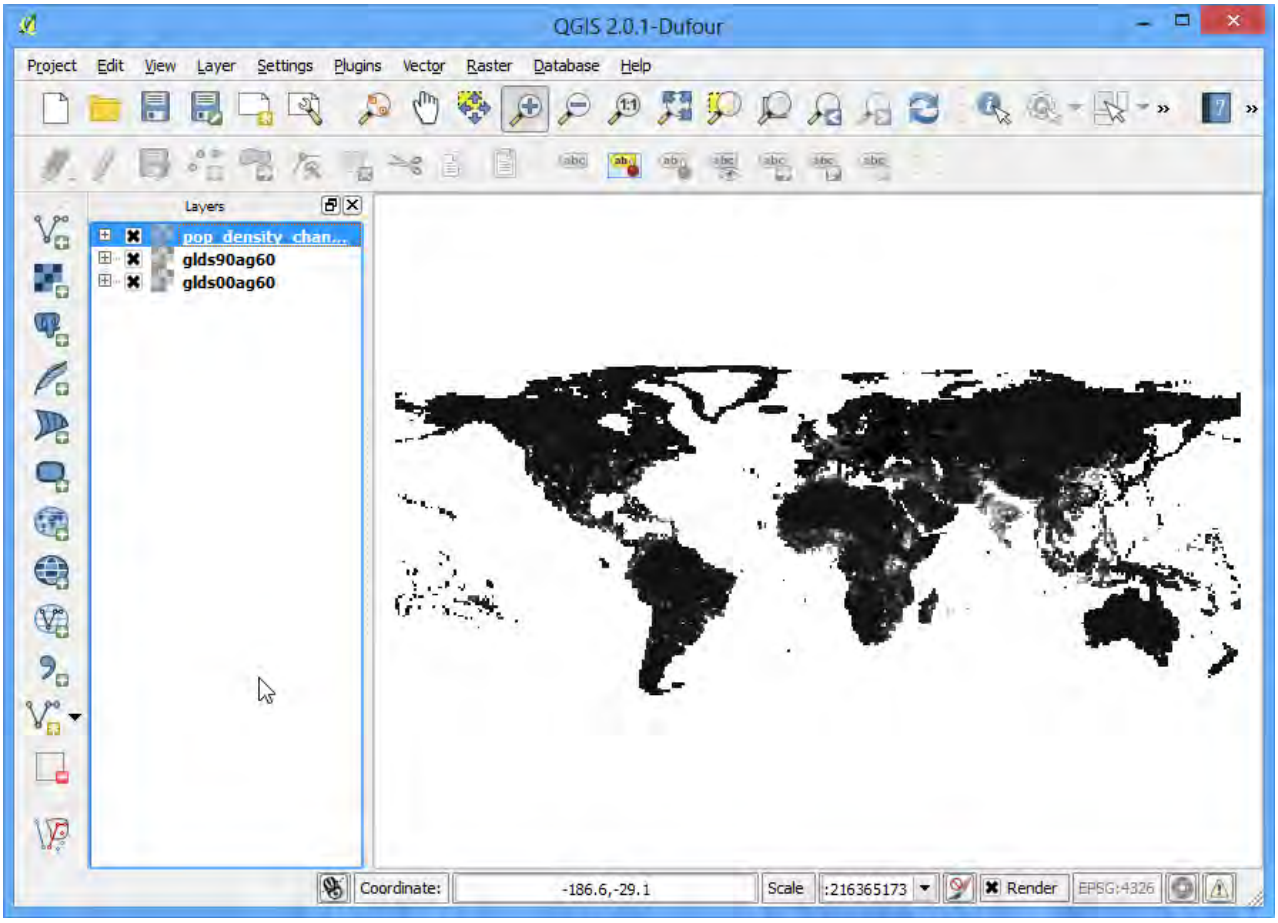
13. For our analysis, we would like to find areas with largest population change between 1990 and 2000. The way to accomplish this is by finding the difference between each grid's pixel value in both the layers. Select Raster ▸ Raster calculator .



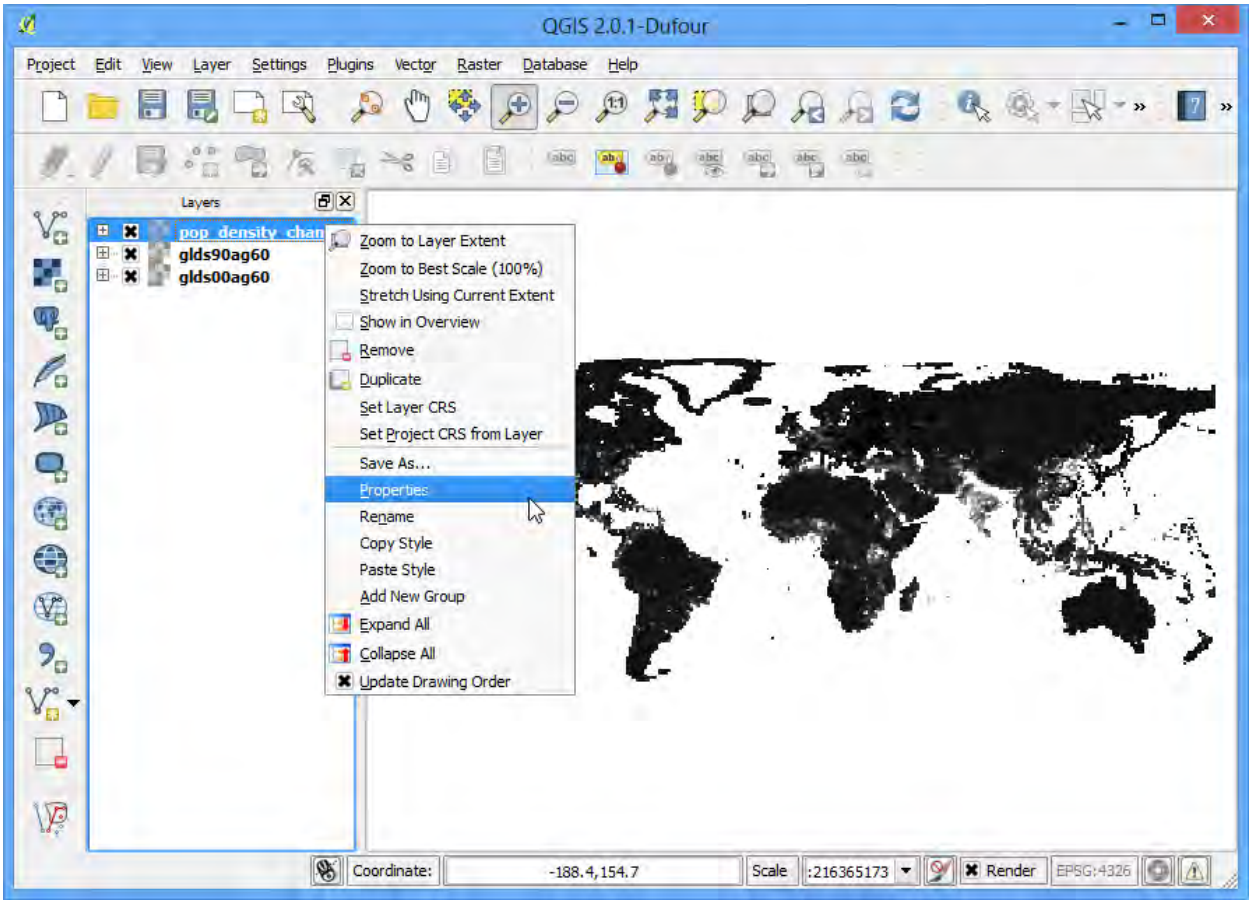
14. In the Raster bands section, you can select the layer by double-clicking on them. The bands are named after the raster name followed by @ and band number. Since each of our rasters have only 1 band, you will see only 1 entry per raster. The raster calculator can apply mathematical operations on the raster pixels. In this case we want to enter a simple formula to subtract the 1990 population density from 2000. Enter `glds00ag60@1 - glds90ag60@1` as the formula. Name your output layer as`pop_density_change_2000_1990.tif` and check the box next to Add result to project. Click OK.



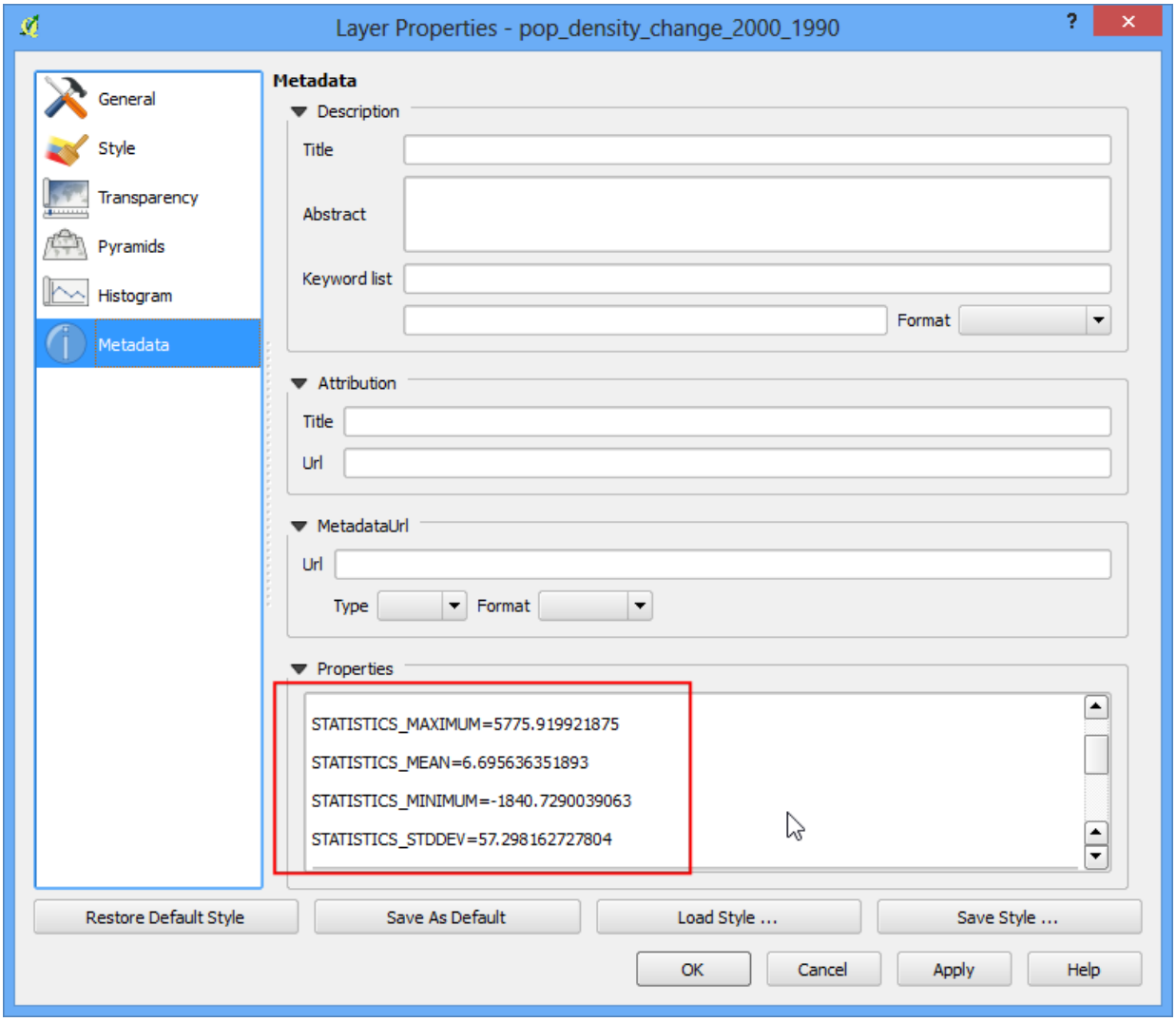
15. Once the operation is complete, you will see the new layer load in QGIS.



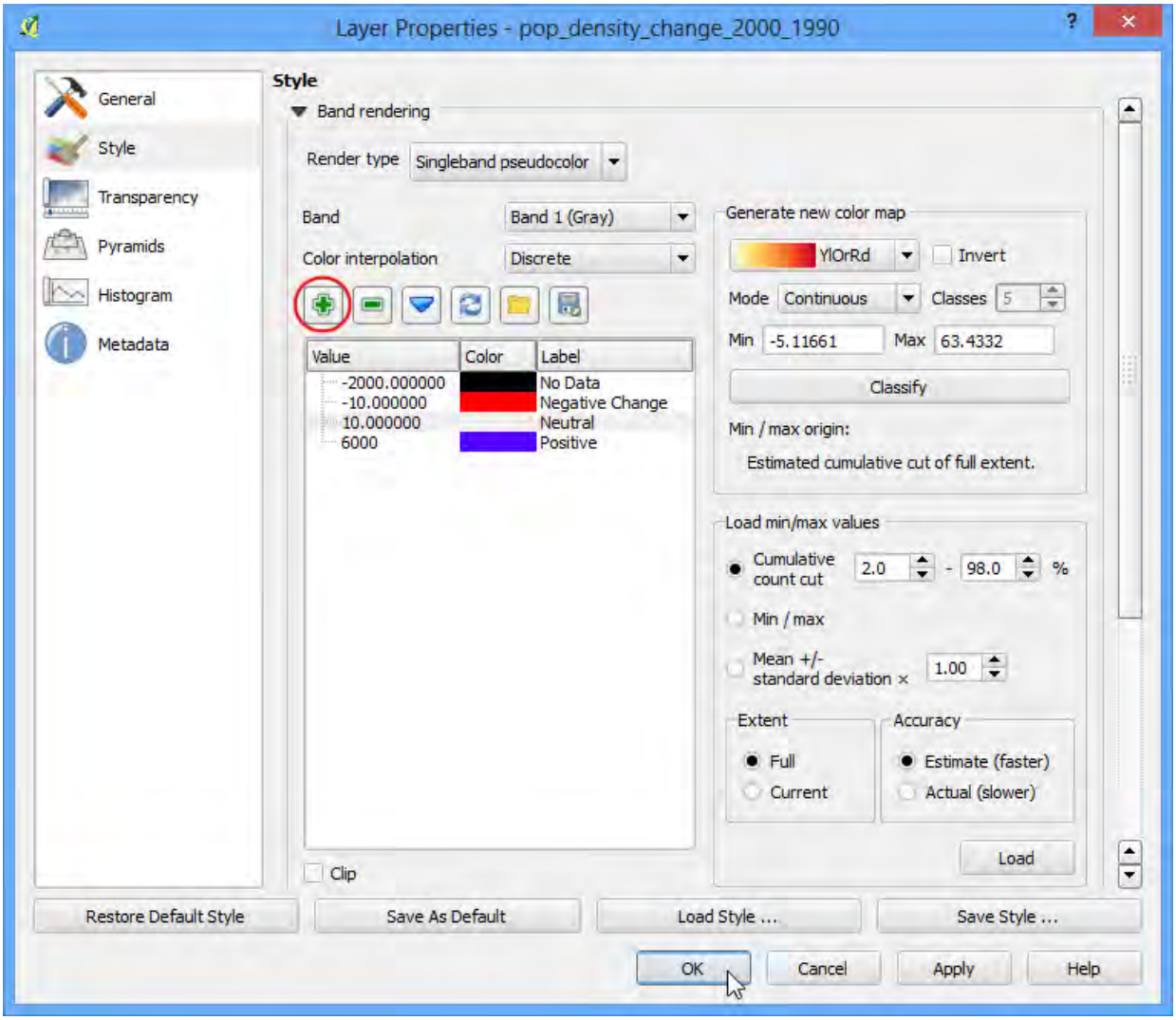
16. This grayscale visualization is useful, but we can create a much more informative output. Right-click on the `pop_density_change_2000_1990` layer and select Properties.



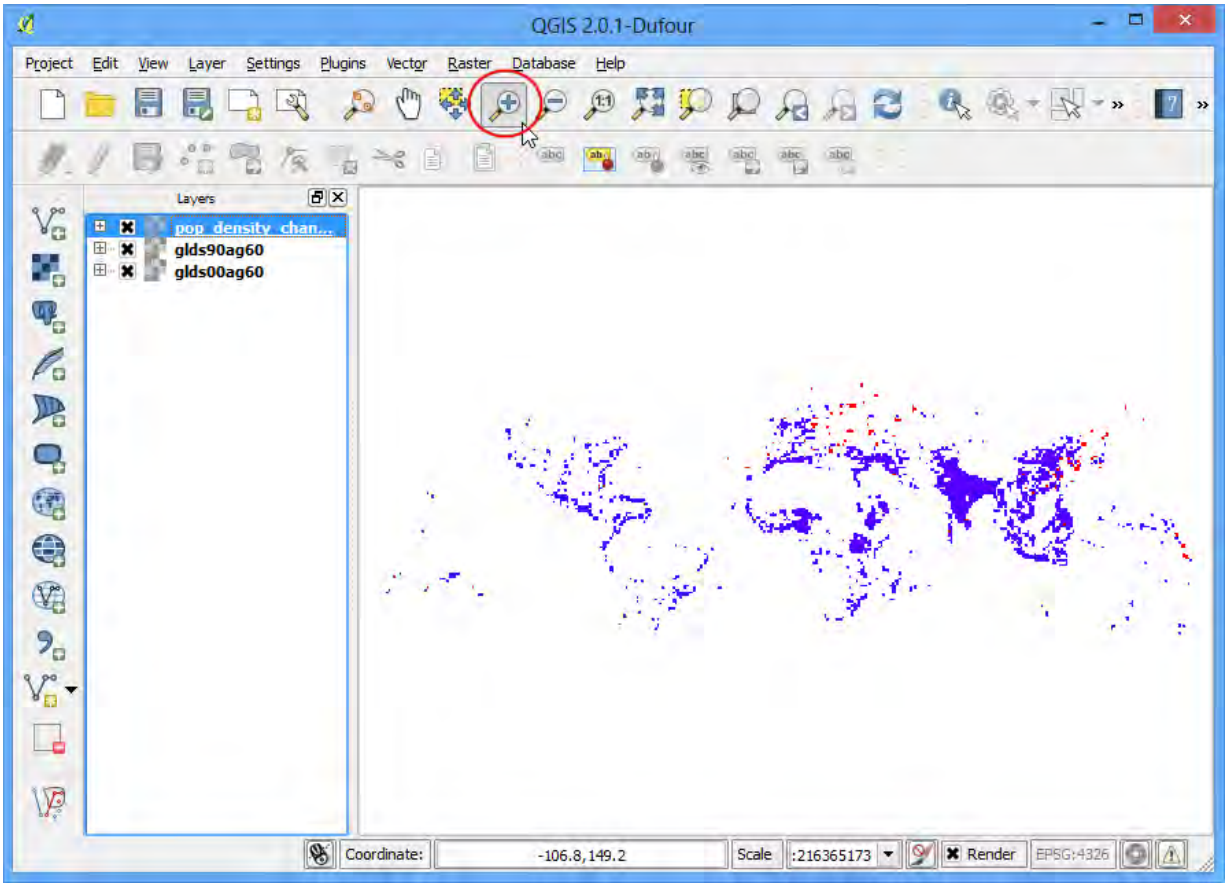
17. We want to style the layer so pixel values in certain ranges get the same color. Before we dive in to that, go to the Metadata tab and look at the properties of the raster. Note the minimum and maximum values of this layer.



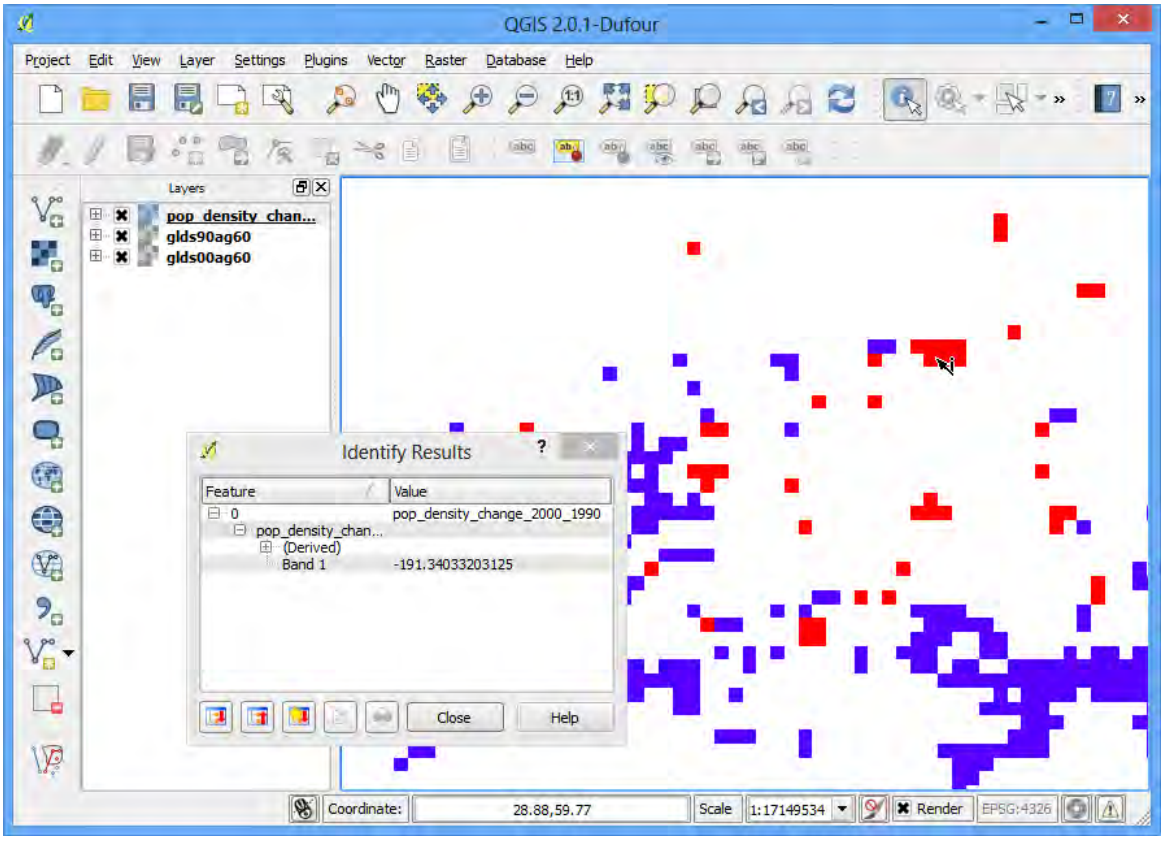
18. Now go to the Style tab. Select Singleband pseudocolor as the Render type under Band Rendering. Set the Color interpolation toDiscrete. Click the Add entry button 4 times to create 4 unique classes. Click on an entry to change the values. The way color map works is that all values lower than the value entered will be given the color of that entry. Since the minmum value in our raster is just above -2000, we choose -2000 as the first entry. This will be for the No Data values. Enter the values and Labels for other entries as below and click OK.



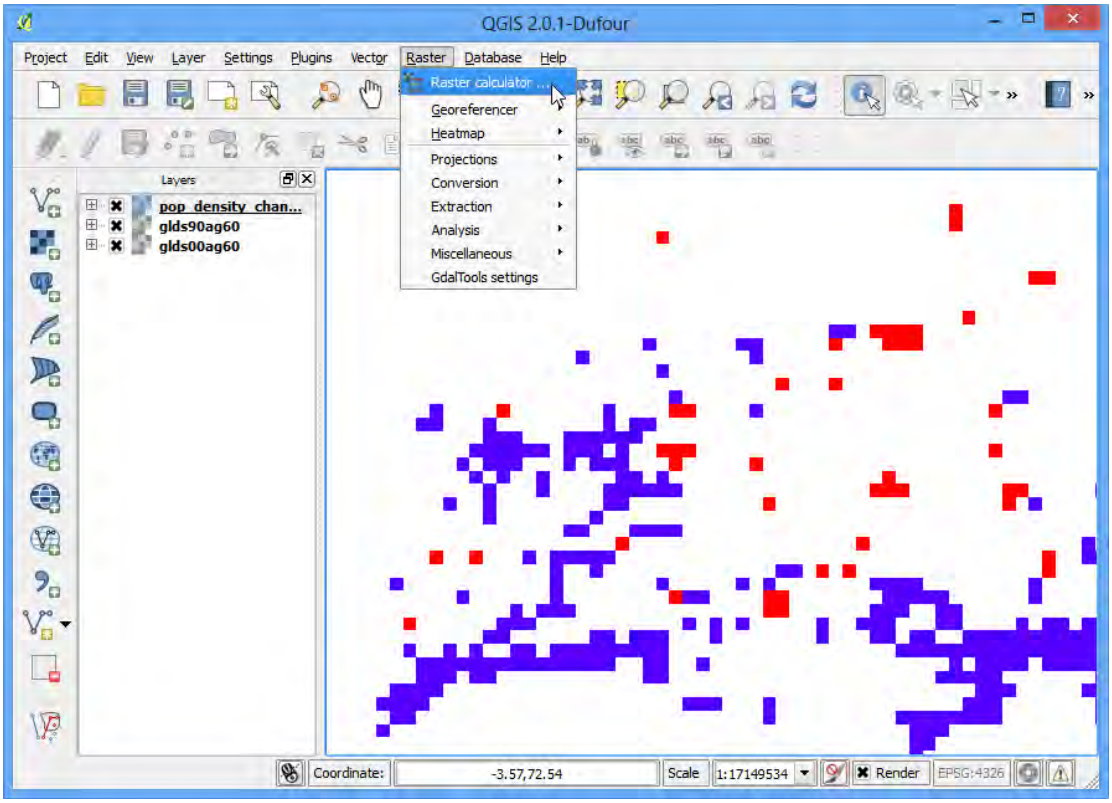
19. Now you will see a much more powerful visualization where you can see areas which has seen positive and negative population density changes. Click on Zoom In button and draw a rectangle around Europe to explore the region in more detail.



20. Select the Identify tool and click on the Red and Blue regions to verify that your styling rules worked as intended.

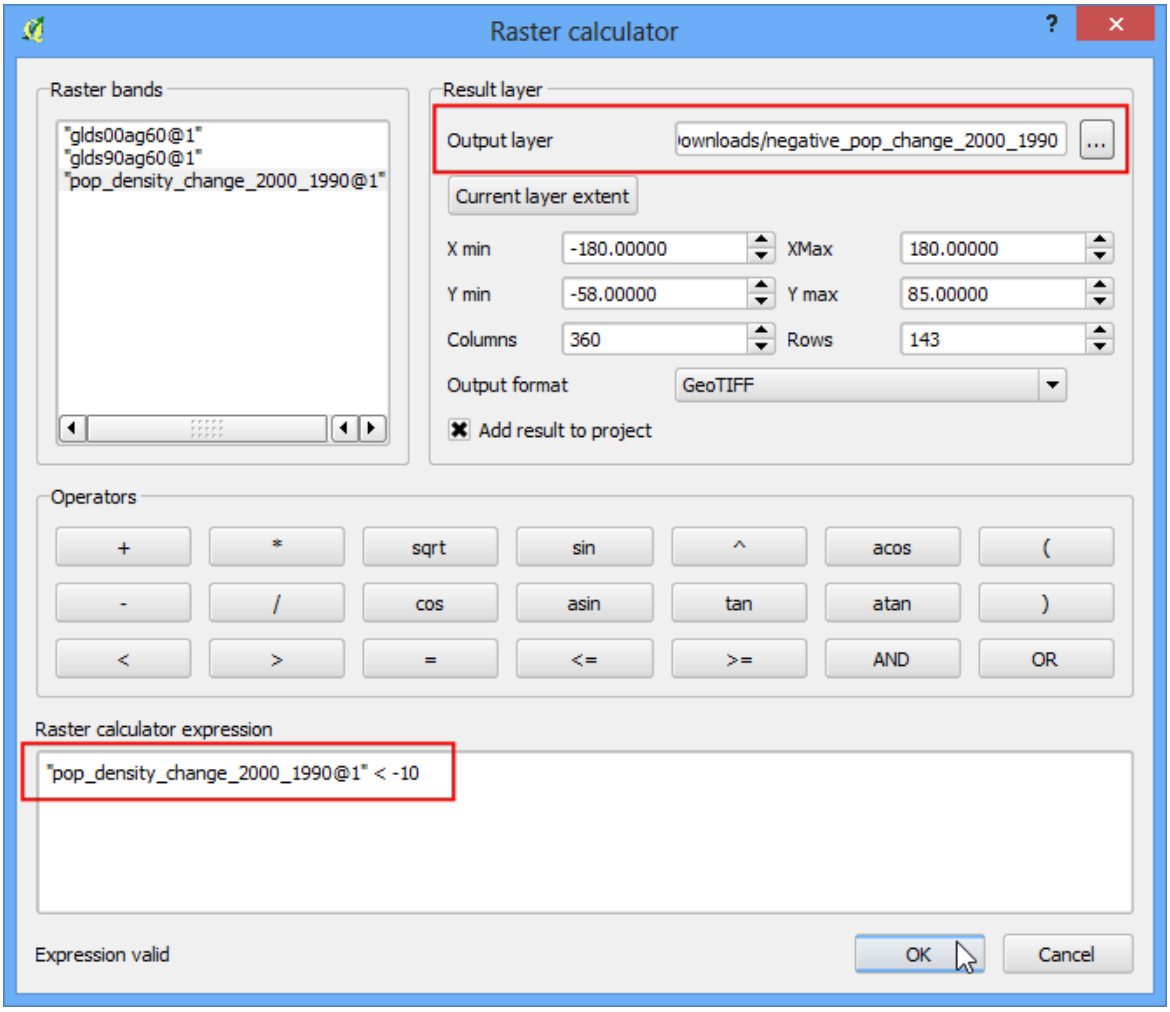


21. Now let's take this analysis one-step further and find areas with only negative population density change. Open Raster ▸ Raster calculator .

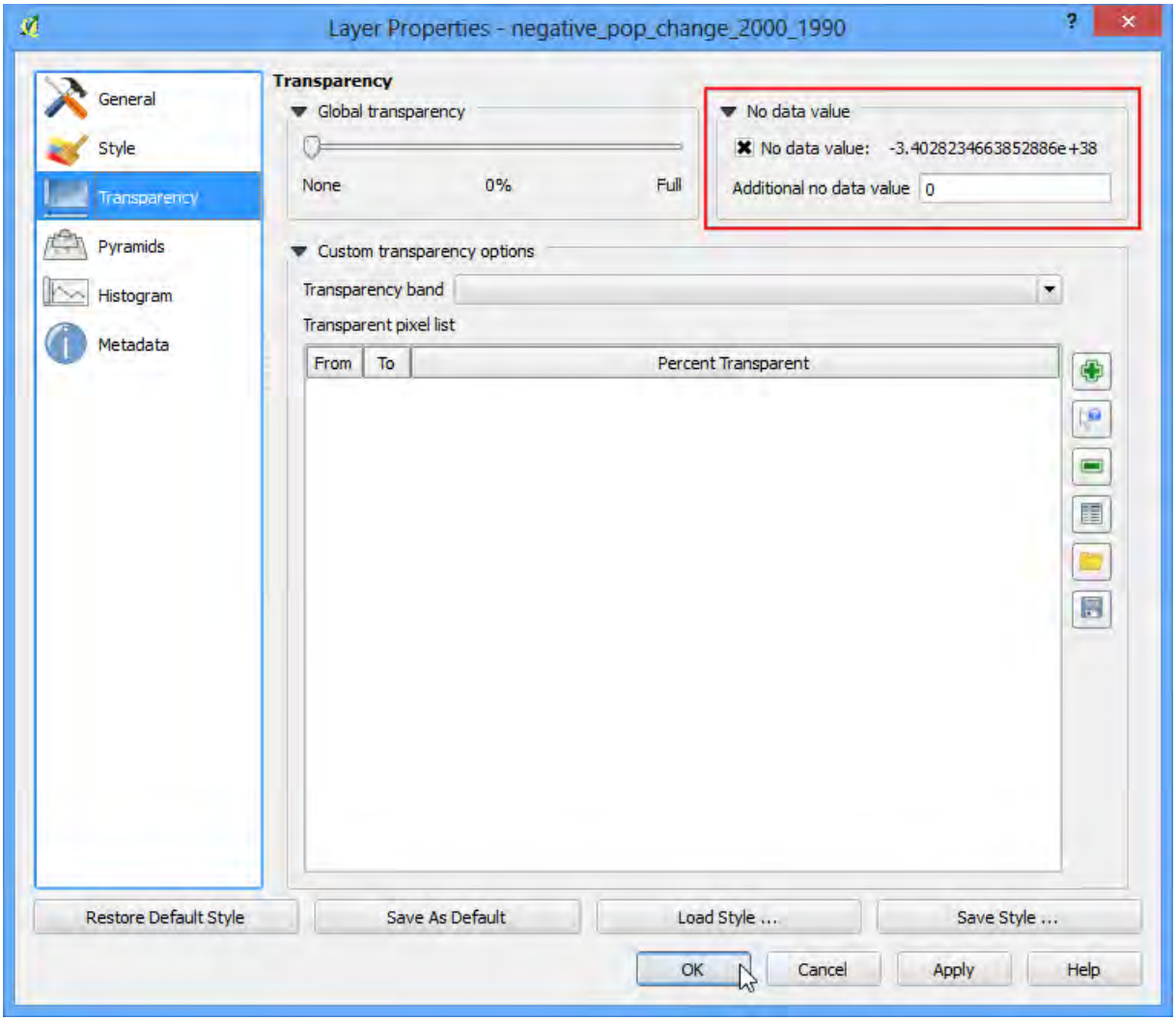


22. Enter the expression as shown below What this expression will do is set the value of the pixel to 1 is if matches the expression and 0 if it doesn't. So we will get a raster with pixel value of 1 where there was negative change and 0 where there wasn't. Name the output layer as `negative_pop_change_2000_1990` and check the box next to Add result to project. Click OK.

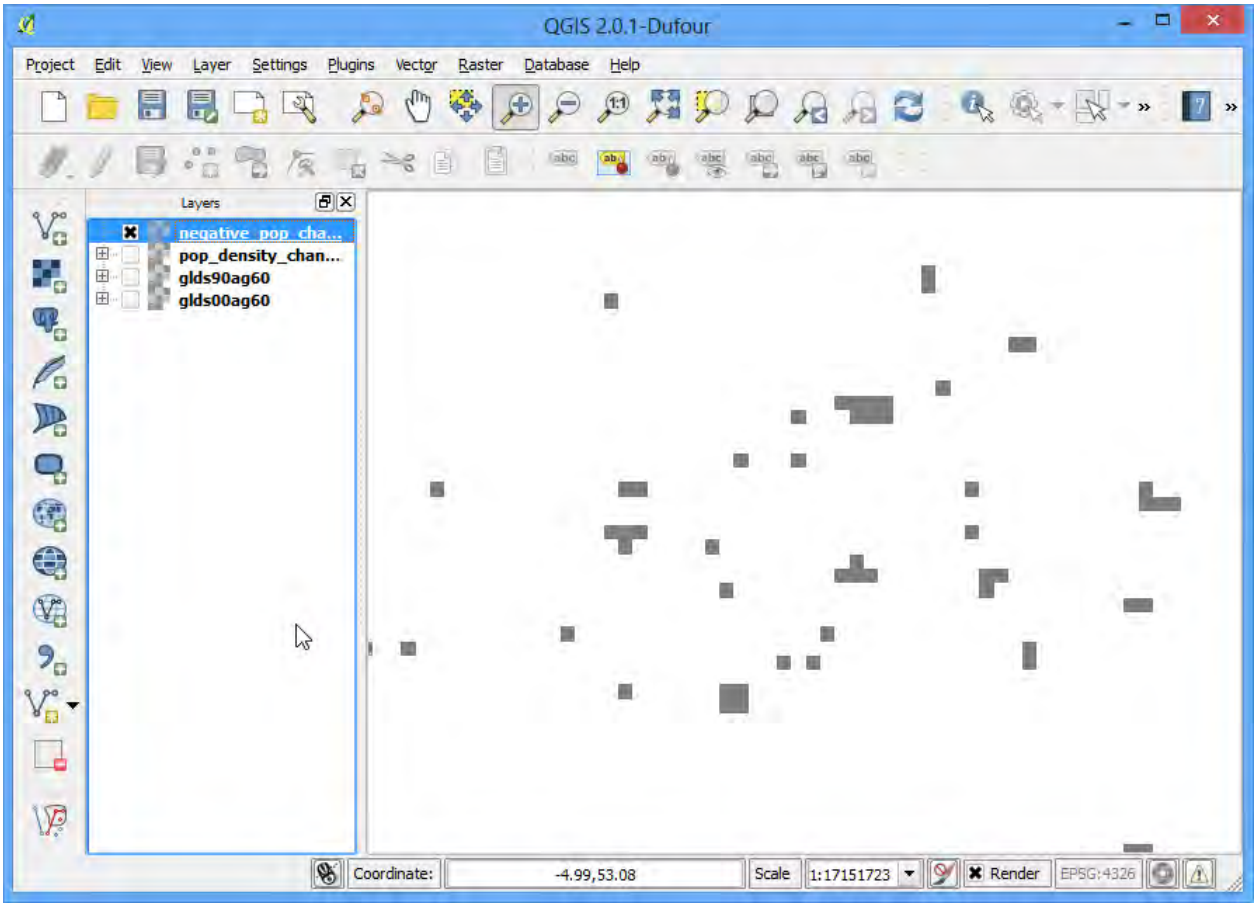
```
pop_density_change_2000_1990@1 < -10
```



23. Once the new layer is loaded, right-click on it and select Properties. In the Transparency tab, add 0 as the Additional no data value. This setting will make the pixels with 0 values also transparent. Click OK.



24. Now you will see the areas of negative population density change as gray pixels.


QGIS 2.0.1-Dufour
Project
Edit
View
Layer
Settings
Plugins
Vector
Raster
Database
Help
Layers
negative_pop_cha...
pop_density_chan...
glds90ag60
glds00ag60
Coordinate:
-4.99,53.08
Scale
1:17151723
Render
EPSG:4326

8 Working with Terrain Data

Terrain or elevation data is useful for many GIS Analysis and it is often used in maps. QGIS has good terrain processing capabilities built-in. In this tutorial, we will work through the steps to generate various products from elevation data such as contours, hillshade etc.

8.1 Overview of the task

The task is to create contours and hillshade map for area around Mountain Hkakabo Razi.

8.1.1 Other skills you will learn

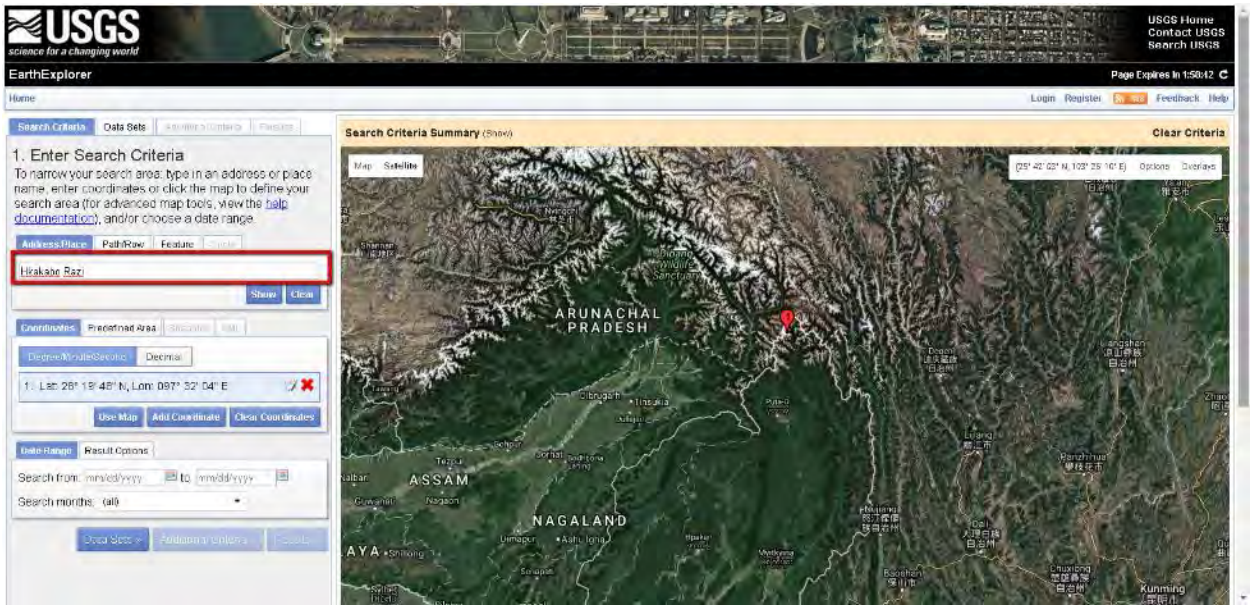
- Searching and downloading freely available terrain data.
- Exporting a vector layer as KML and viewing it in Google Earth.

8.2 Get the data

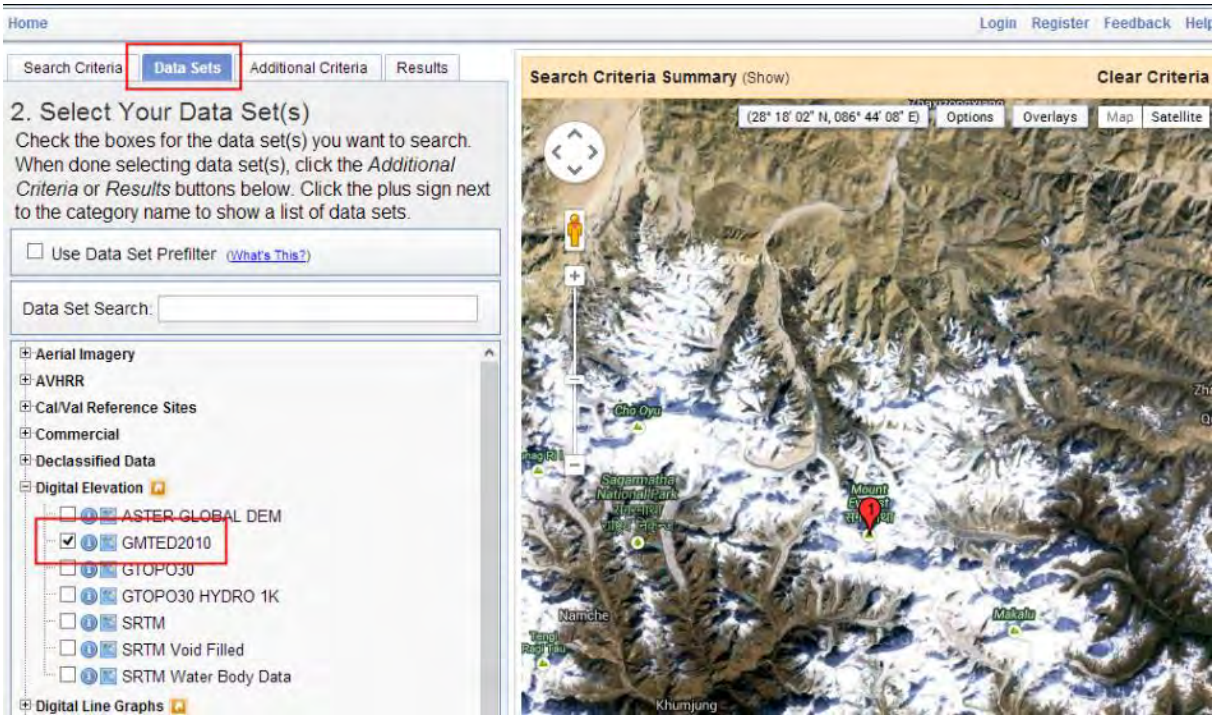
We will be working with GMTED2010 dataset from USGS. This data can be downloaded from the USGS Earthexplorer site. GMTED (Global Multi-resolution Terrain Elevation Data) is a global terrain dataset that is the newer version of GTOPO30 dataset.

Here is how to search and download the revelant data from USGS Earthexplorer.

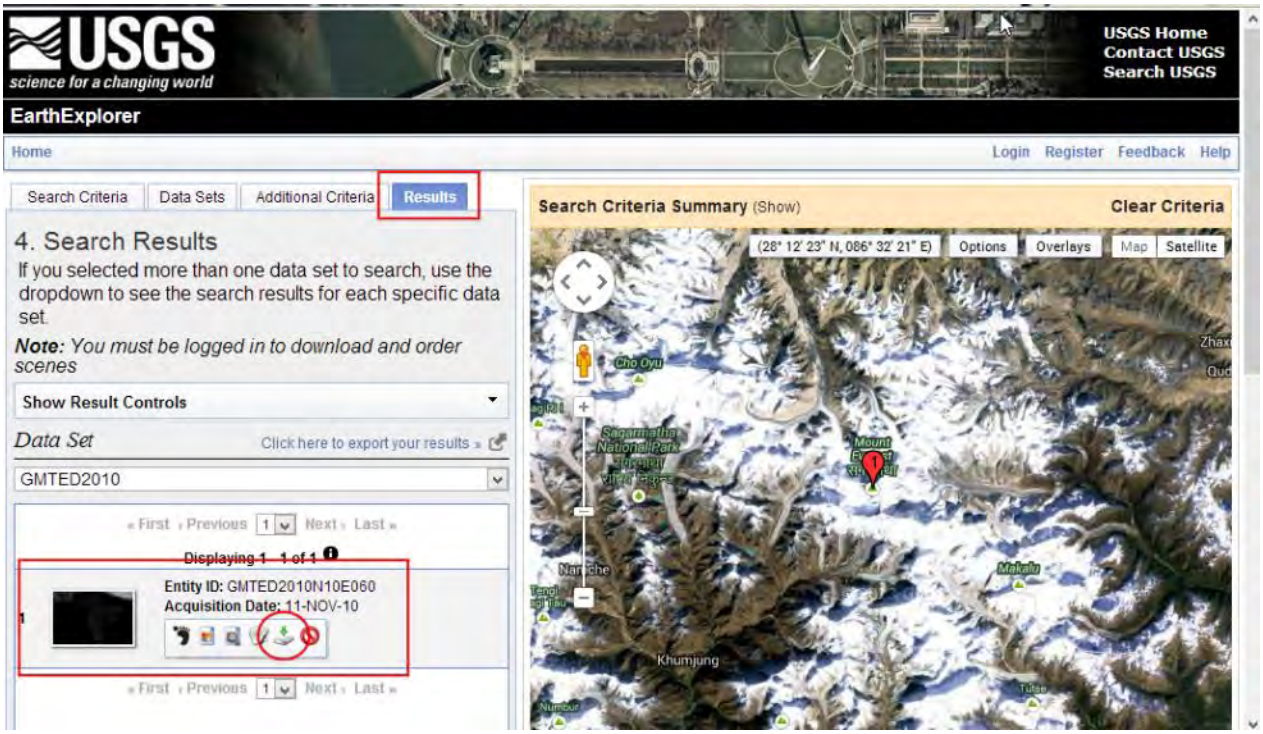
1. Go to the USGS Earthexplorer . In the Search Criteria tab, search for the place name Hkakabo Razi. Click on the result to select the location.



2. In the Data Sets tab, expand the Digital Elevation group, and check GMTED2010.



3. You can now skip to the Results tab and see the part of the dataset intersecting your search criteria. Click the Download Options button. You will have to log in to the site at this point. You can create a free account if you do not have one.



4. Select the 30 ARC SEC option and click Select Download Option.

You will now have a file named GMTED2010N10E060_300.zip. Elevation data is distributed in various raster formats such as ASC, BIL, GeoTiff etc. QGIS supports a wide variety of raster formats via the GDAL library. The GMTED data comes as GeoTiff files which are contained in this zip archive.

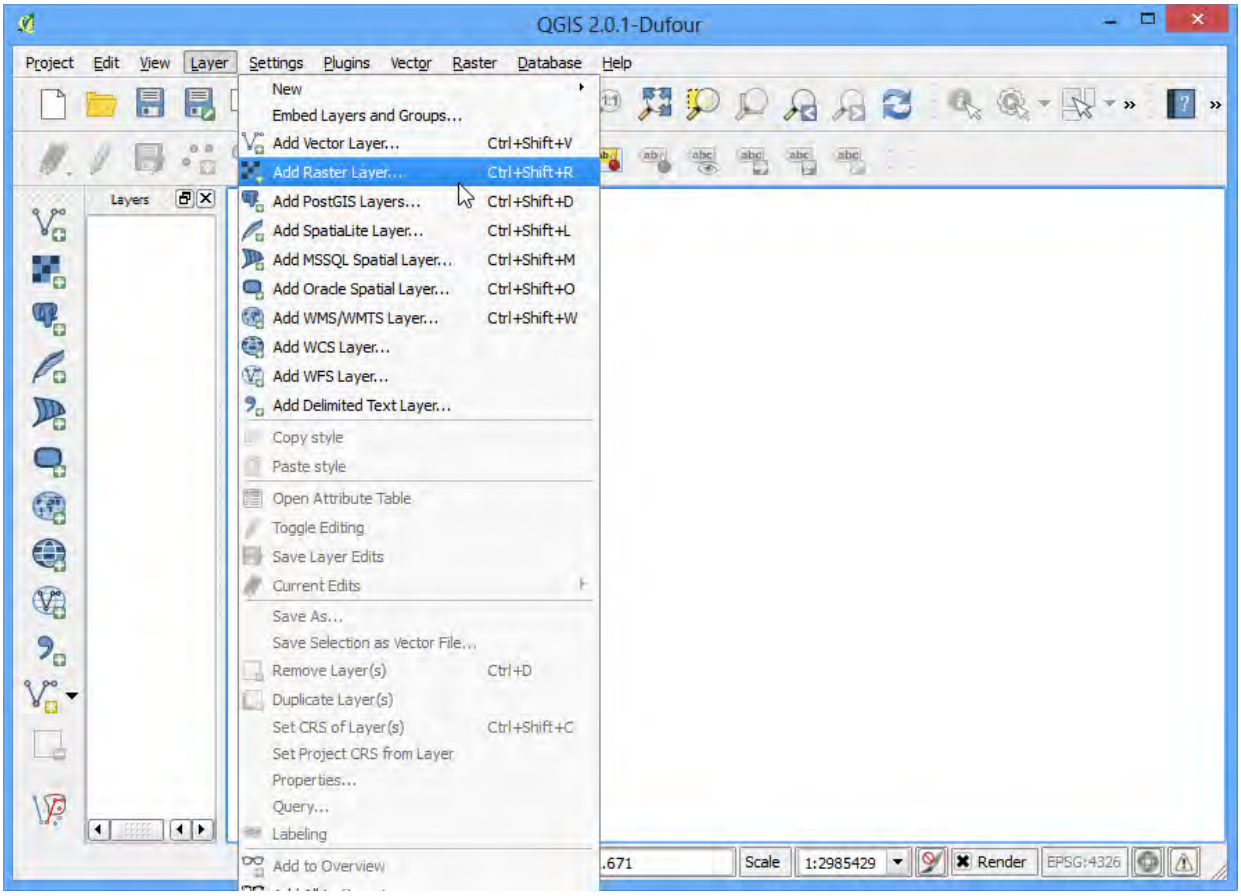
For convenience, you can download a copy of the data directly from below.

GMTED2010N10E060_300.zip

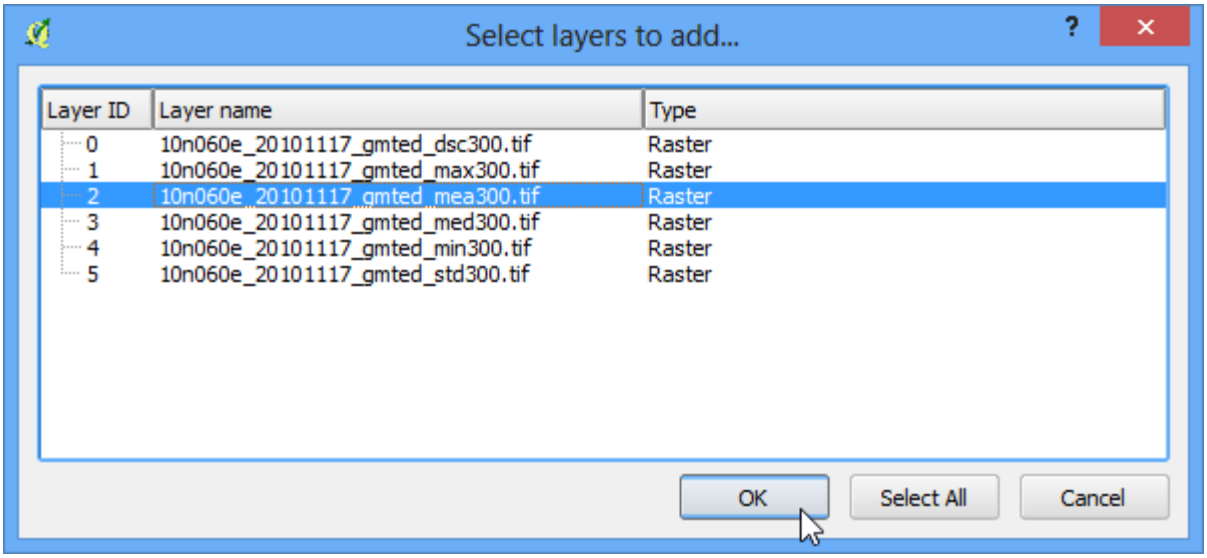
Data Source: [GMTED2010]

8.3 Procedure

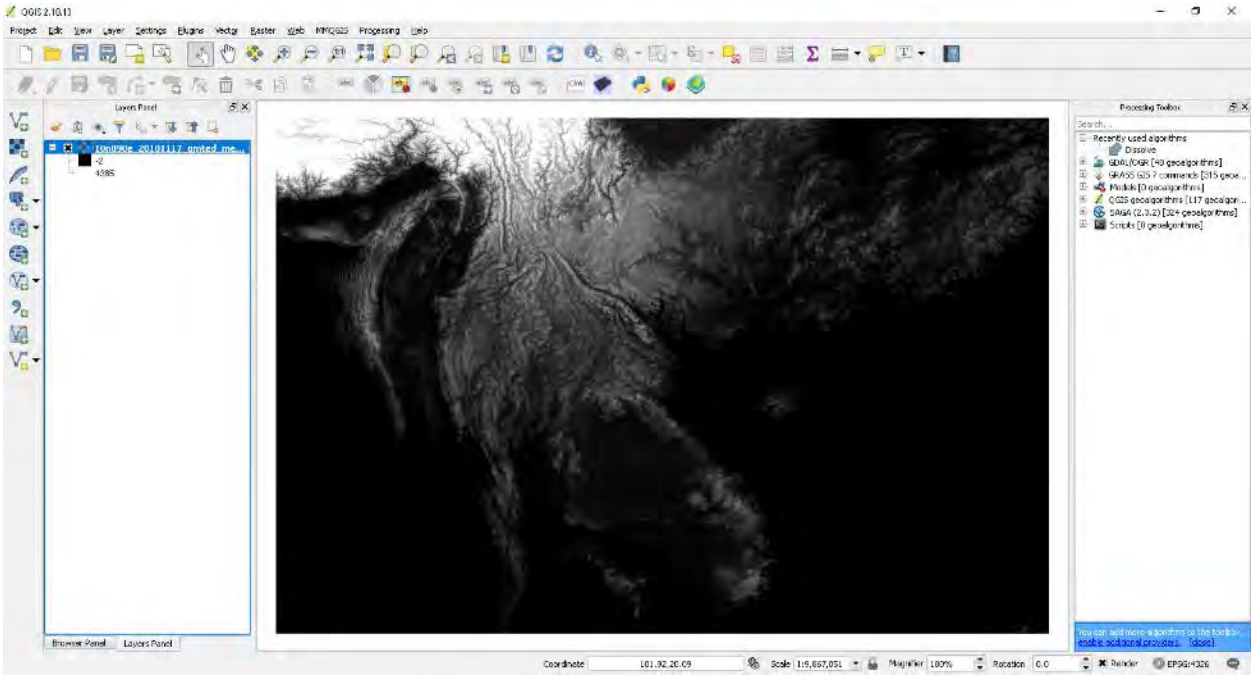
5. Open Layer ▸ Add Raster Layer and browse to the downloaded zip file.



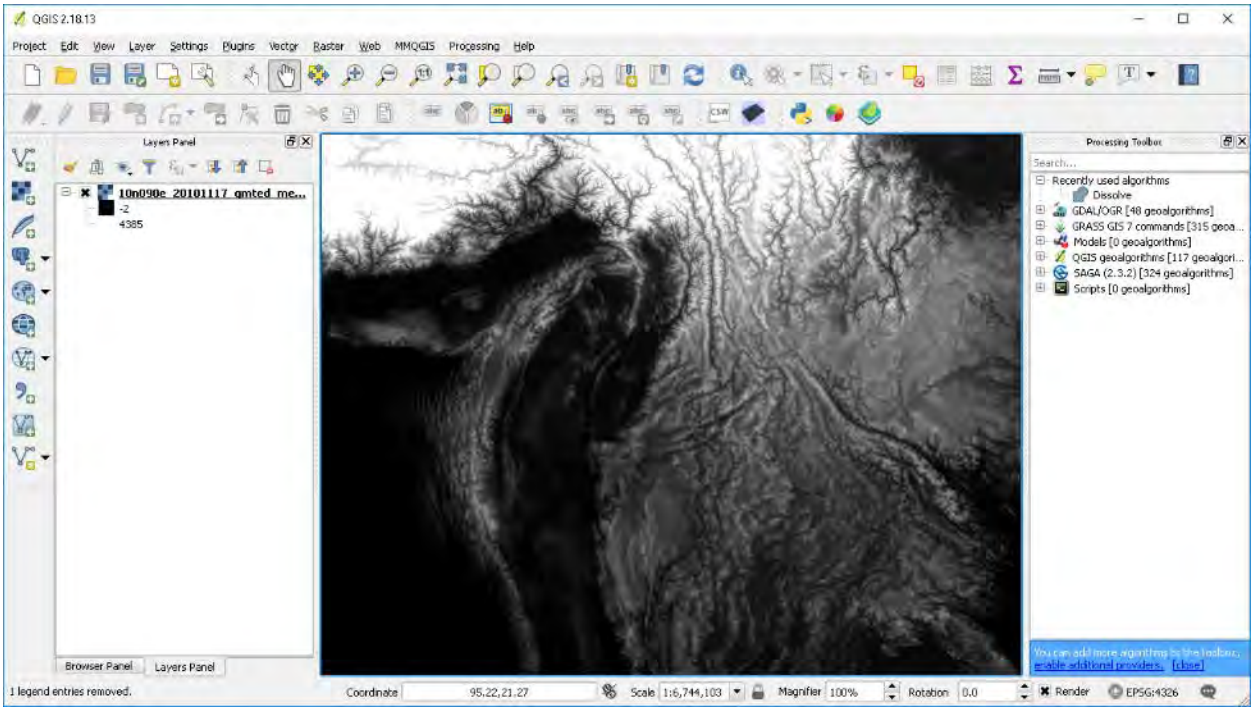
6. There are many different files generated from different algorithms. For this tutorial, we will use the file named 10n060e_20101117_gmted_mea300.tif.



7. You will see the terrain data rendered in the QGIS Canvas. Each pixel in the terrain raster represents the average elevation in meters at that location. The dark pixels represent areas with low altitude and lighter pixels represent areas with high altitude.



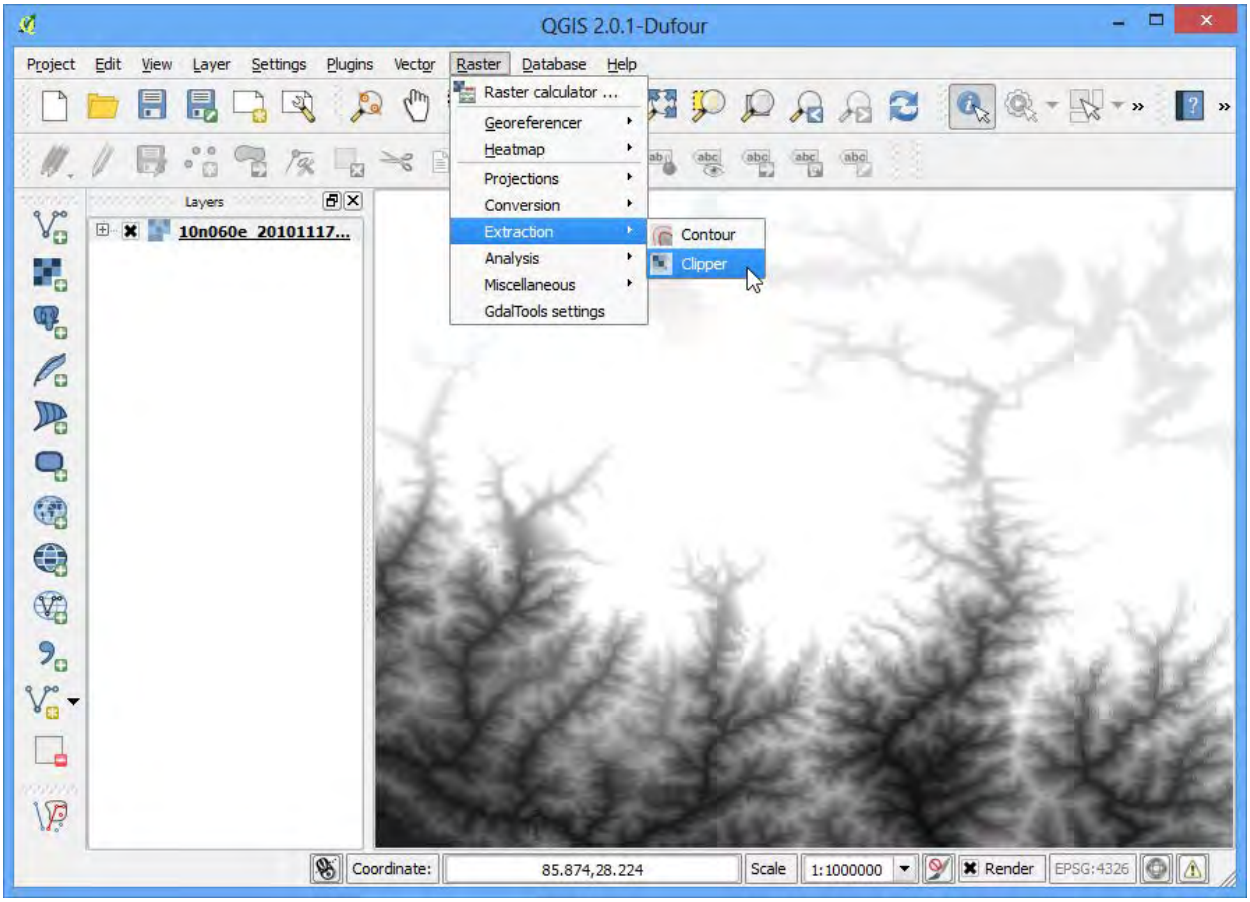
8. Zoom to the area around Hkakabo Razi.



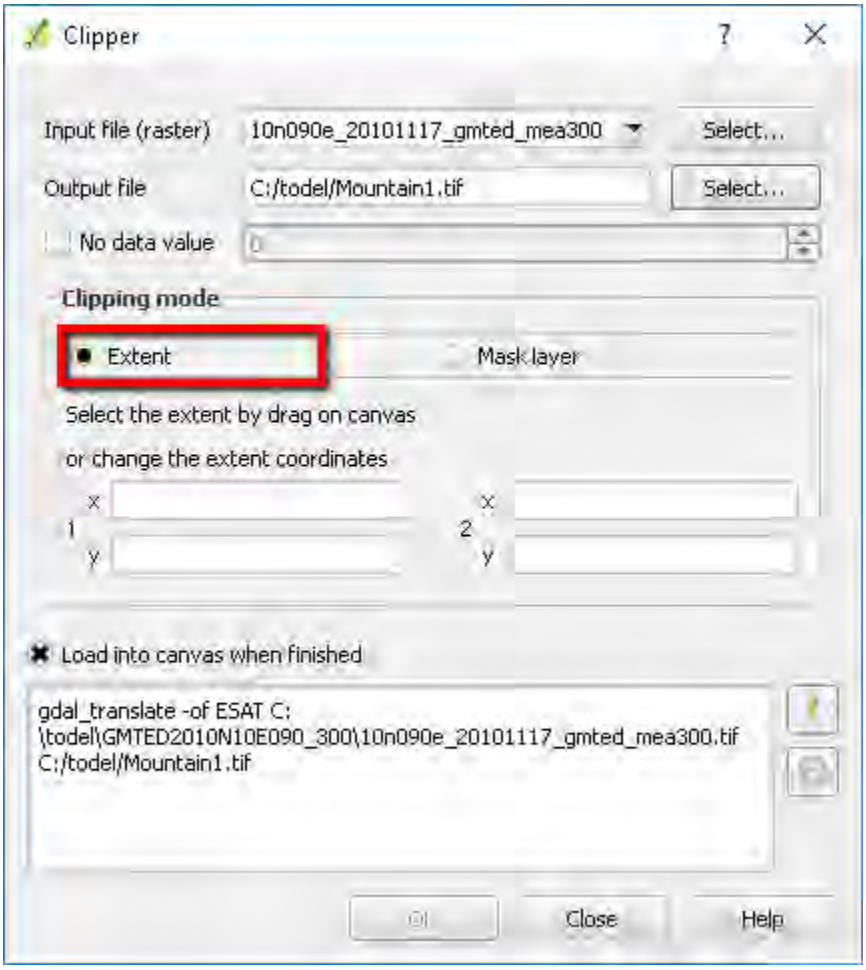
9. We will now crop the raster to this area of interest. Select the Clipper tool from Raster ▸ Extraction ▸ Clipper .

Note

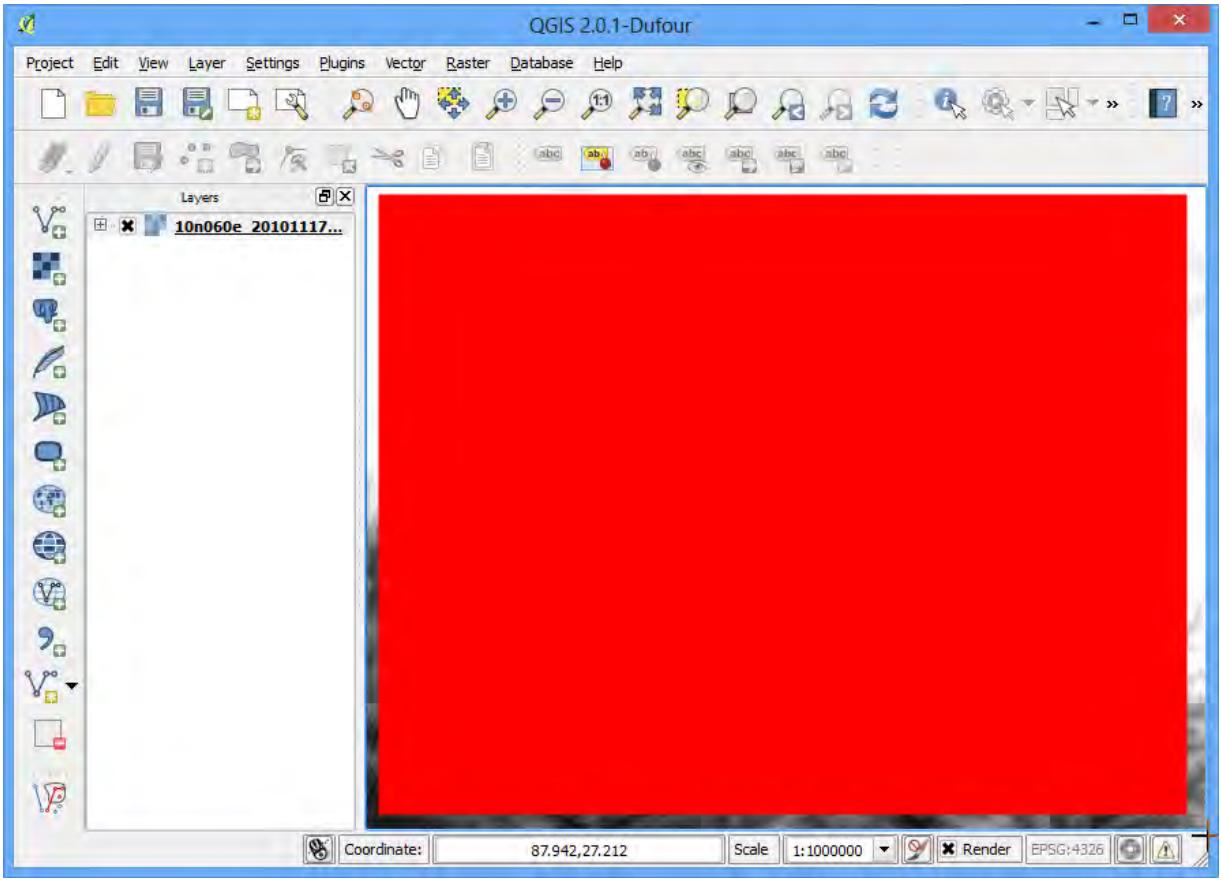
The Raster menu in QGIS comes from a core plugin called GdalTools. If you do not see the Raster menu, enable the GdalTools plugin from Plugins ▸ Manage and install plugins ▸ Installed. See *Using Plugins* for more details.



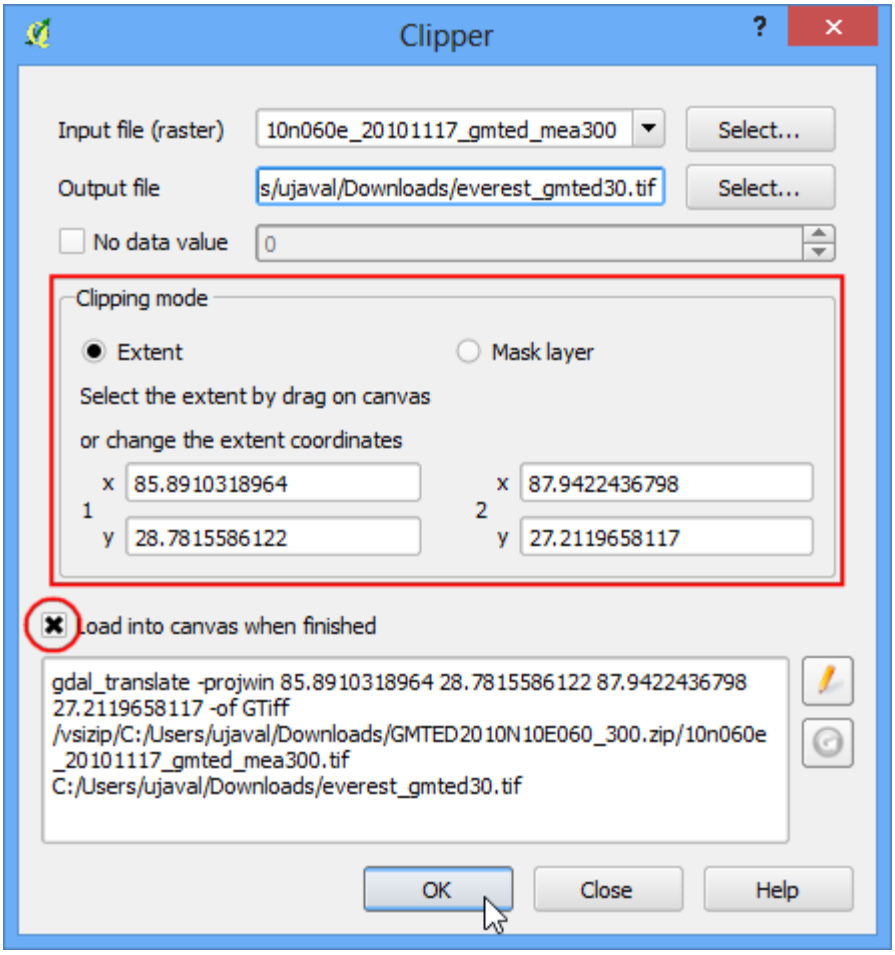
10. In the Clipper window, name your output file as everest_gmted30.tif. Select the Clipping mode as Extent.



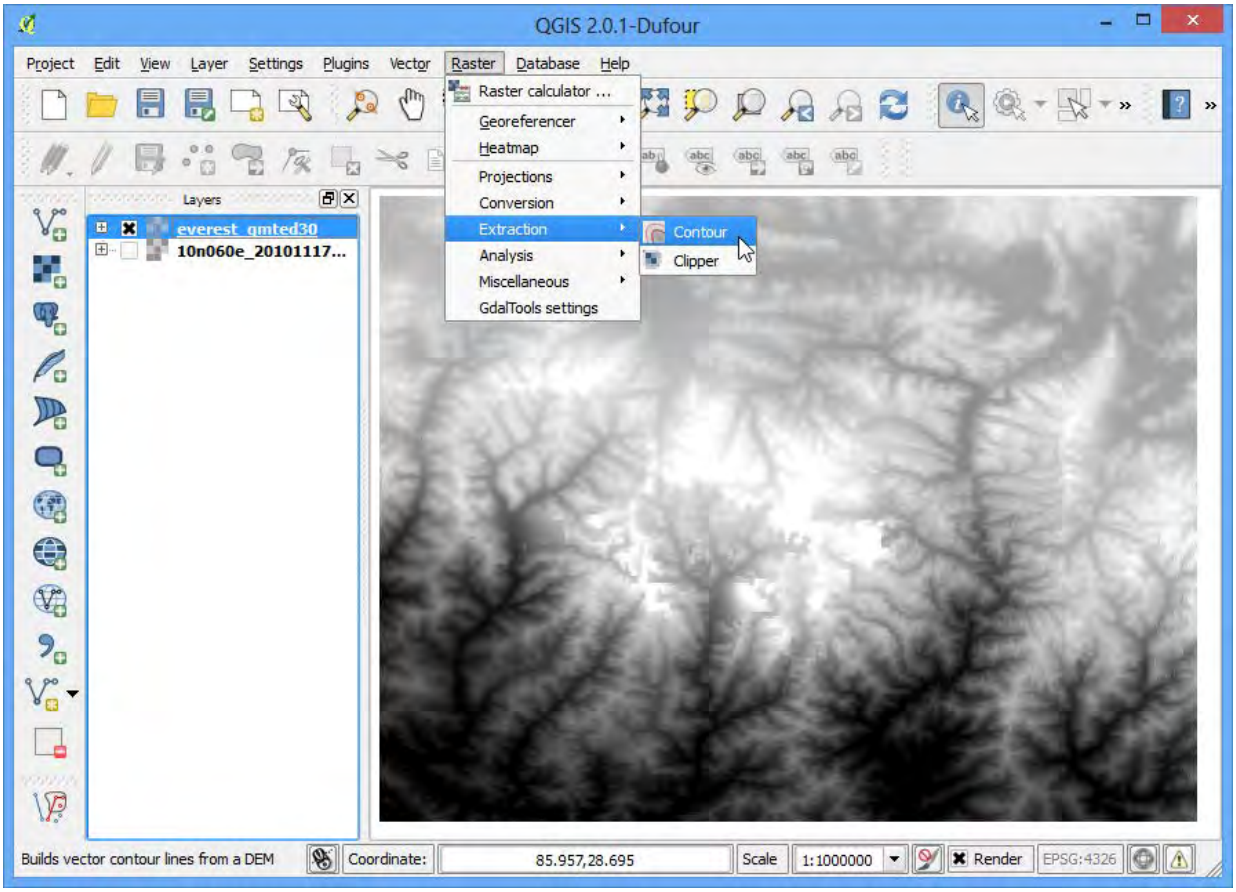
11. Keep the Clipper window open and switch to the main QGIS window. Hold your left mouse button and draw a rectangle covering the full canvas.



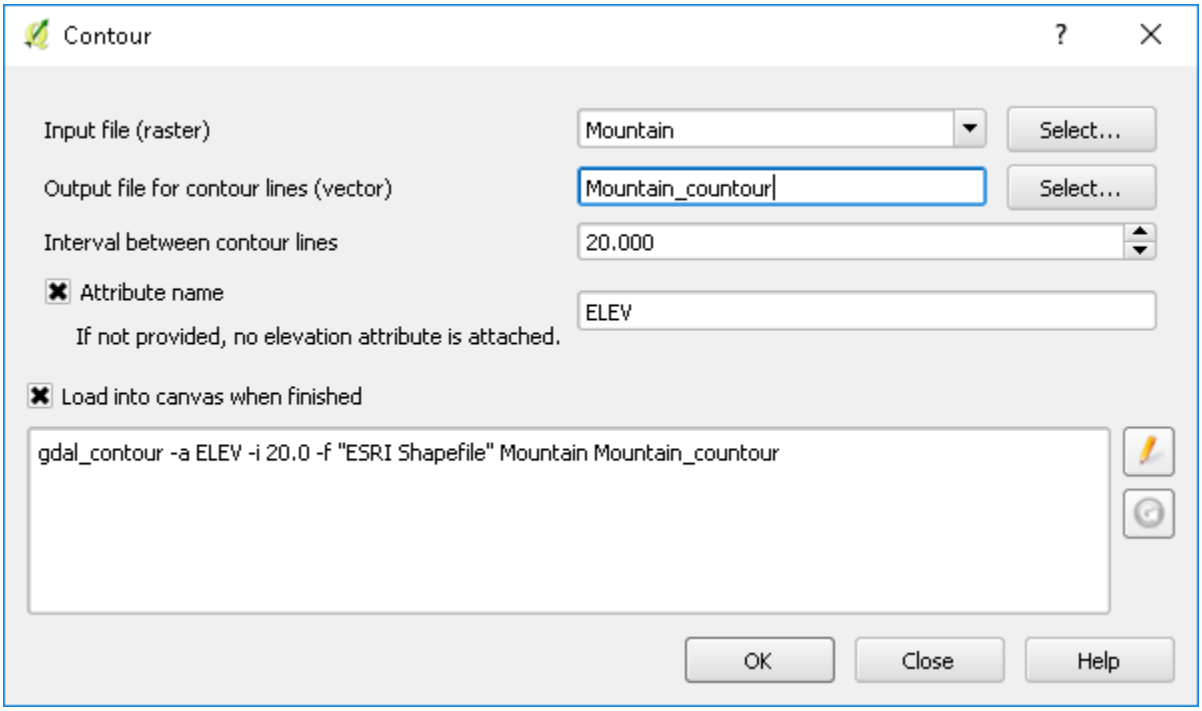
12. Now back in the Clipper window, you will see the coordinates auto-populated from your selection. Make sure the Load into canvas when finished option is checked, and click OK.



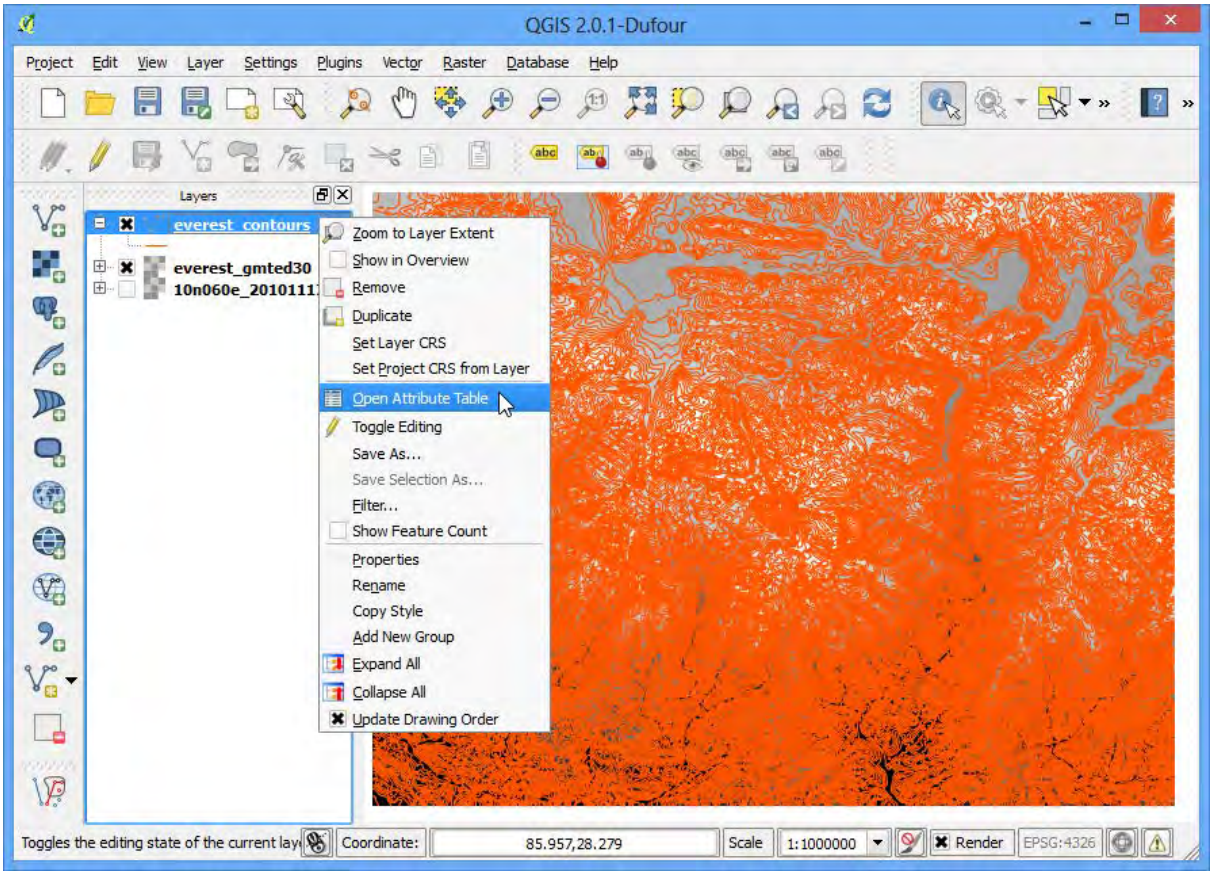
13. Once the process finishes, you will see a new layer loaded in QGIS. This layer covers only the area around Mountain Hkakabo Razi. Now we are ready to generate contours. Select the contour tool from Raster ▸ Extraction ▸ Contour .



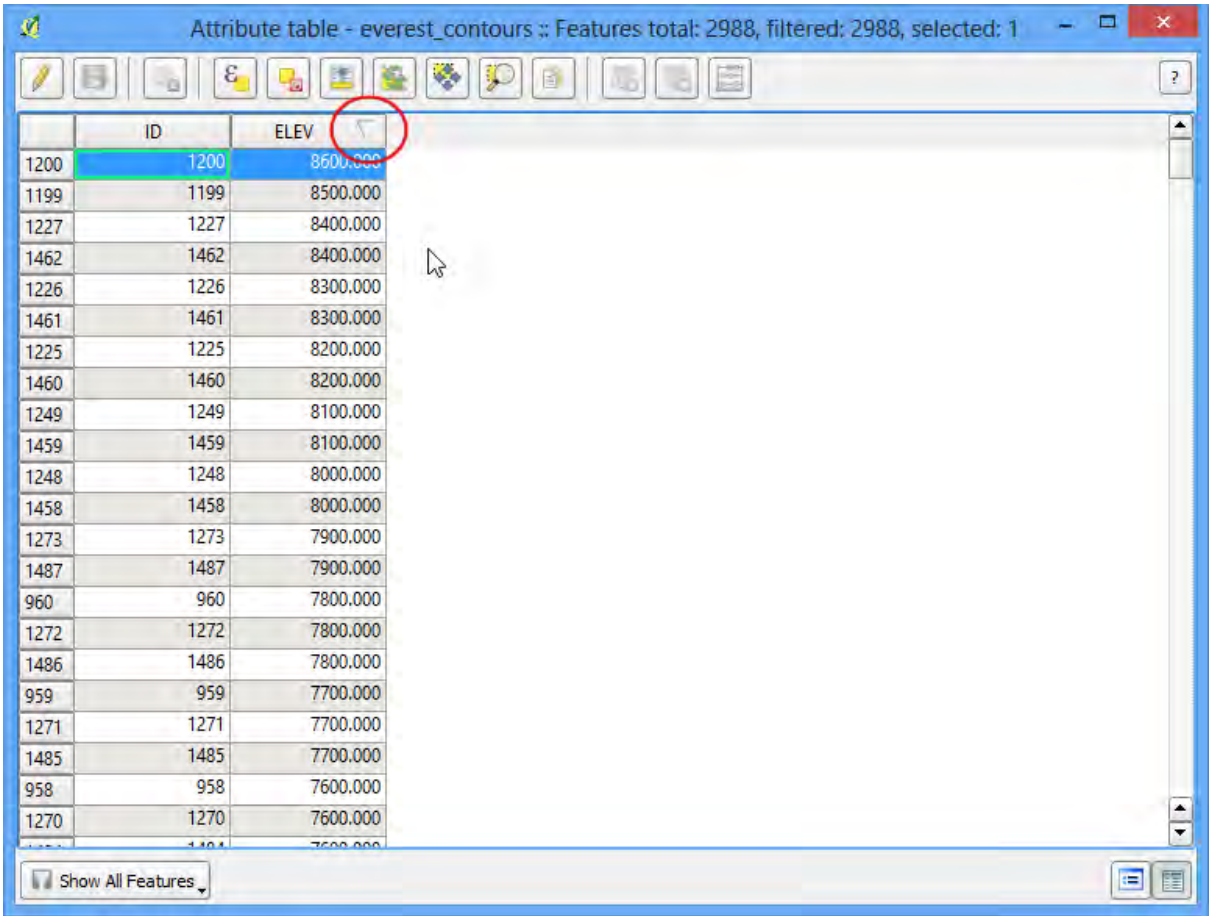
14. In the Contour dialog, select everest_gmted30 as the Input file. Name the Output file for contour lines as h_countours.shp. We will generate contour lines for 100m intervals, so put 100 as the Interval between contour lines. Also check the Attribute name option so elevation value will be recorded as attribute of each contour line. Click OK.



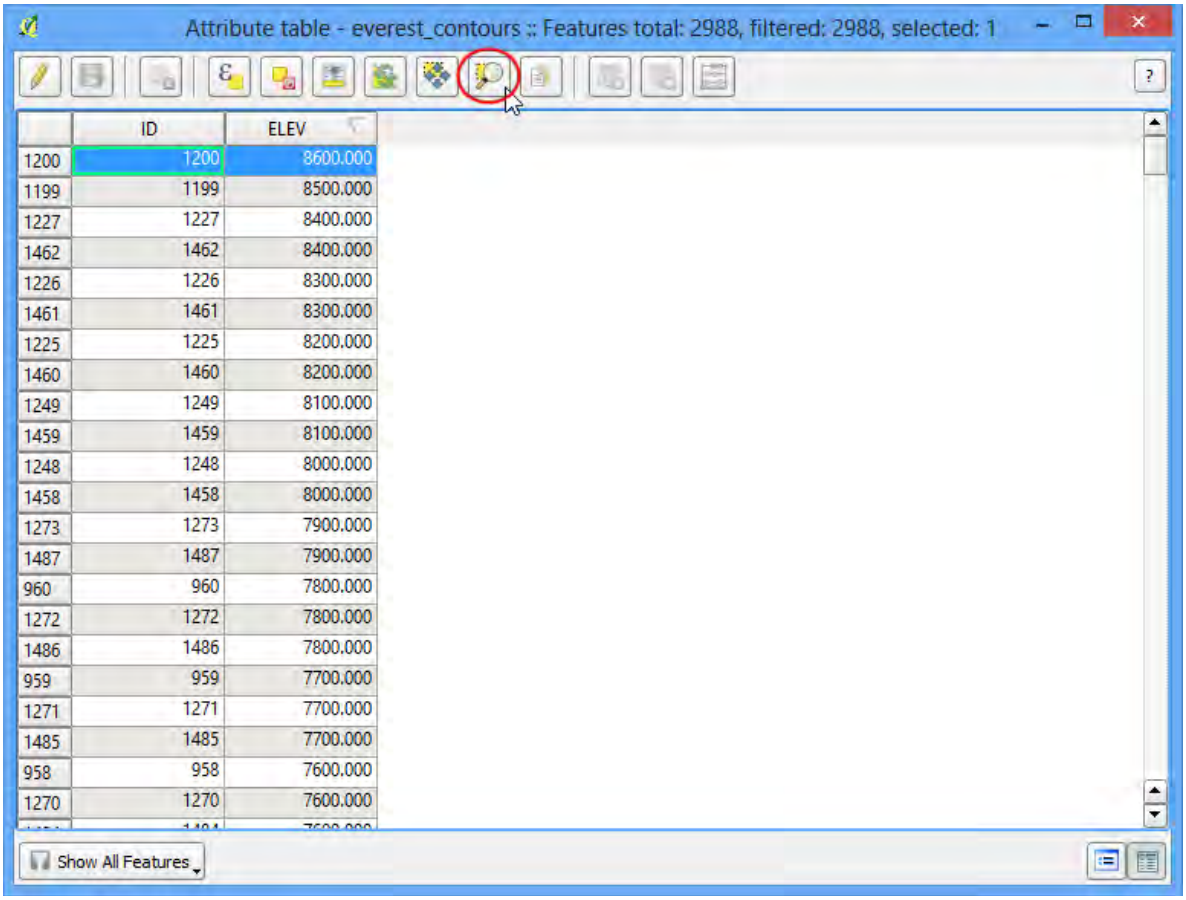
15. Once the processing is complete, you will see contour lines loaded into the canvas. Each line in this layer represents a particular elevation. All points along a countour line in the underlying raster would be at the same elevation. The closer the lines, the steeper the slope. Let's inspect the contours a bit more. Right click on the contours layer and choose Open Attribute Table.



16. You will see that each line feature has an attribute named ELEV. This is the height in metres that each line represents. Click on the column header a couple of times to sort the values in descending order. Here you will find the line representing the highest elevation in our data.

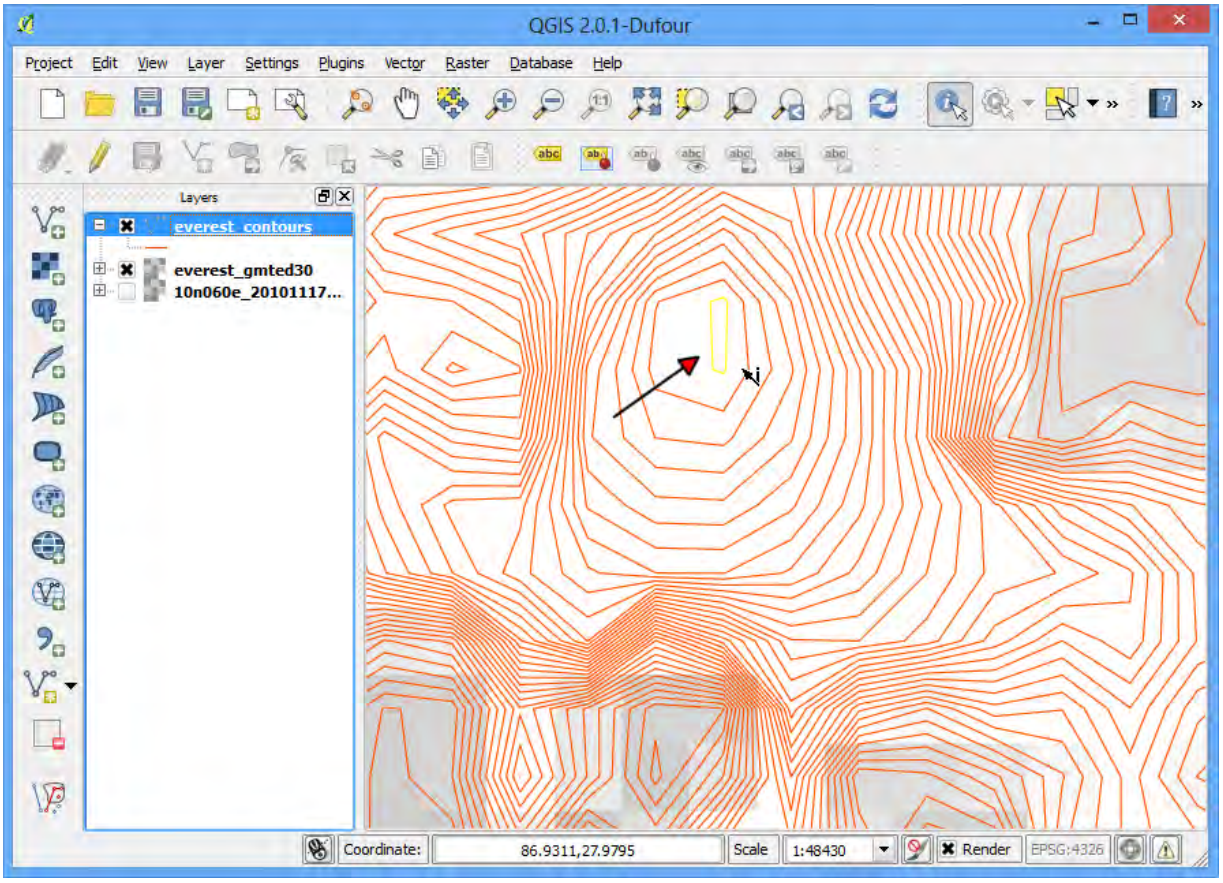


17. Select the top row, and click on the Zoom to selection button.

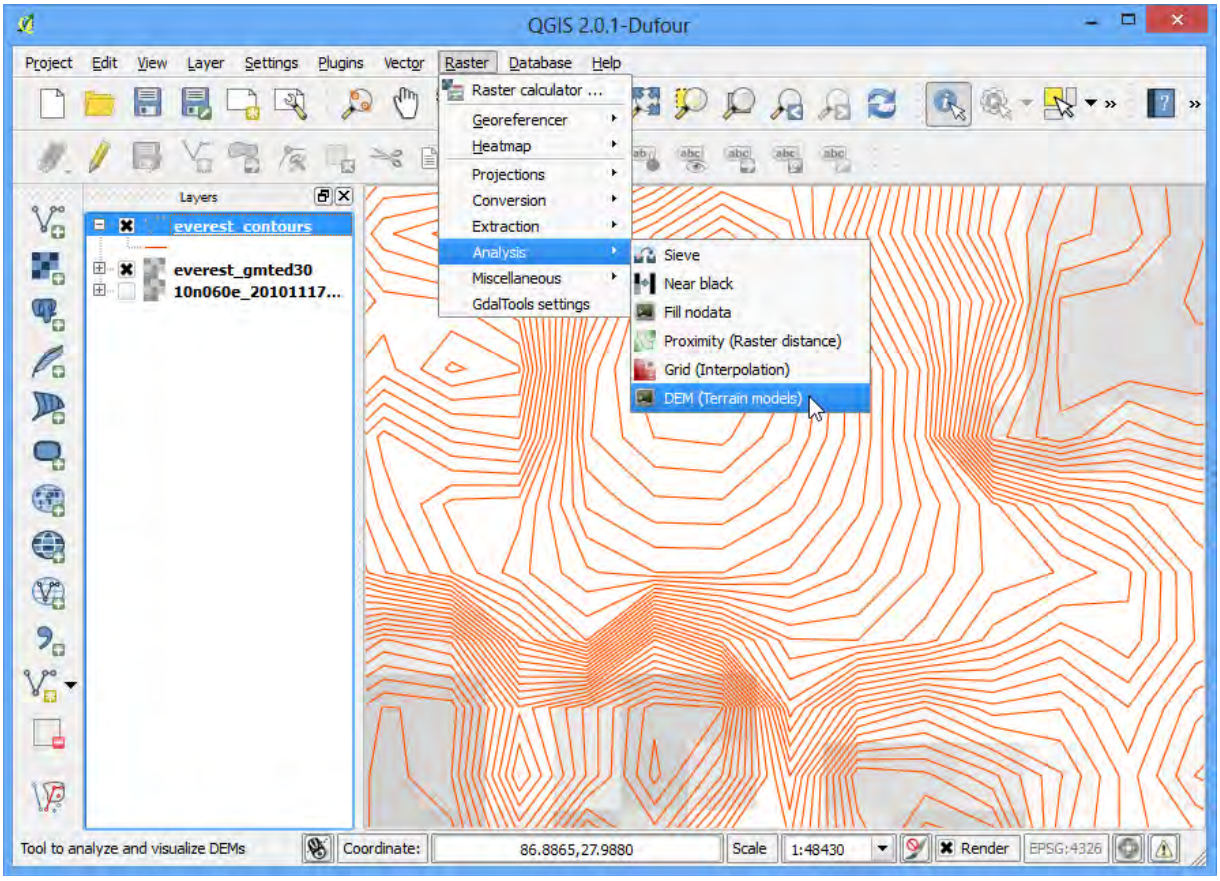


	ID	ELEV
1200	1200	8600.000
1199	1199	8500.000
1227	1227	8400.000
1462	1462	8400.000
1226	1226	8300.000
1461	1461	8300.000
1225	1225	8200.000
1460	1460	8200.000
1249	1249	8100.000
1459	1459	8100.000
1248	1248	8000.000
1458	1458	8000.000
1273	1273	7900.000
1487	1487	7900.000
960	960	7800.000
1272	1272	7800.000
1486	1486	7800.000
959	959	7700.000
1271	1271	7700.000
1485	1485	7700.000
958	958	7600.000
1270	1270	7600.000

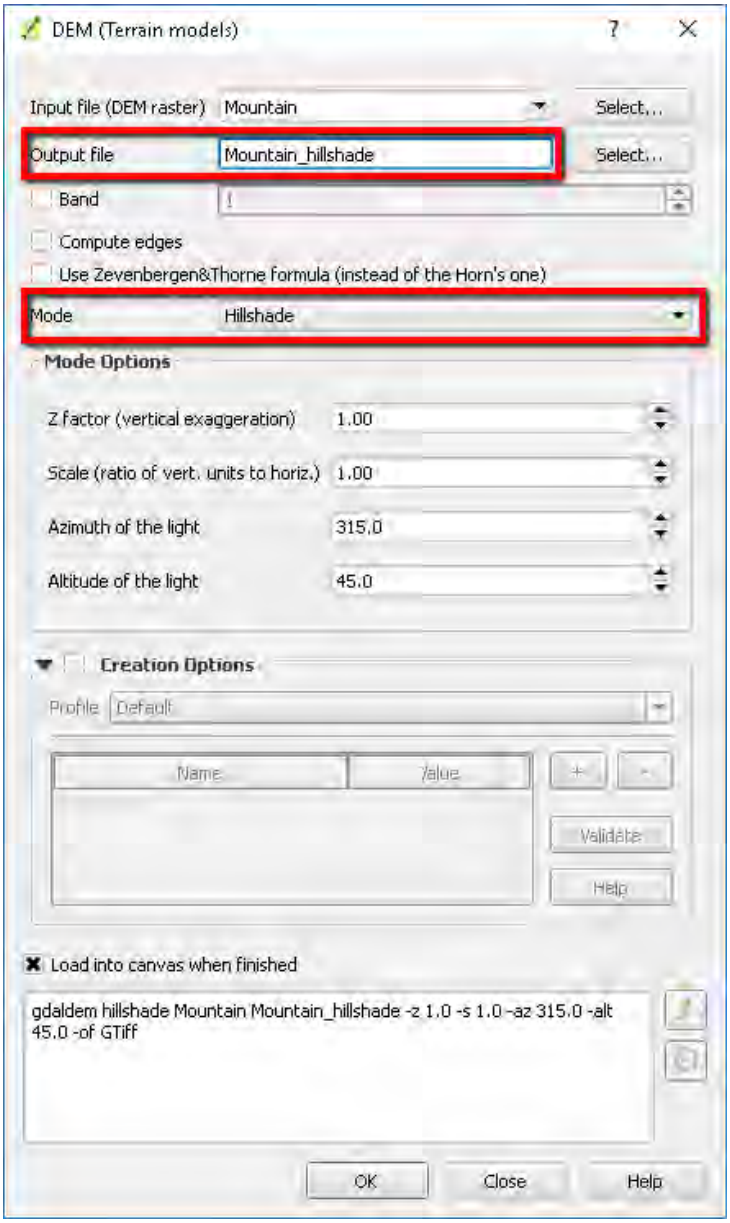
18. Switch to the main QGIS window. You will see the selected contour line highlighted in yellow. This is the area of the highest elevation in our dataset.



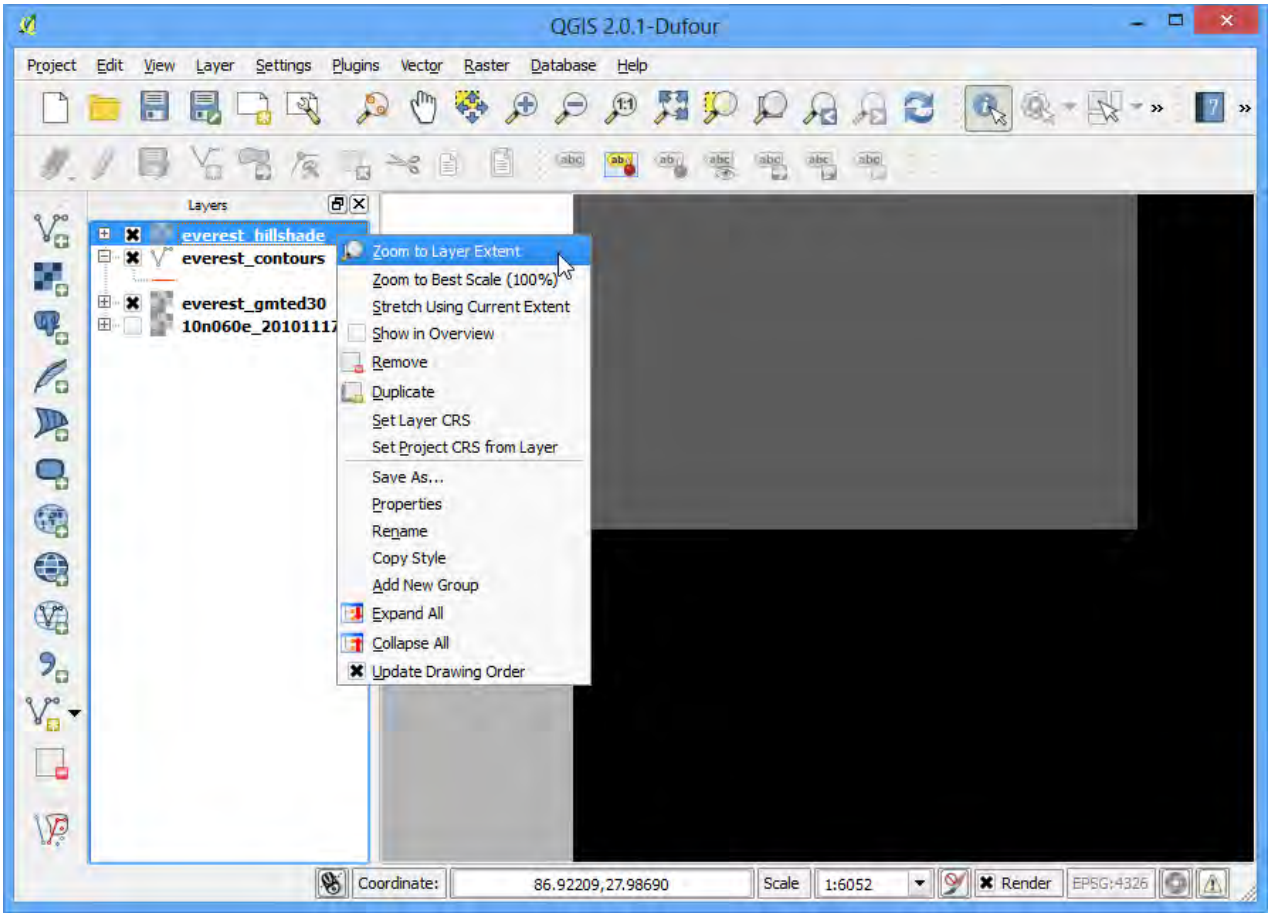
19. Now let us create a hillshade map from the raster. Select Raster ▸ Analysis ▸ DEM (Terrain Models).



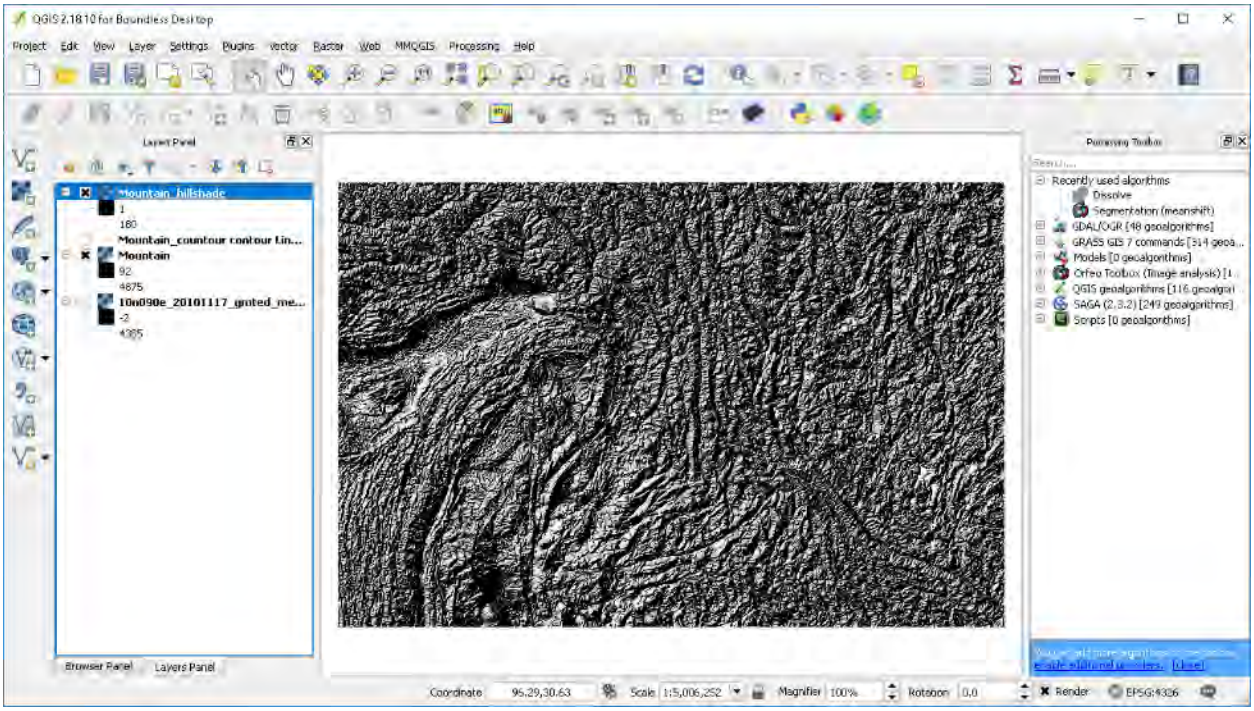
20. In the DEM (Terrain Models) dialog, choose mountain.tif as the Input file. Name the Output file as mountain_hillshade.tif. Choose Hillshade as the Mode. Leave all other options as is. Make sure the Load into canvas when finished option is checked, and click OK.



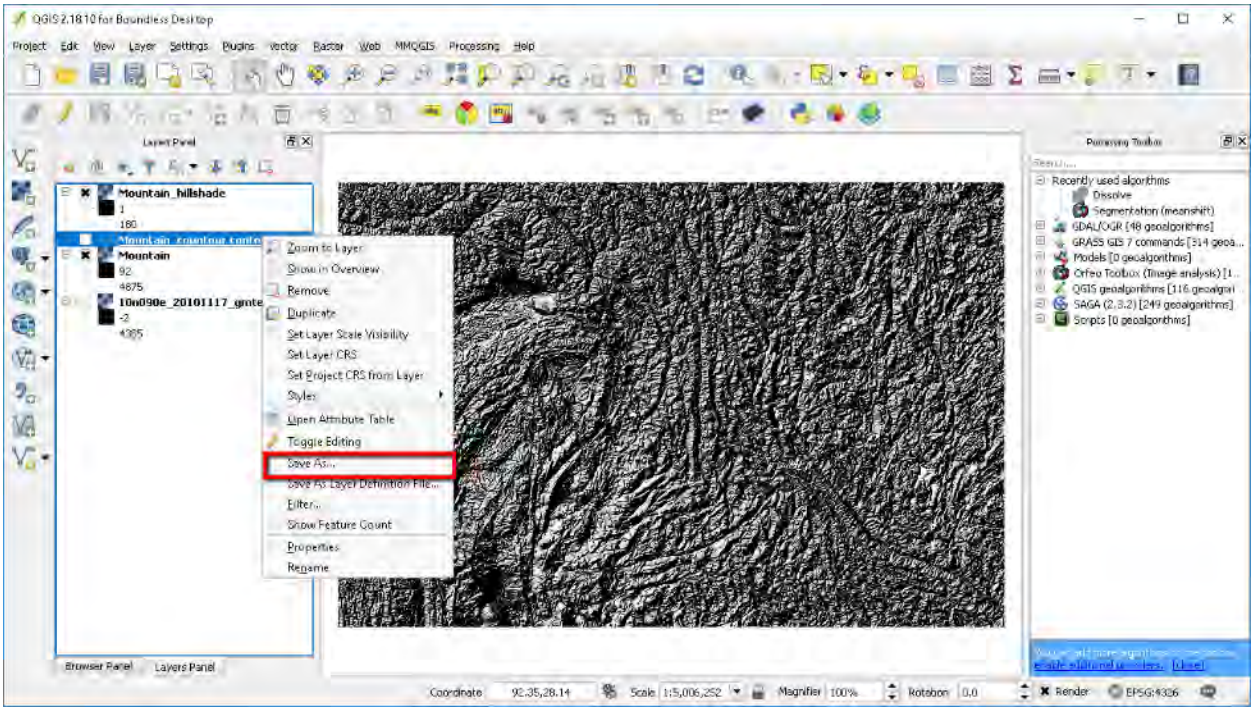
21. Rright click on the Mountain_hillshade layer and choose Zoom to Layer Extent.



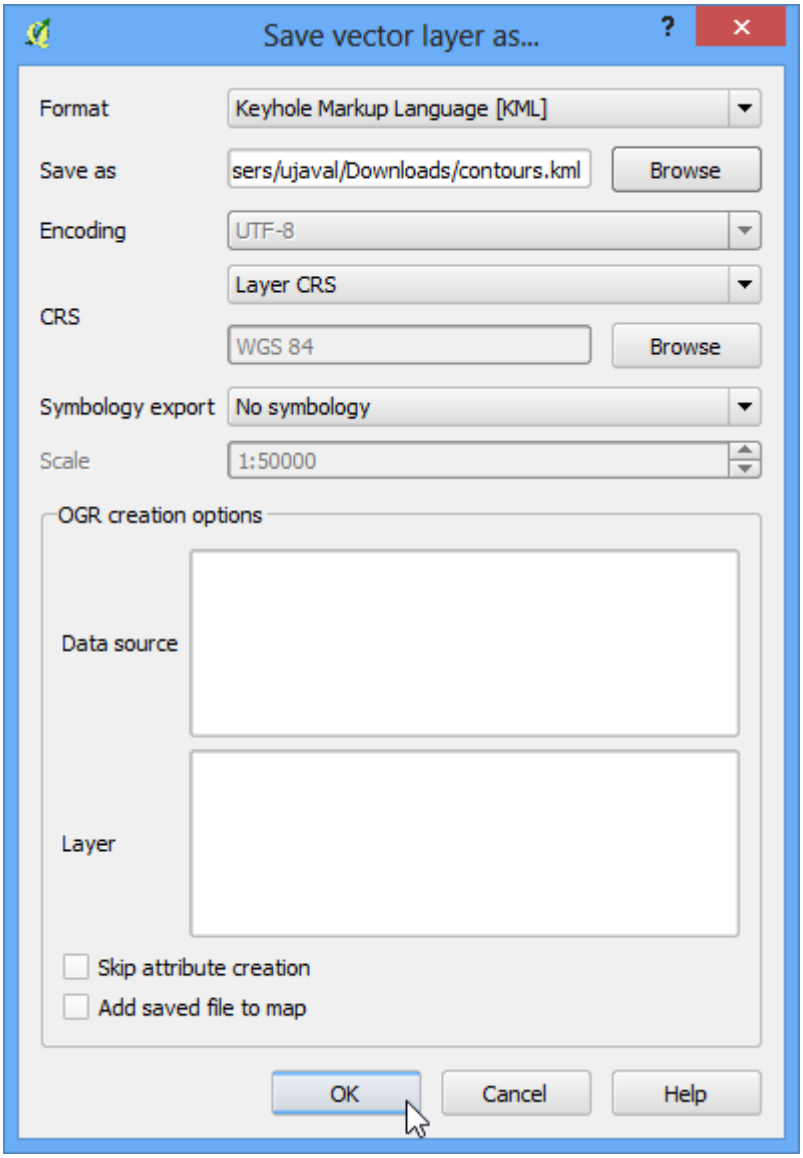
22. Now you will see the full extent of the hillshade raster.



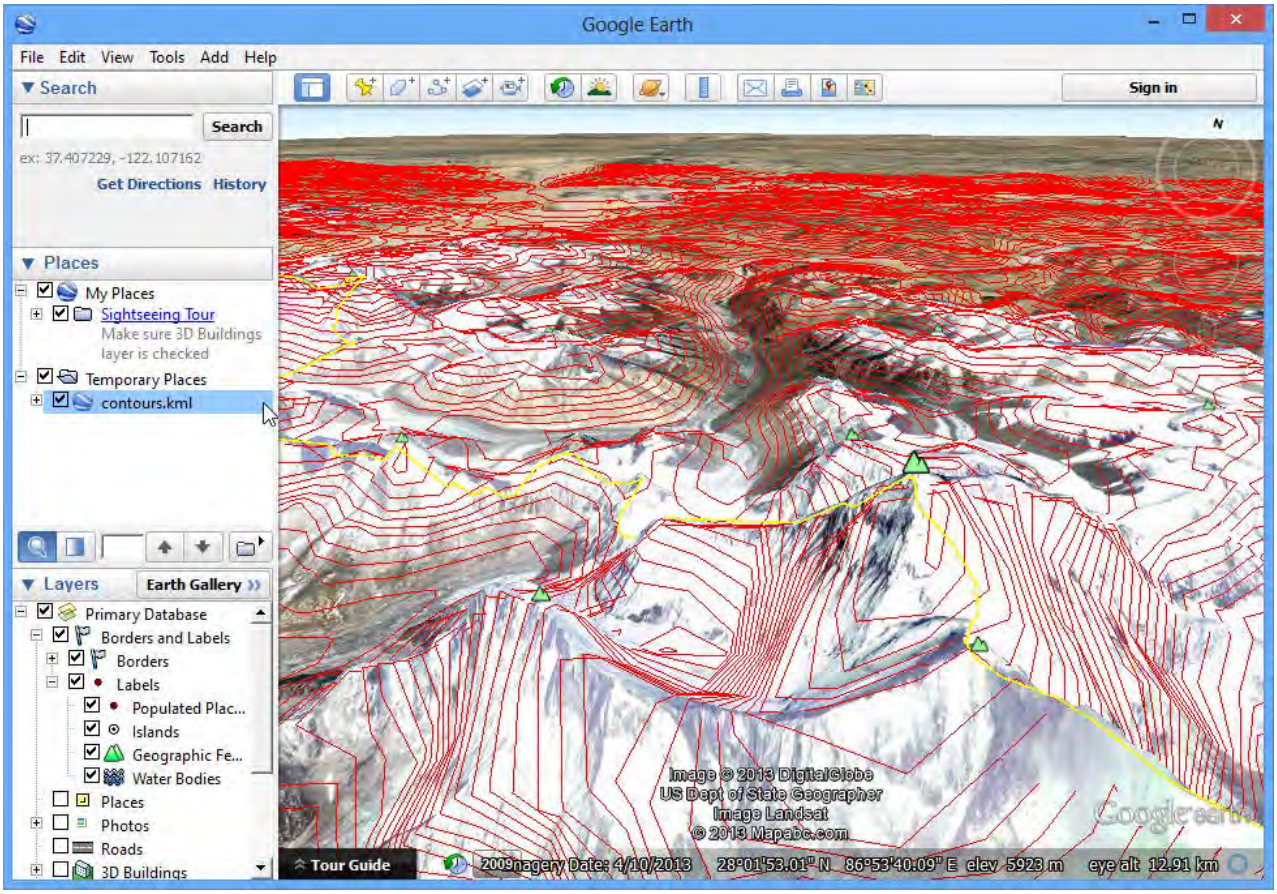
23. You can also visualize your contour layer and verify your analysis by exporting the contours layer as KML and viewing it in Google Earth. Right click on the contours layer, select Save as...



24. Select Keyhole Markup Language [KML] as the Format. Name your output as contours.kml and click OK.



25. Browse to the output file on your disk and double-click on it to open Google Earth.


Google Earth
File Edit View Tools Add Help
Search
Sign in
Search
ex: 37.407229, -122.107162
Get Directions History
Places
My Places
Sightseeing Tour
Make sure 3D Buildings layer is checked
Temporary Places
contours.kml
Layers
Earth Gallery
Primary Database
Borders and Labels
Borders
Labels
Populated Plac...
Islands
Geographic Fe...
Water Bodies
Places
Photos
Roads
3D Buildings
Image © 2013 DigitalGlobe
US Dept of State Geographer
Image Landsat
© 2013 Mapabc.com
Tour Guide
2009 Imagery Date: 4/10/2013 28°01'53.01" N 86°53'40.09" E elev 5923 m eye alt 12.91 km

9 Digitizing Map Data

Digitizing is one of the most common tasks that a GIS Specialist has to do. Often a large amount of *GIS time* is spent in digitizing raster data to create vector layers that you use in your analysis. QGIS has powerful on-screen digitizing and editing capabilities that we will explore in this tutorial.

9.1 Overview of the task

We will use a raster topographic map and create several vector layers representing features around a park.

9.2 Other skills you will learn

- Building pyramids for large raster datasets to speed up zoom and pan operations.
- Working with a Spatialite database.

9.3 Get the data

Land Information New Zealand (LINZ) provides raster topographic maps at 1:50,000 scale for the New Zealand mainland and Chatham Islands.

Download the GeoTIFF Image file from the Christchurch Topo50 map download page.

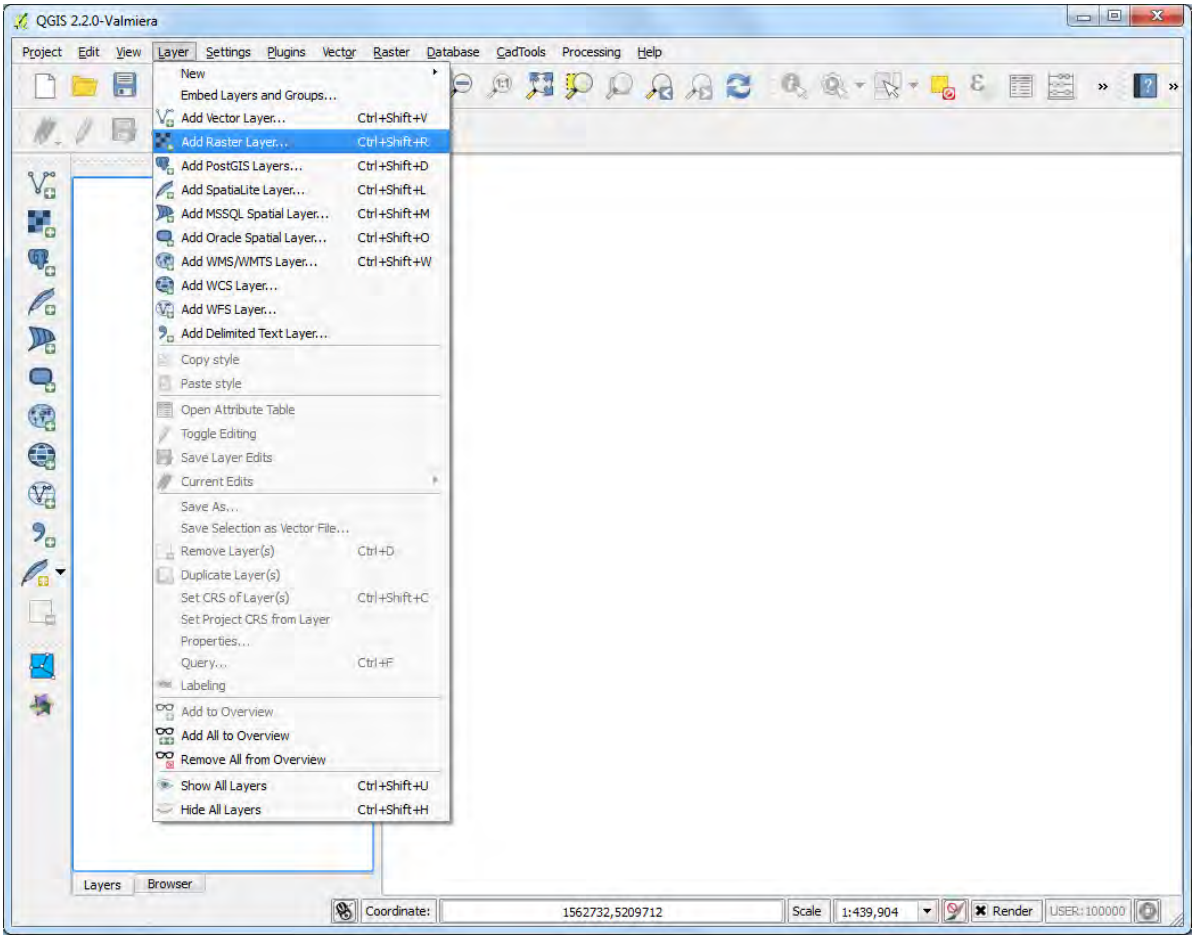
For convenience, you may directly download a copy of the dataset from the link below:

BX24_GeoTifv1-02-clip.tif

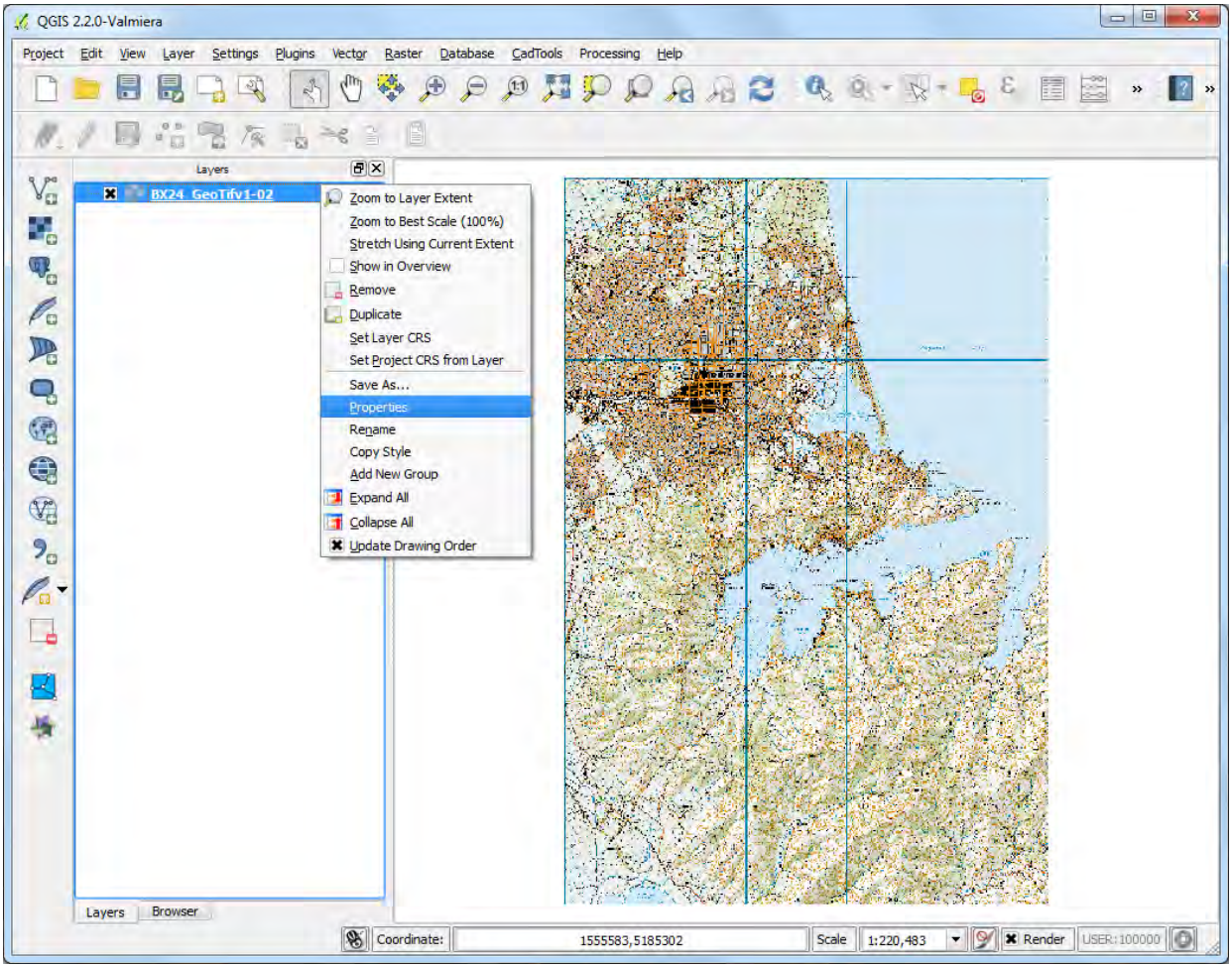
Data Source [LINZ]

9.4 Procedure

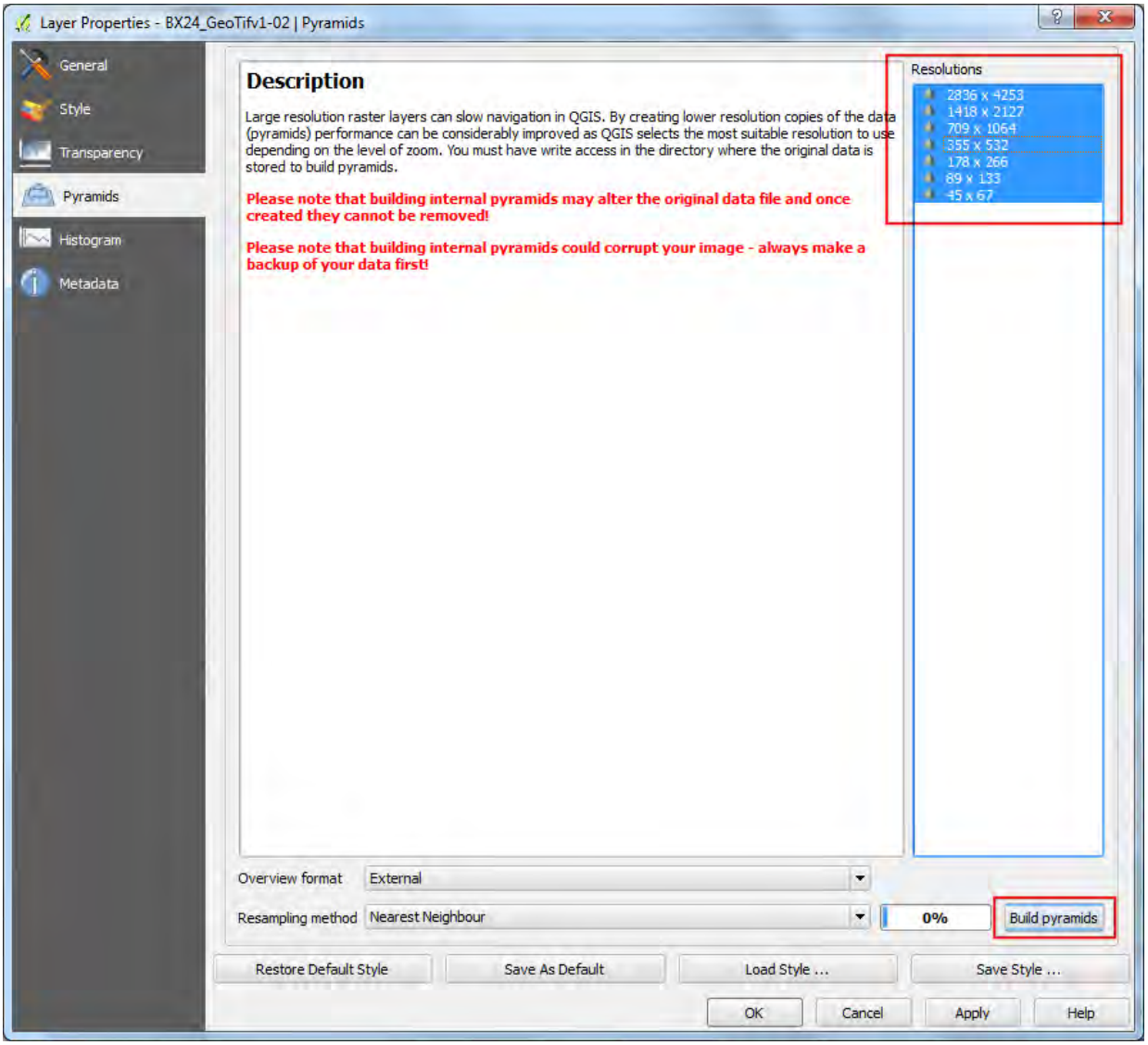
1. Go to Layer ▸ Add Raster Layer . Locate the downloaded `BX24_GeoTifv1-02.tif` and click Open.



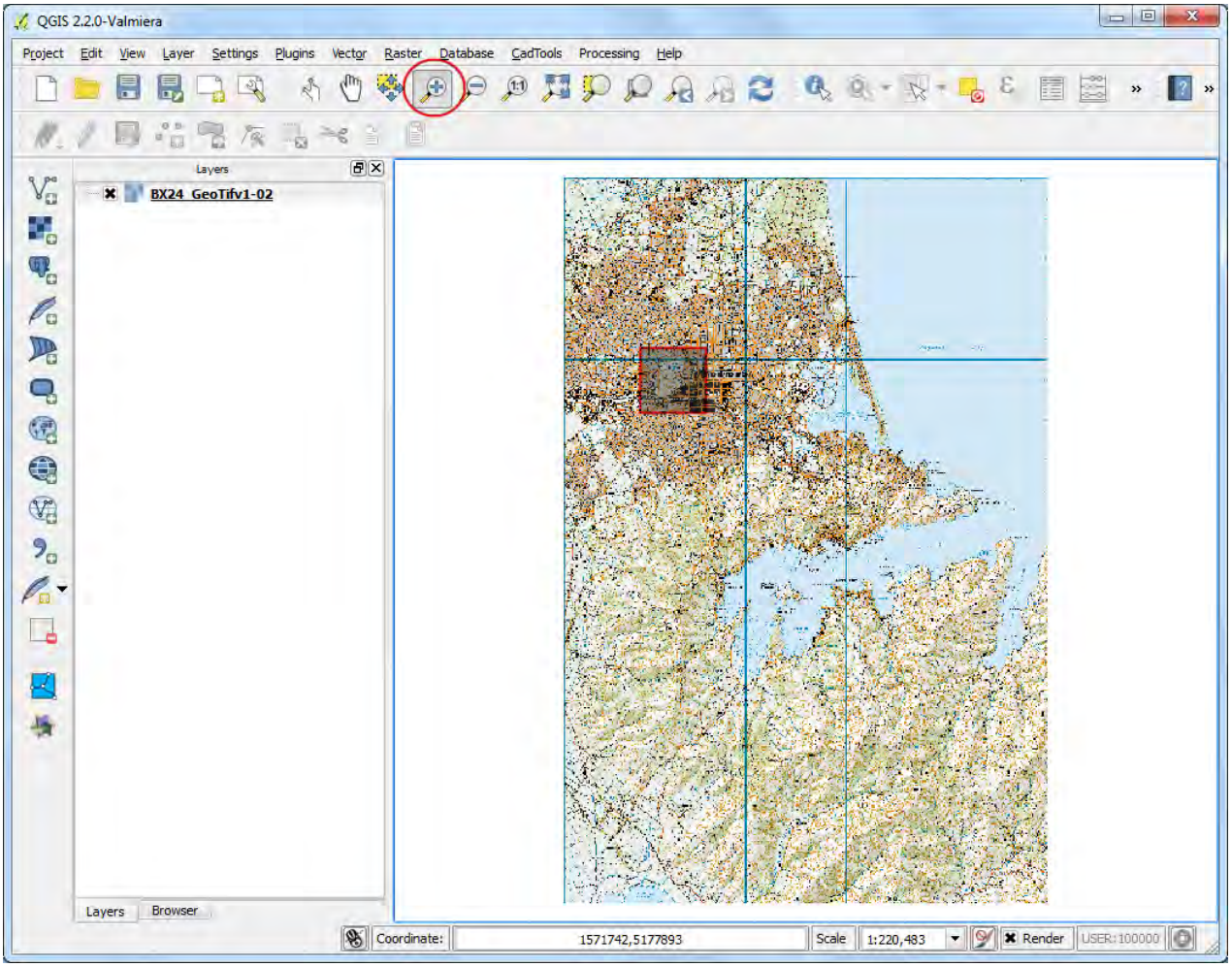
2. This is a large raster file and you may notice that when you zoom or pan around the map, the map takes a little time to render the image. QGIS offers a simple solution to make rasters load much faster by using **Image Pyramids**. QGIS creates pre-rendered tiles at different resolutions and these are presented to you instead of the full raster. This makes map navigation snappy and responsive. Right-click the `BX24_GeoTifv1-02` layer and choose Properties.



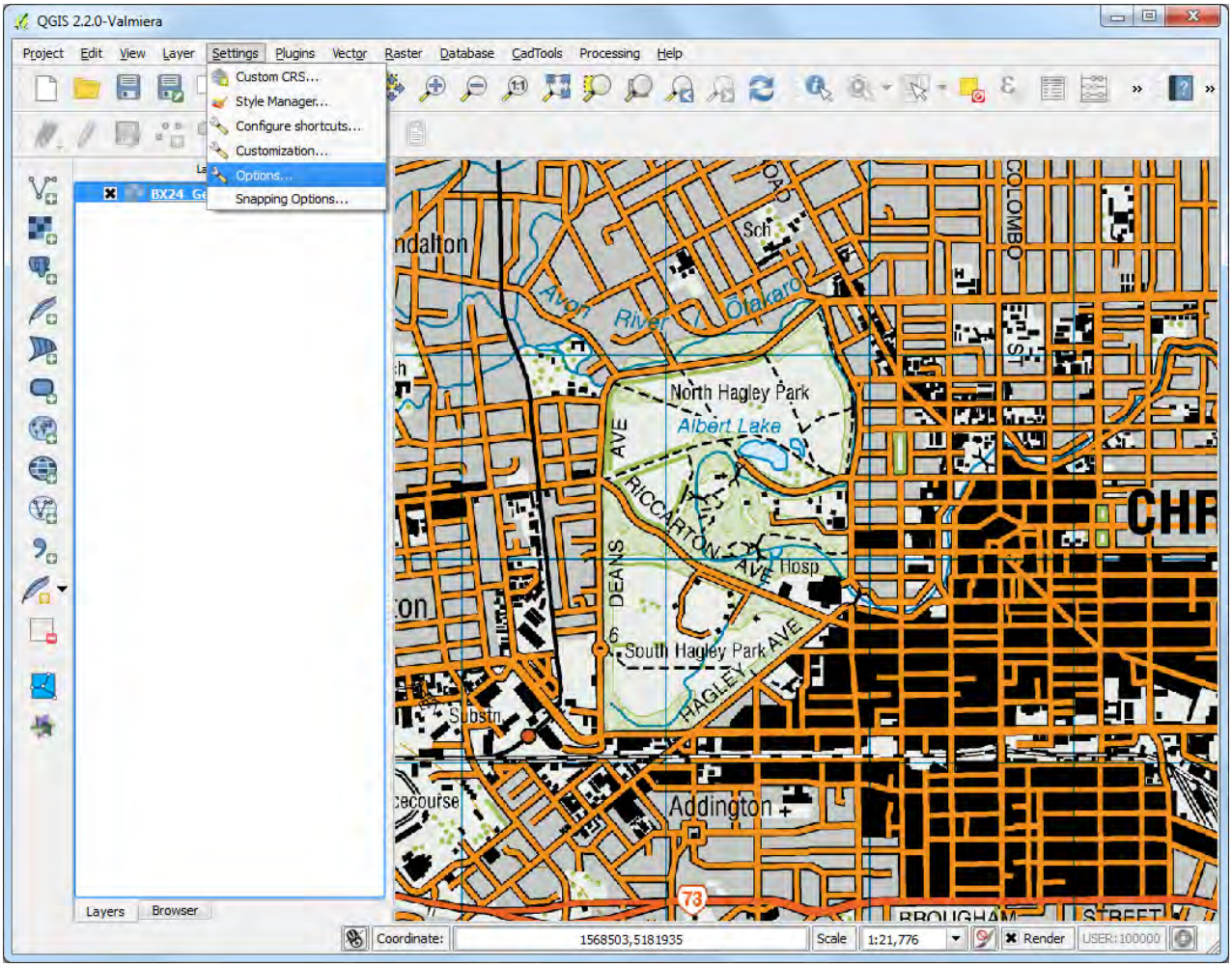
3. Choose the Pyramids tab. Hold the `Ctrl` key and select all the resolutios offered in the Resolutions panel. Leave other options to defaults and click Build pyramids. Once the process finishes, click OK.



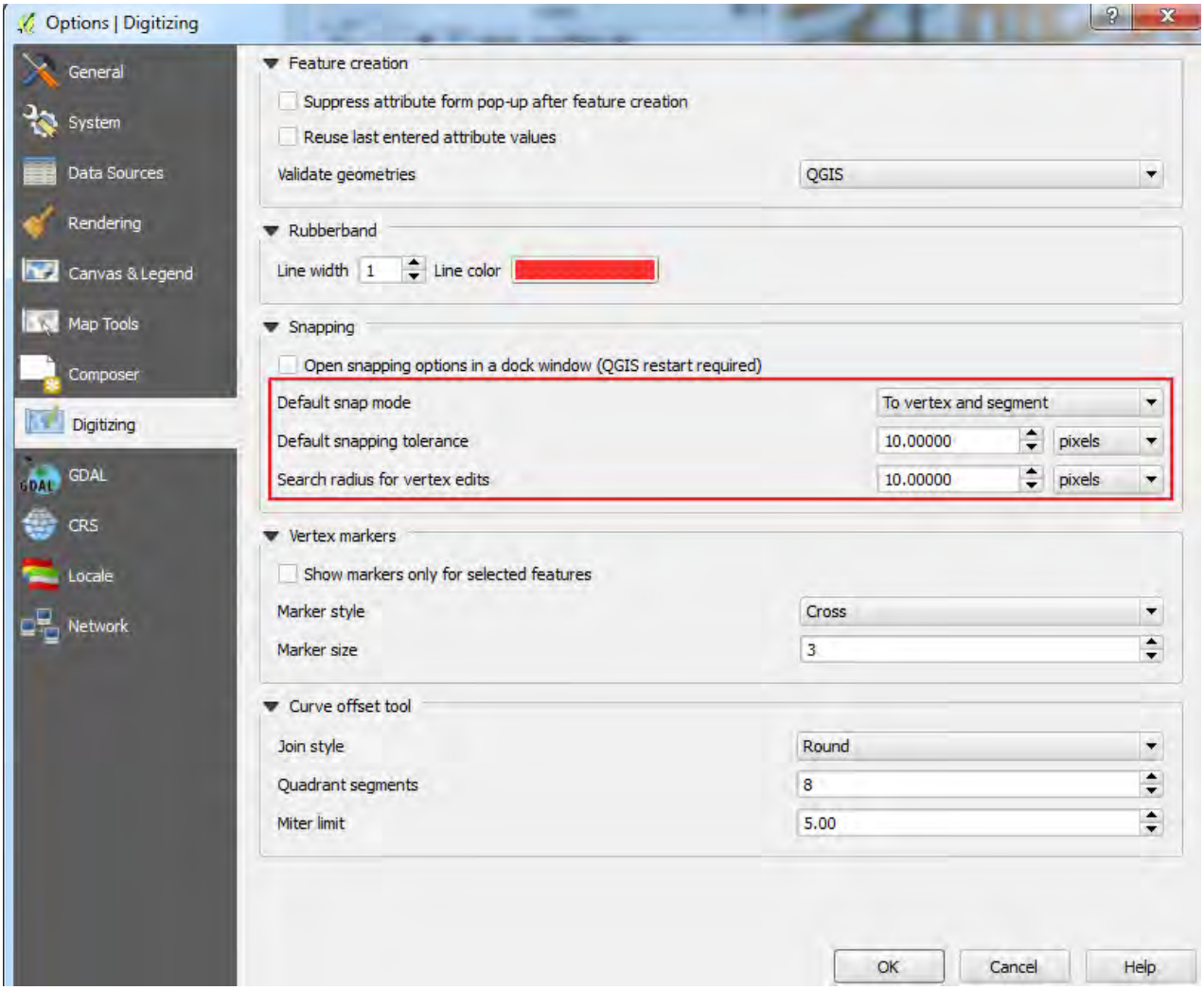
4. Back in the main QGIS window, use the Zoom tool to locate *Hagley Park* area in Christchurch. This is the park that we will be digitizing.



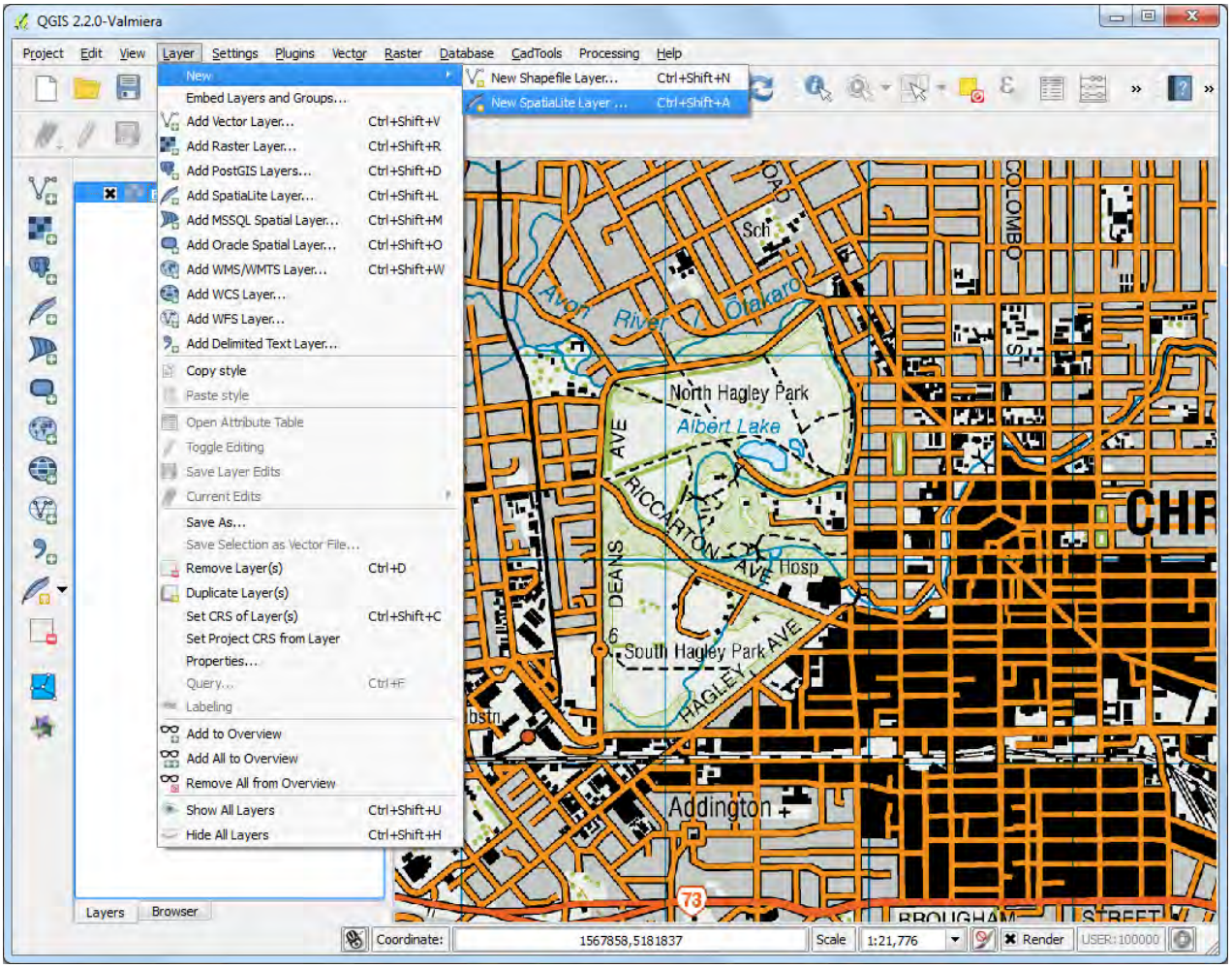
5. Before we start, we need to set default **Digitizing Options**. Go to Settings ▸ Options... .



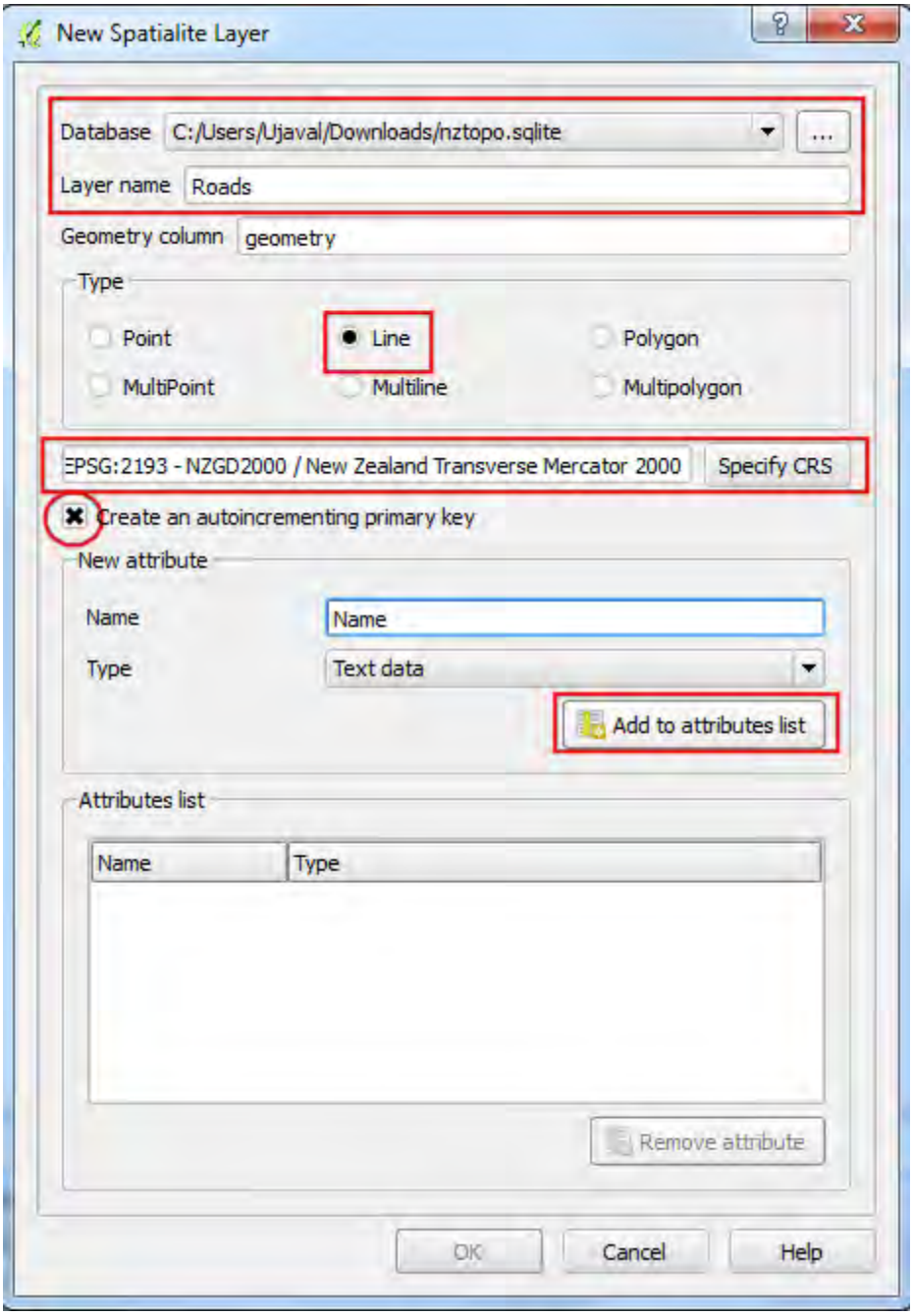
6. Select the Digitizing tab in the Options dialog. Set the Default snap mode to To vertex and segment. This will allow you to snap to the nearest vertex or line segment. I also prefer to set the Default snapping tolerance and Search radius for vertex edits in pixels instead of map units. This will ensure that the snapping distance remains constant regardless of zoom level. Depending on your computer screen resolution, you may choose an appropriate value. Click OK.



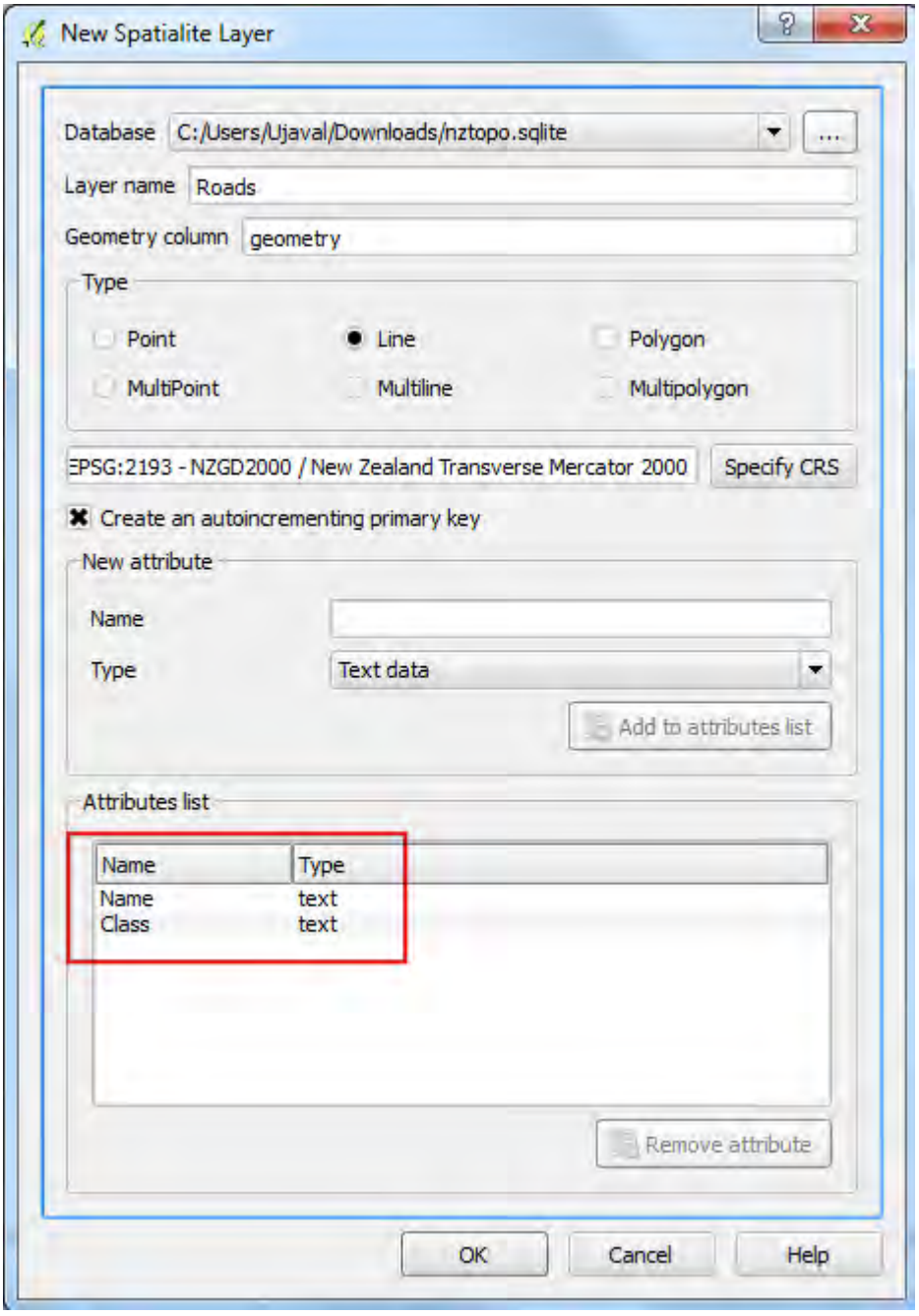
7. Now we are ready to start digitizing. We will first create a roads layer and digitize the roads around the park area. Select Layer ▸ New ▸ New Spatialite Layer... . You may also choose to create a New Shapefile Layer... instead if you prefer. Spatialite is an open database format similar to ESRI's geodatabase format. Spatialite database is contained within a single file on your hard drive and can contain diferent types of spatial (point, line, polygon) as well as non-spatial layers. This makes is much easier to move it around instead of a bunch of shapefiles. In this tutorial, we are creating a couple of polygon layers and a line layer, so a Spatialite database will be better suited. You can always load a spatialite layer and save it as a shapefile or any other format you want.



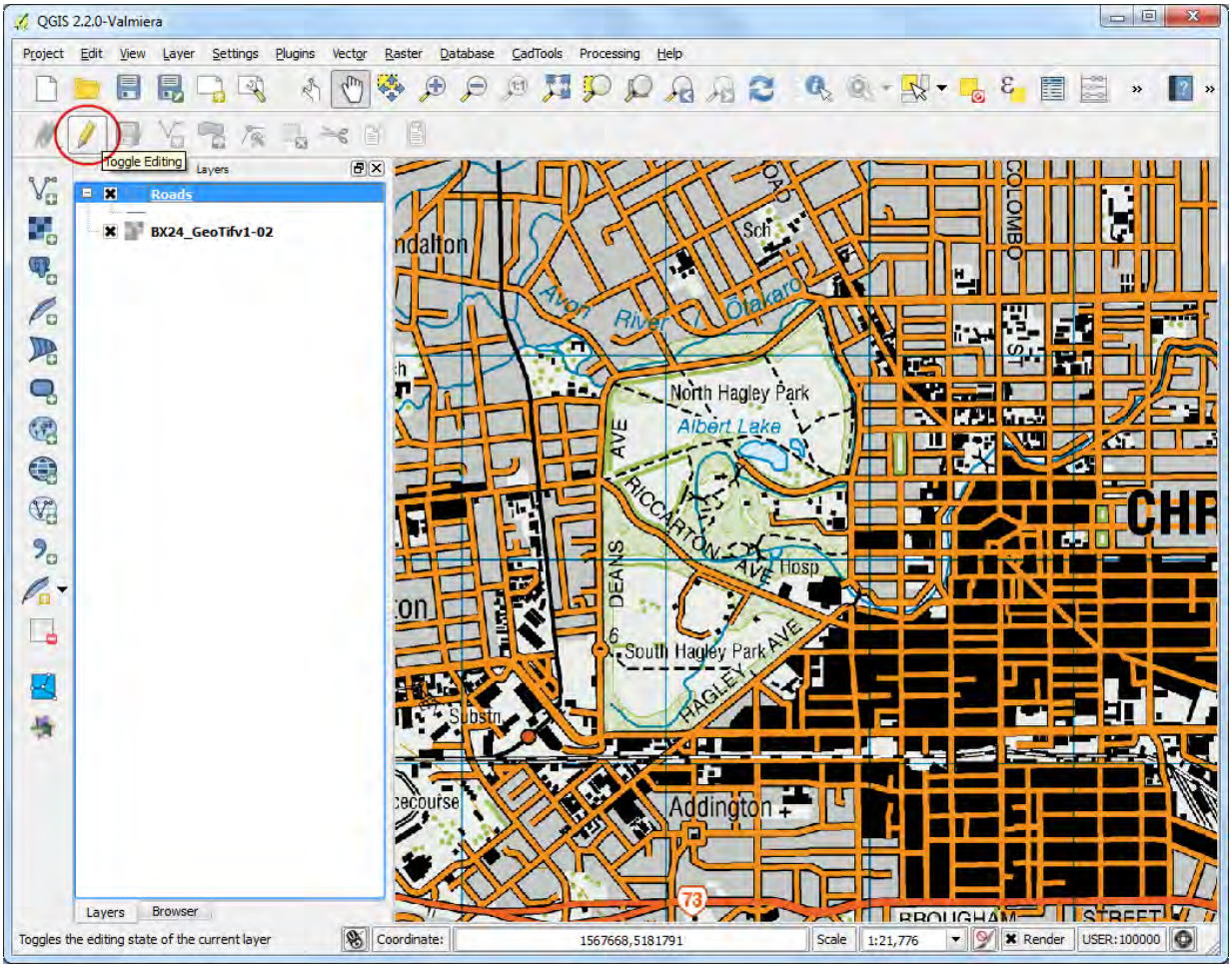
8. In the New Spatialite Layer dialog, click the ... button and save a new spatialite database named `nztopo.sqlite`. Choose the Layer name as `Roads` and select `Line` as the Type. The base topographic map is in the `EPSG:2193 - NZGD 2000` CRS, so we can select the same for our roads layer. Check the Create an autoincrementing primary key box. This will create a field called **pkuid** in the attribute table and assign a unique numeric id automatically to each feature. When creating a GIS layer, you must decide on the attributes that each feature will have. Since this is a roads layer, we will have 2 basic attributes - Name and Class.
Enter `Name`as the Name of the attribute in the New attribute section and click Add to attribute list.



9. Similarly create a new attribute `Class` of the type Text data. Click OK.



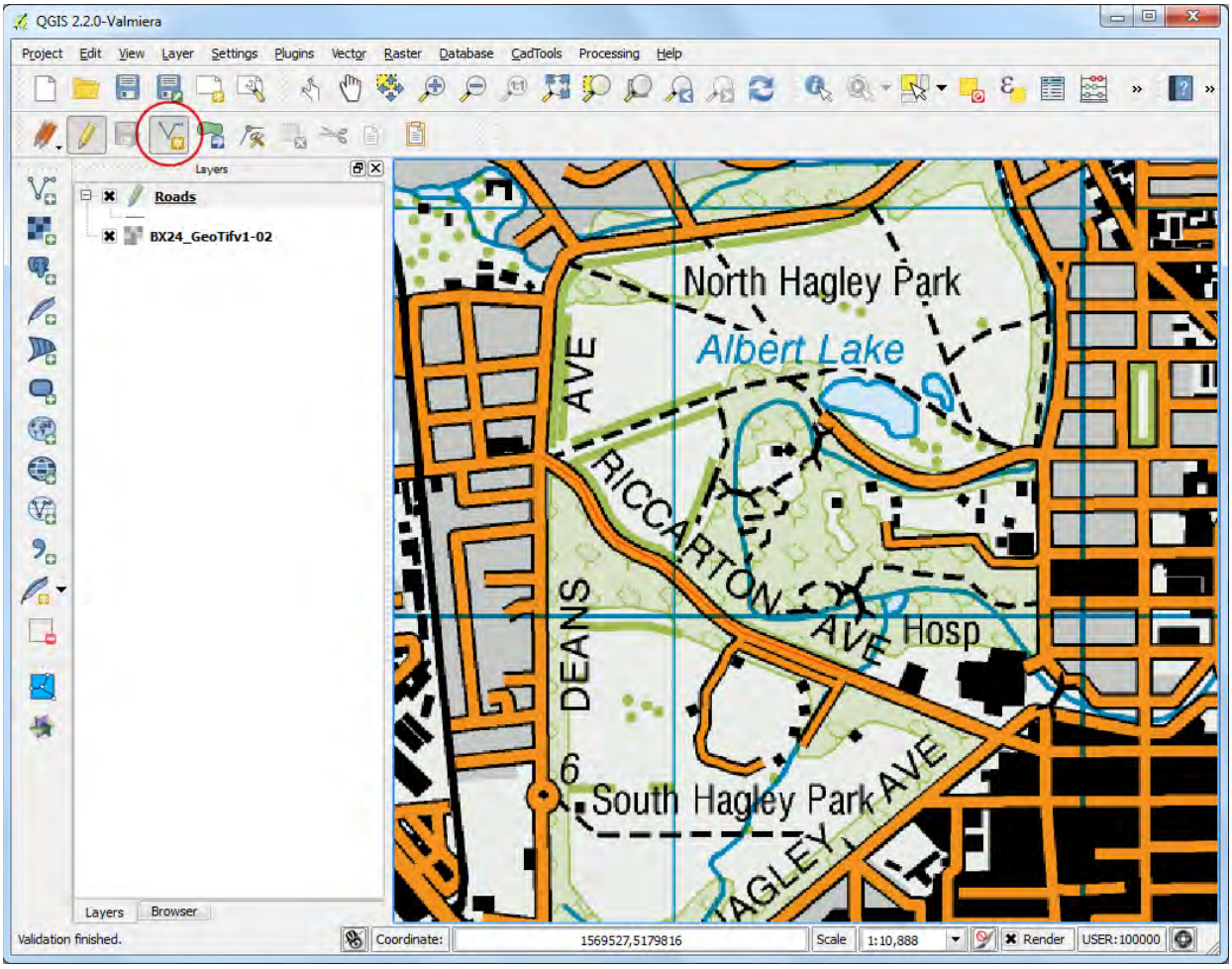
10. Once the layer is loaded, click the Toggle Editing button to put the layer in editing mode.



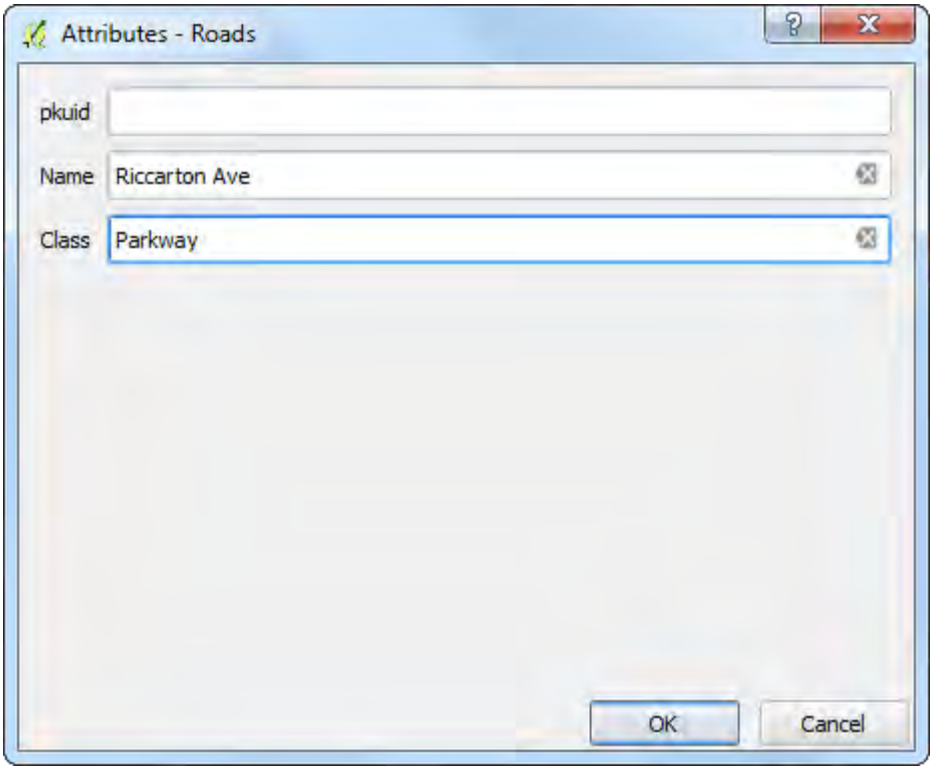
11. Click the Add feature button. Click on the map canvas to add a new vertex. Add new vertices along the road feature. Once you have digitized a road segment, right-click to end the feature.

Note

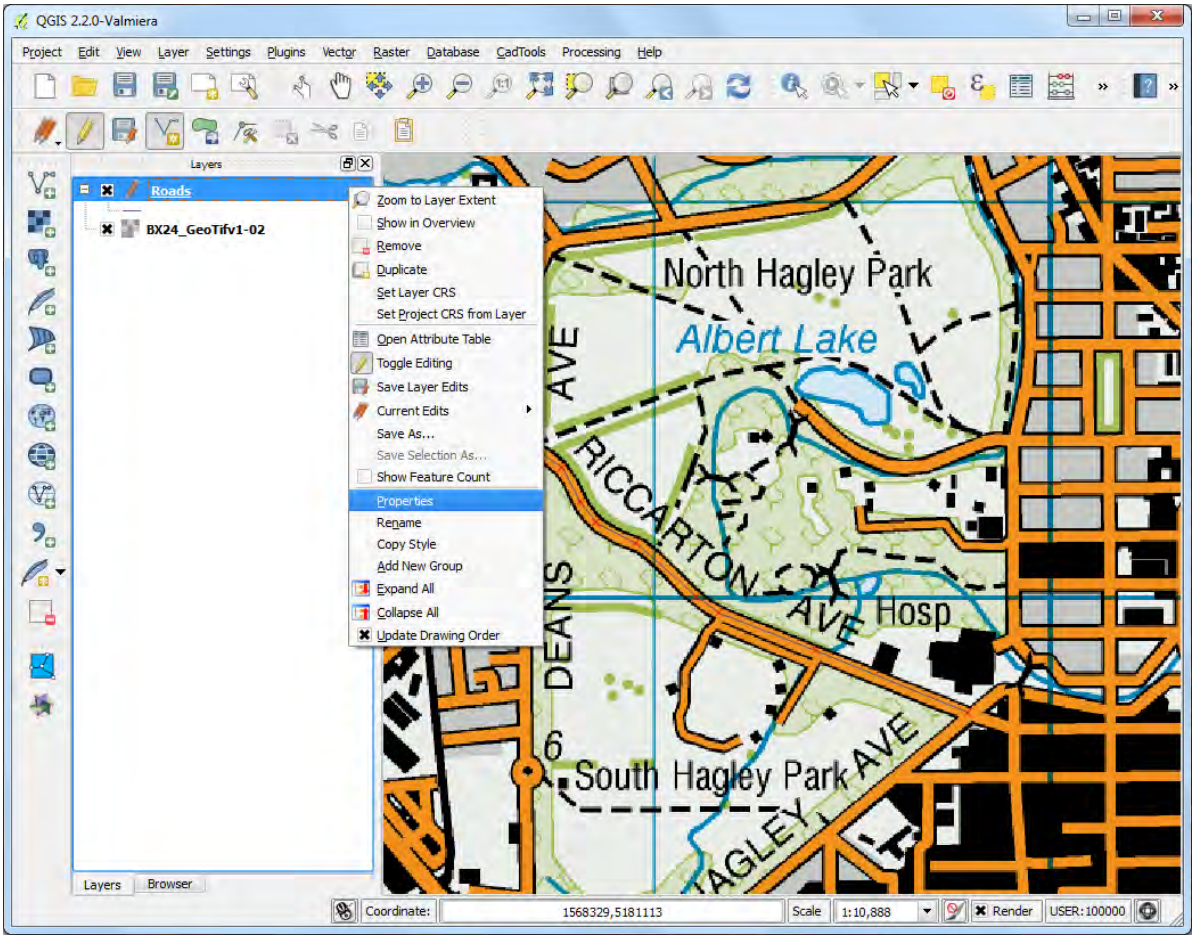
You can use the scroll wheel of the mouse to zoom in or out while digitizing. You can also hold the scroll button and move the mouse to pan around.



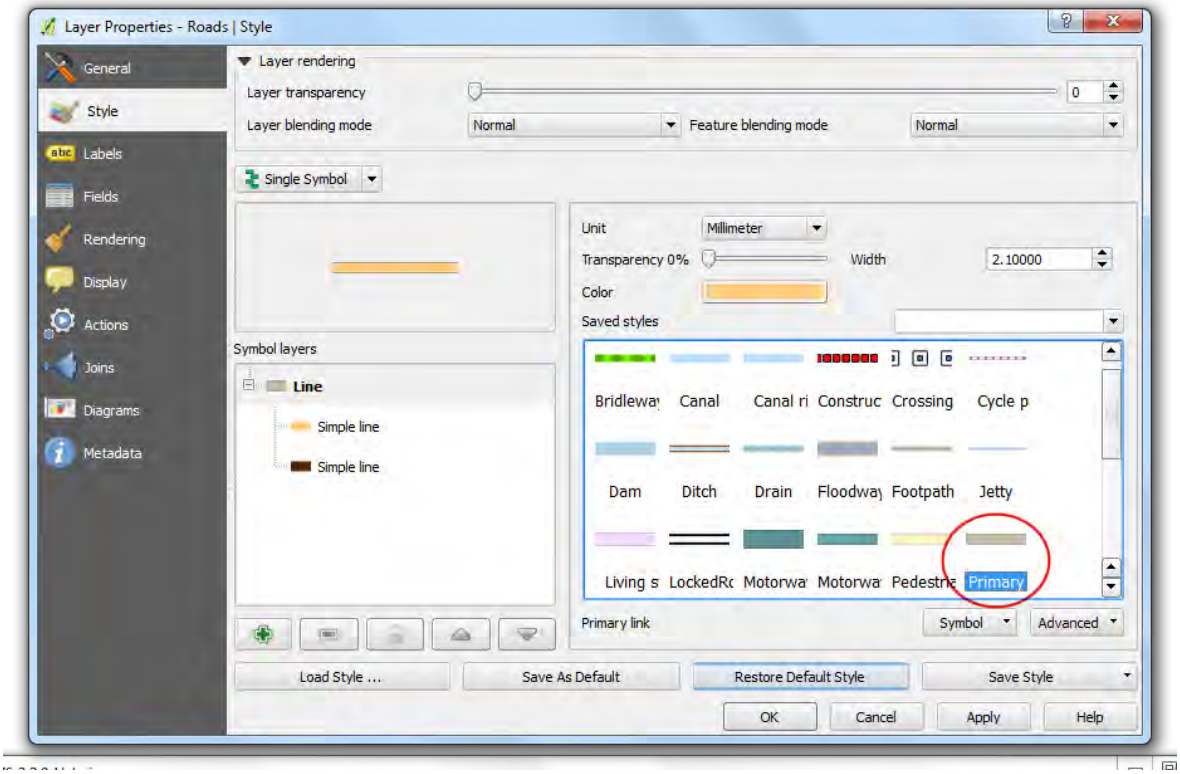
12. After you right-click to end the feature, you will get a pop-up dialog called Attributes. Here you can enter attributes of the newly created feature. Since the **pkuid** is an auto-incrementing field, you will not be able to enter a value manually. Leave it blank and enter the road name as it appears on the topo map. Optionally, assign a Road Class value as well. Click OK.



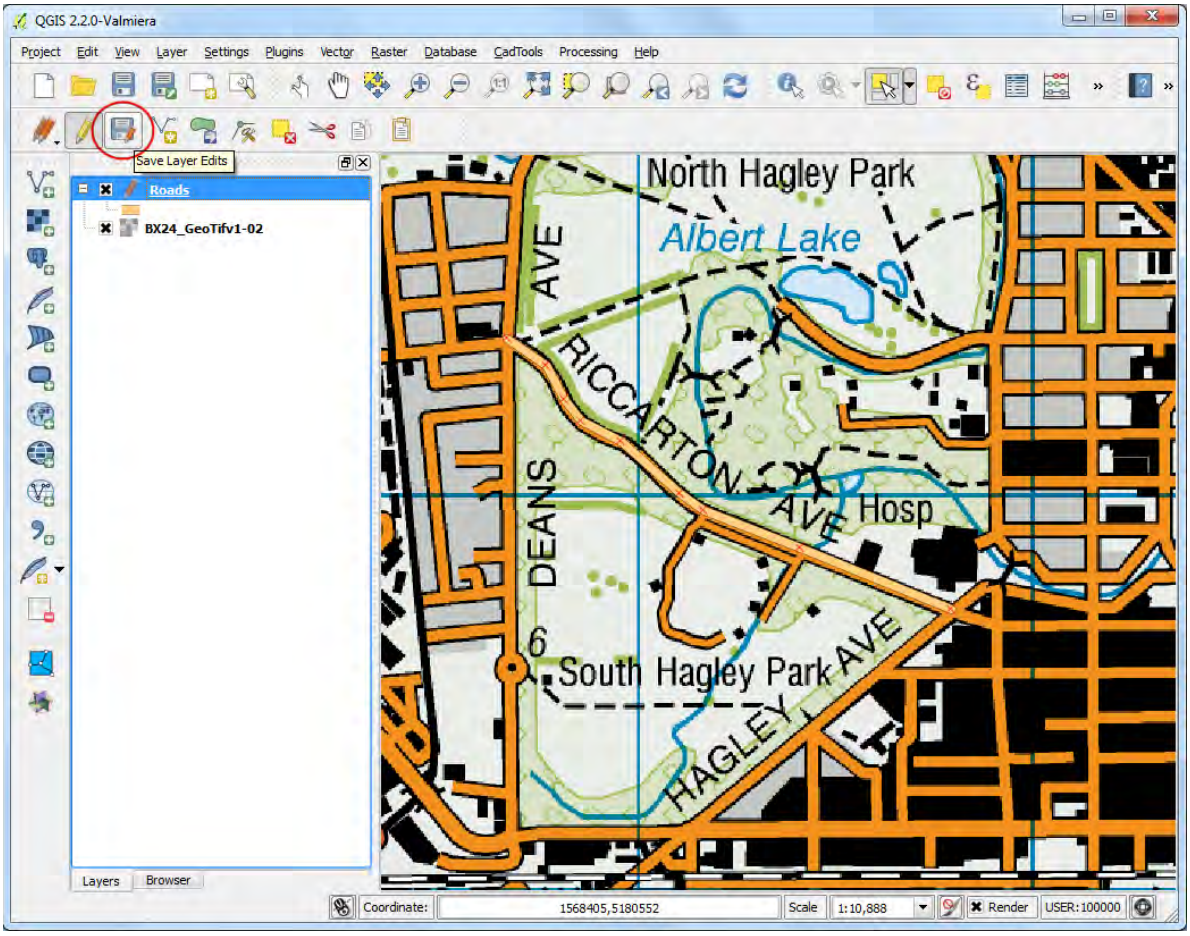
13. The default style of the new line layer is a thin line. Let's change it so we can better see the digitized features on the canvas. Right click the `Roads` layer and select Properties.



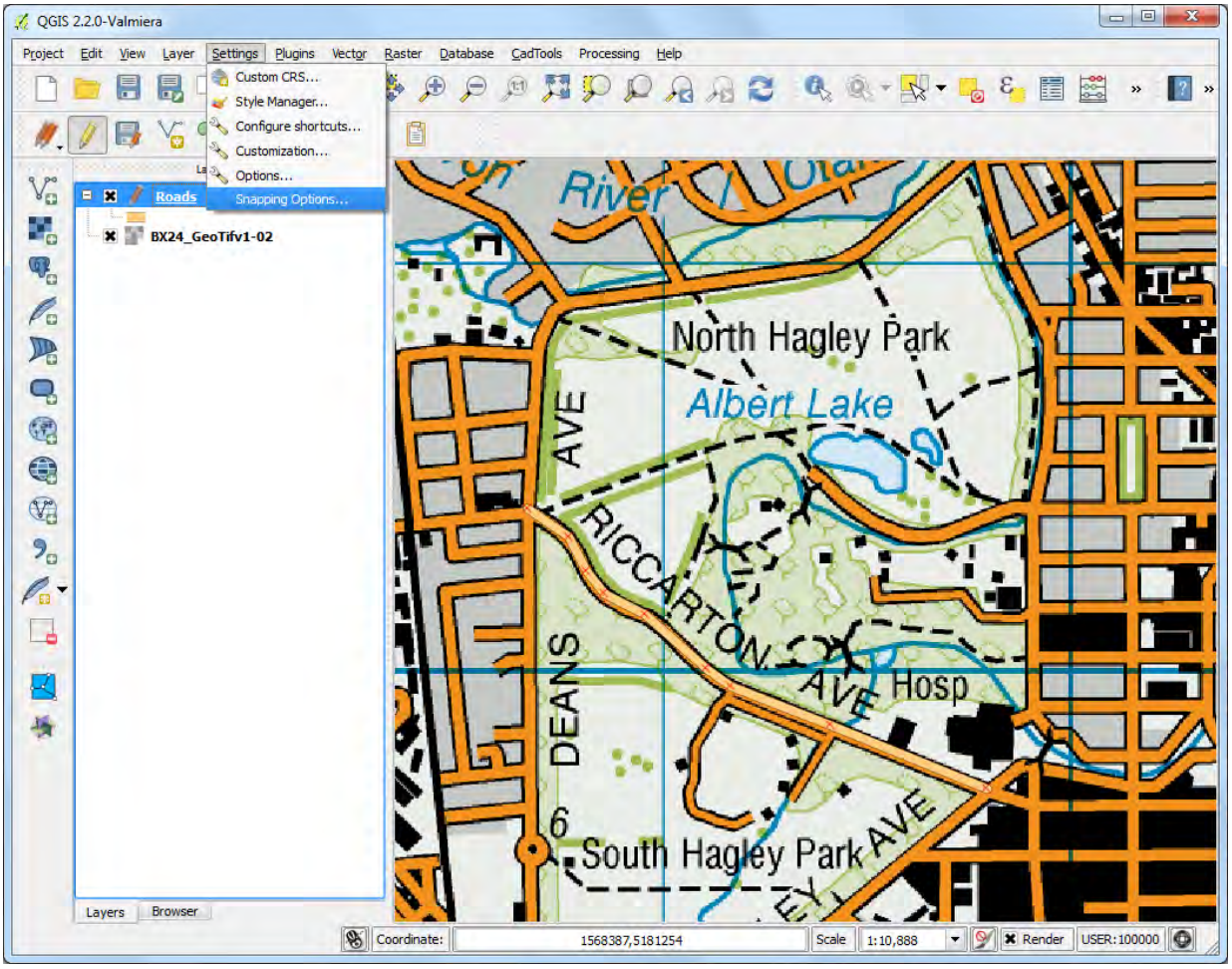
14. Select the Style tab in the Layer Properties dialog. Choose a thicker line style such as Primary from the predefined styles. Click OK.



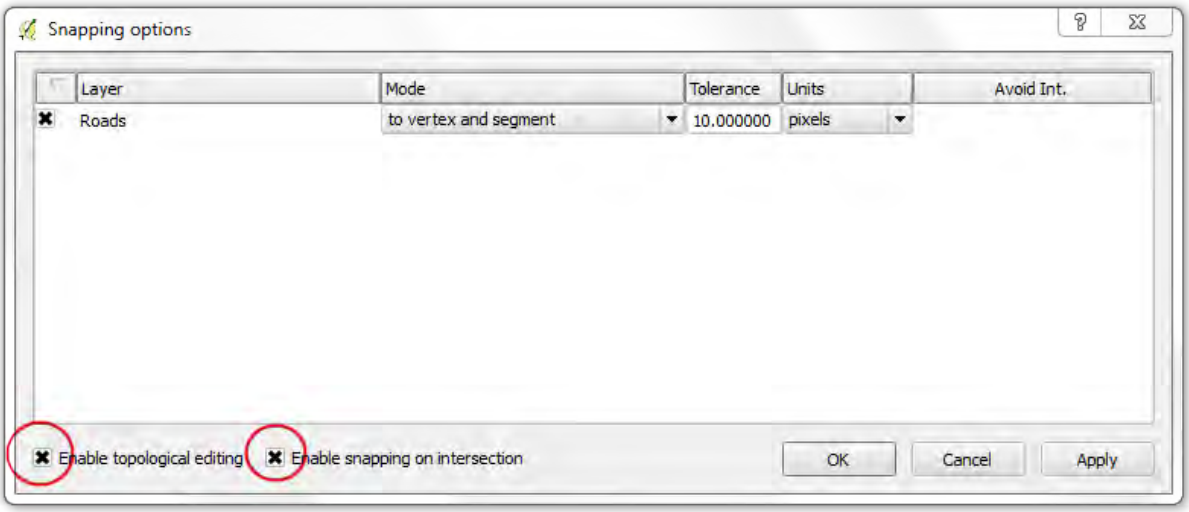
15. Now you will see the digitized road feature clearly. Click Save Layer Edits to commit the new feature to disk.



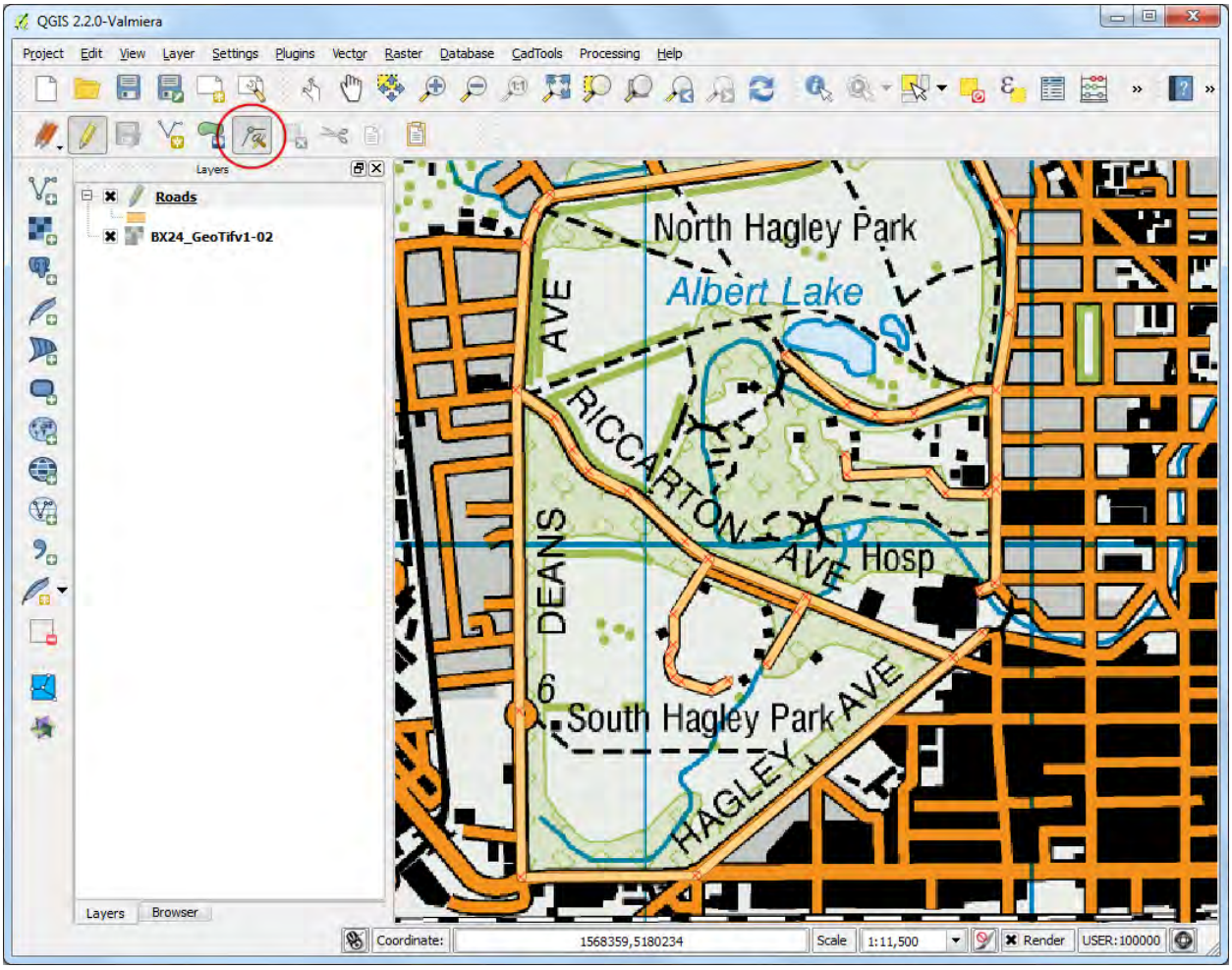
16. Before we digitize remaining roads, it is important to update some other settings that are important to create an error free layer. Go to Settings ▸ Snapping Options... .



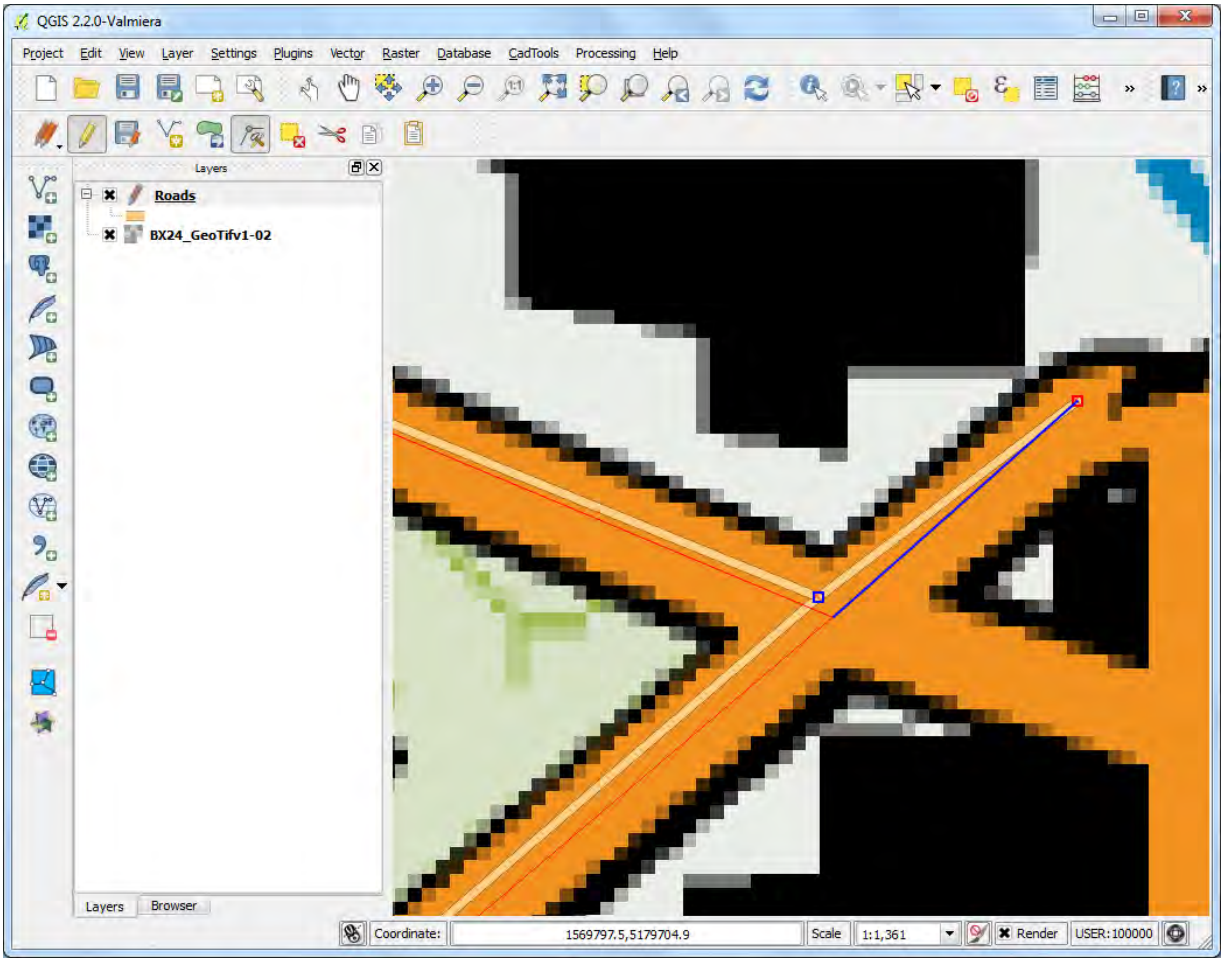
17. In the Snapping Options dialog, check the Enable topological editing. This option will ensure that the common boundaries are maintained correctly in polygon layers. Also check the Enable snapping on intersection which allows you to snap on an intersection of a background layer.



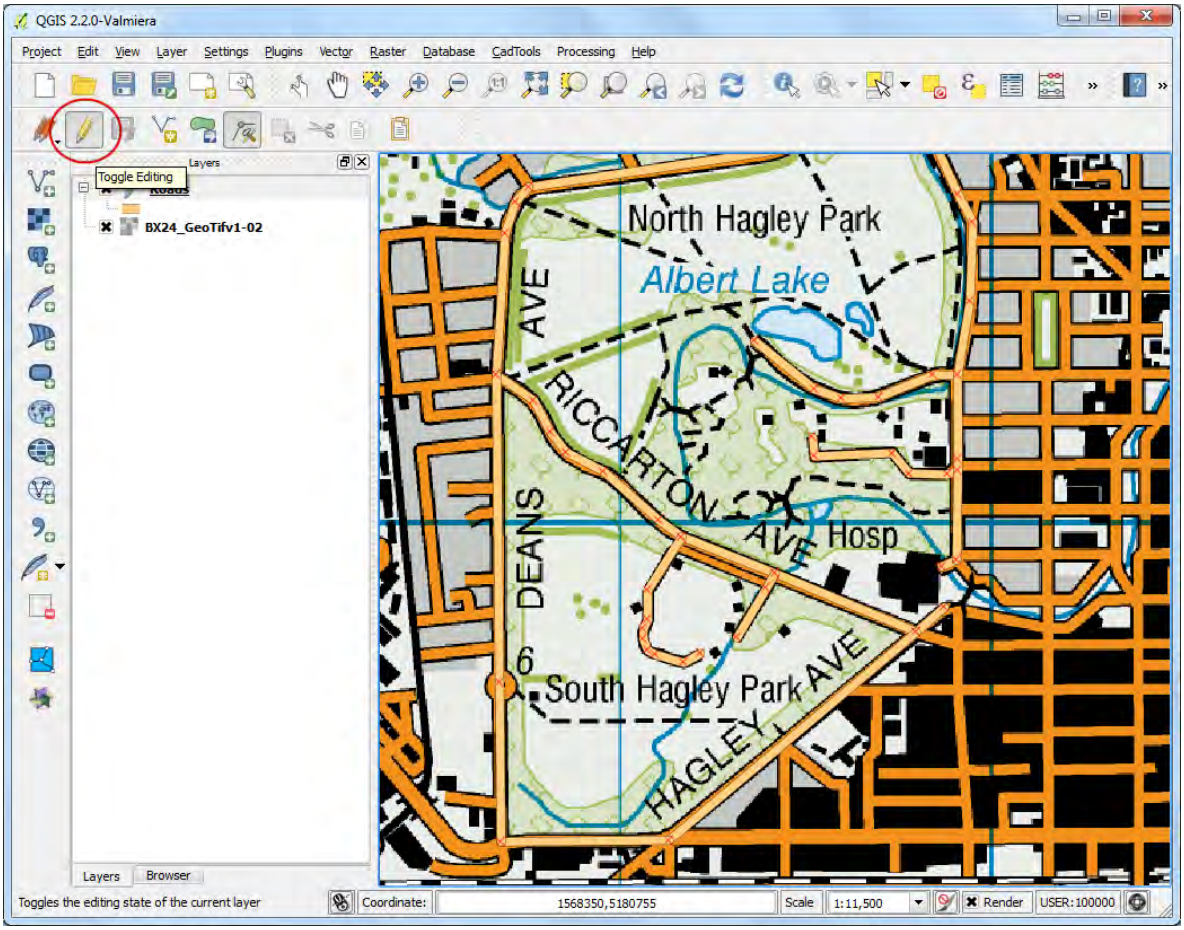
18. Now you can click Add feature button and digitize other roads around the park. Make sure to click Save Edits after you add a new feaure to save your work. A useful tool to help you with digitizing is the **Node Tool**. Click the Node Tool button.



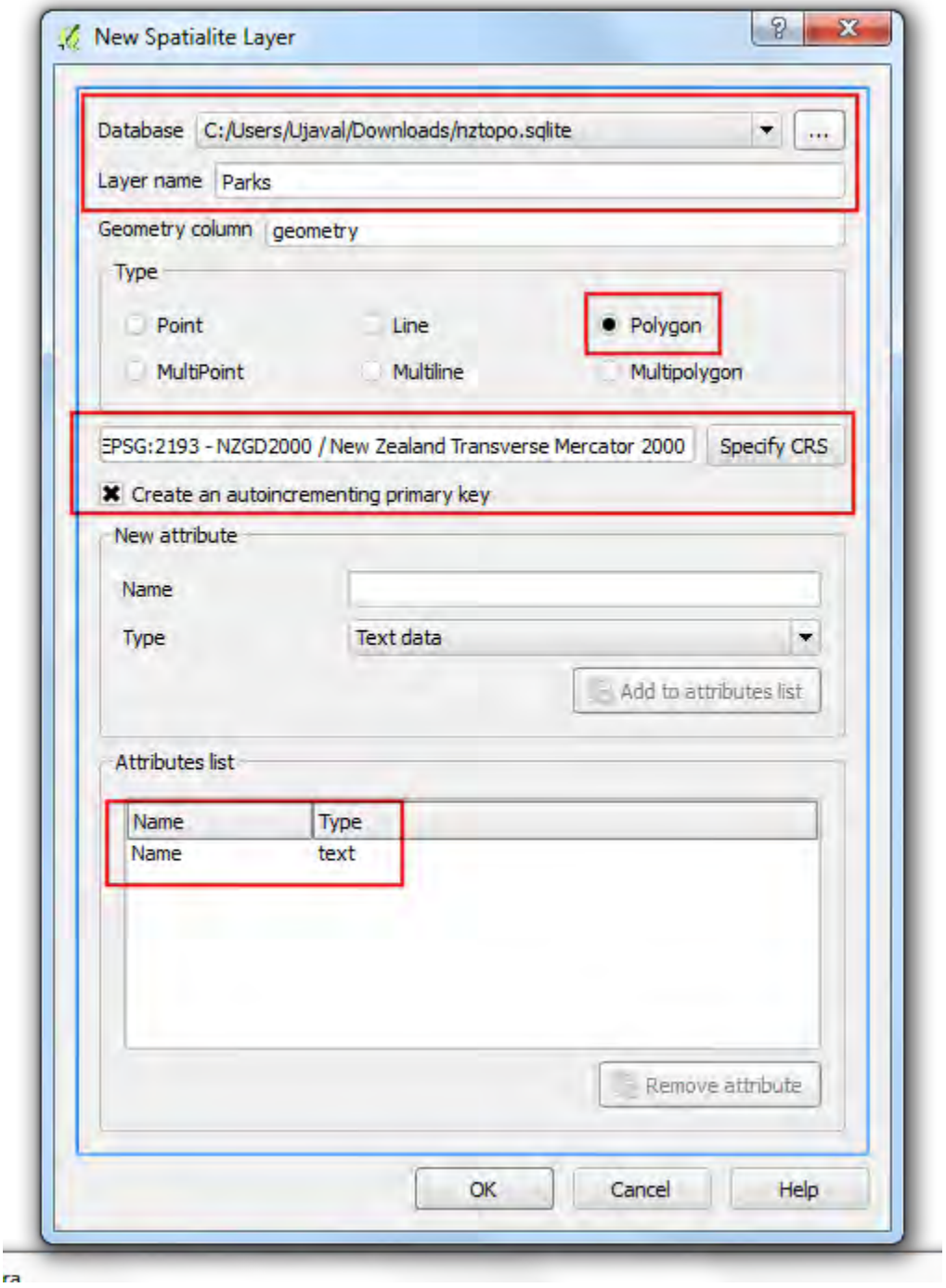
19. Once the node tool is activated, click on any feature to show the vertices. Click on any vertex to select it. The vertex will change the color once it is selected. Now you can click and drag your mouse to move the vertex. This is useful when you want to make adjustments after the feature is created. You can also delete a selected vertex by clicking the `Delete` key. (`Option+Delete` on a mac)



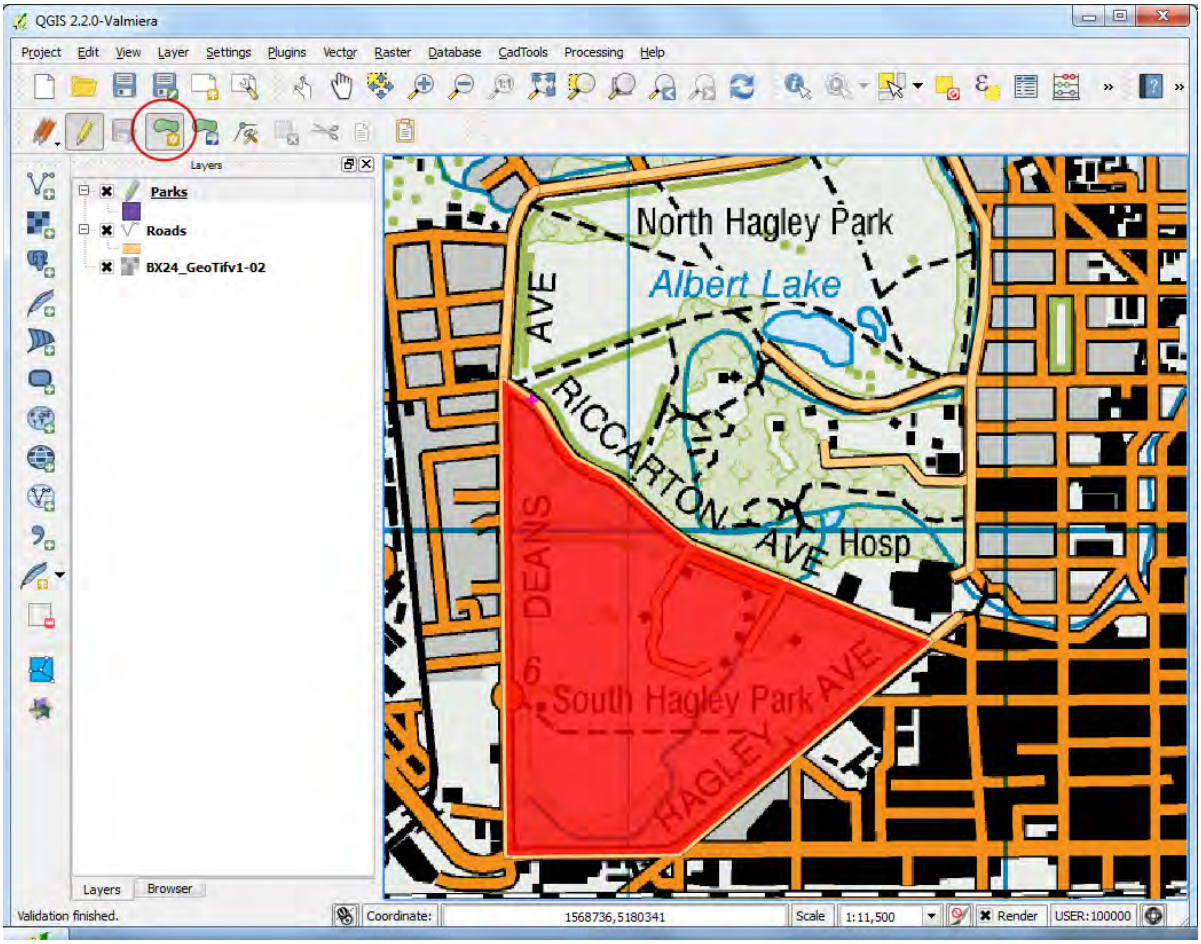
20. Once you have finished digitizing all the roads, click the Toggle Editing button.



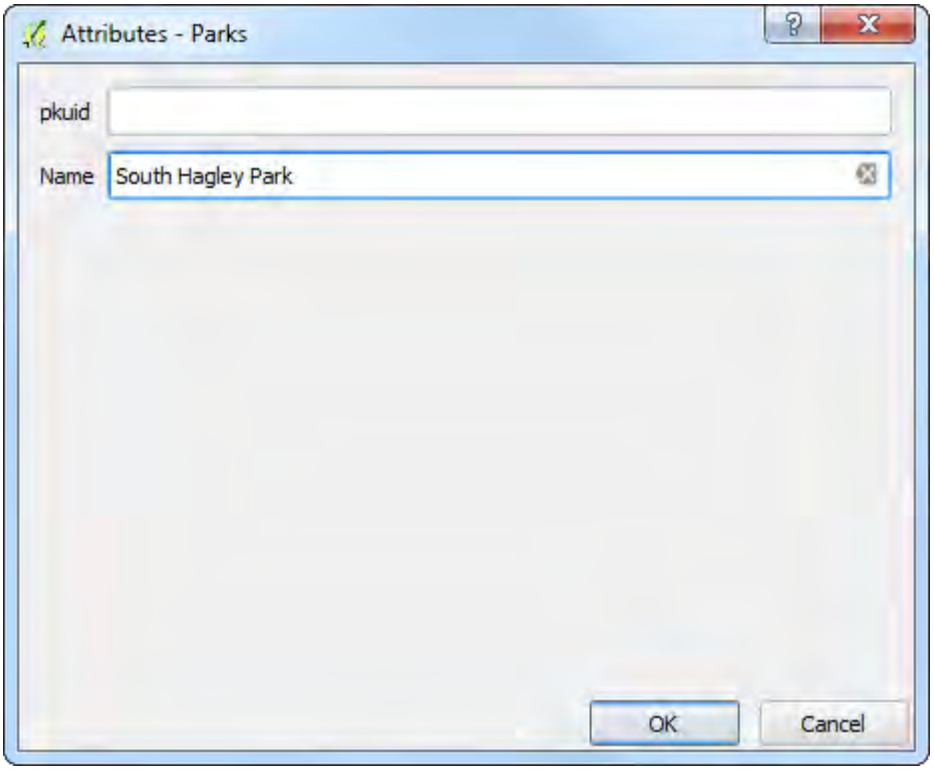
21. Now we will create a polygon layer representing the park boundaries. Go to Layer ▸ New ▸ New Spatialite Layer.... Select the `nztopo.sqlite` database from the dropdown list. Name the new layer as `Parks`. Select `Polygon` as the Type. Create a new attribute called `Name`. Click OK.



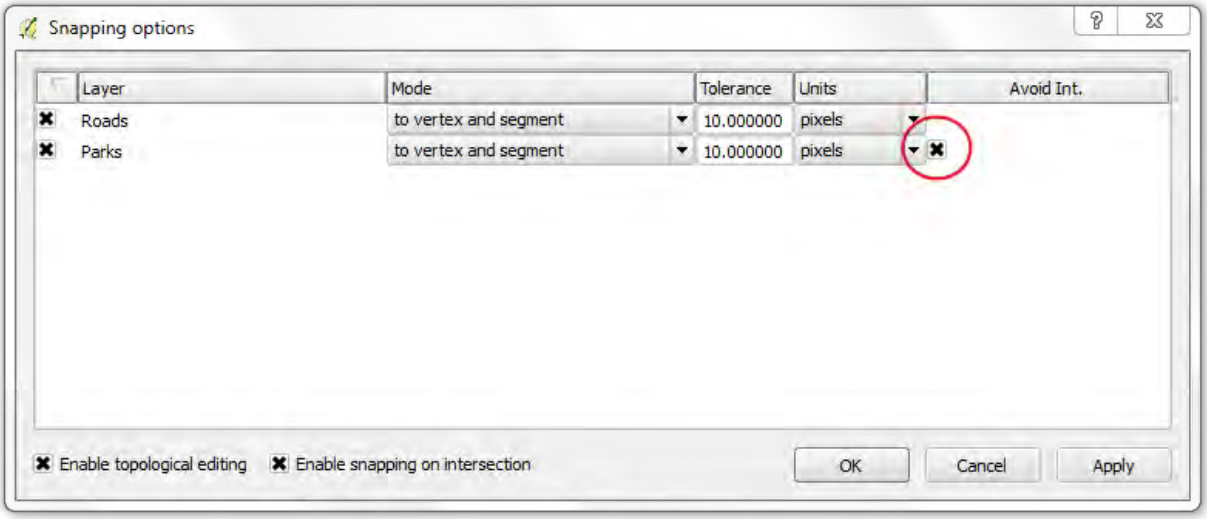
22. Click the Add feature button and click on the map canvas to add a polygon vertex. Digitize the polygon representing the park. Make sure you snap to the roads vertices so there are no gaps between the park polygons and road lines. Right-click to finish the polygon.



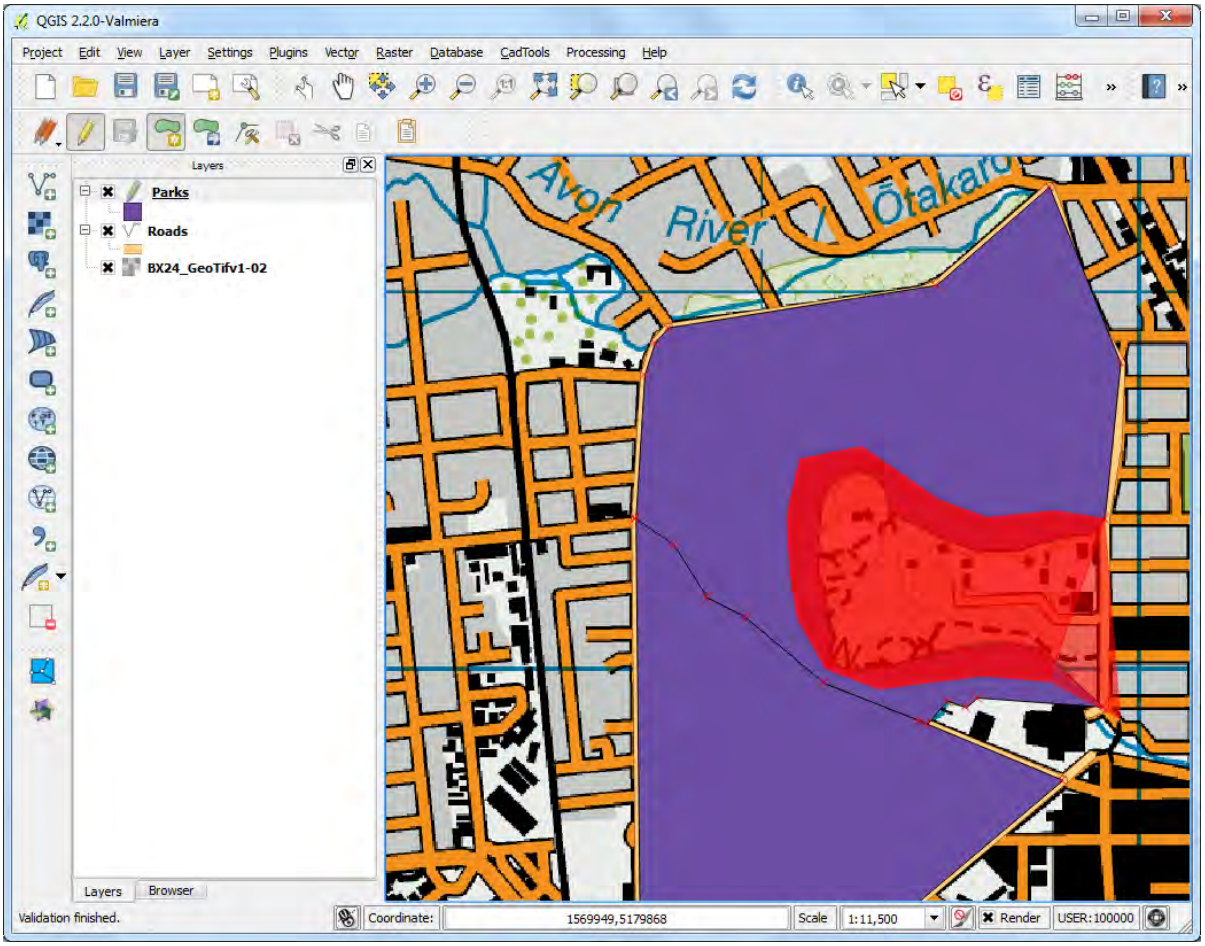
23. Enter the park name in the Attributes pop-up.



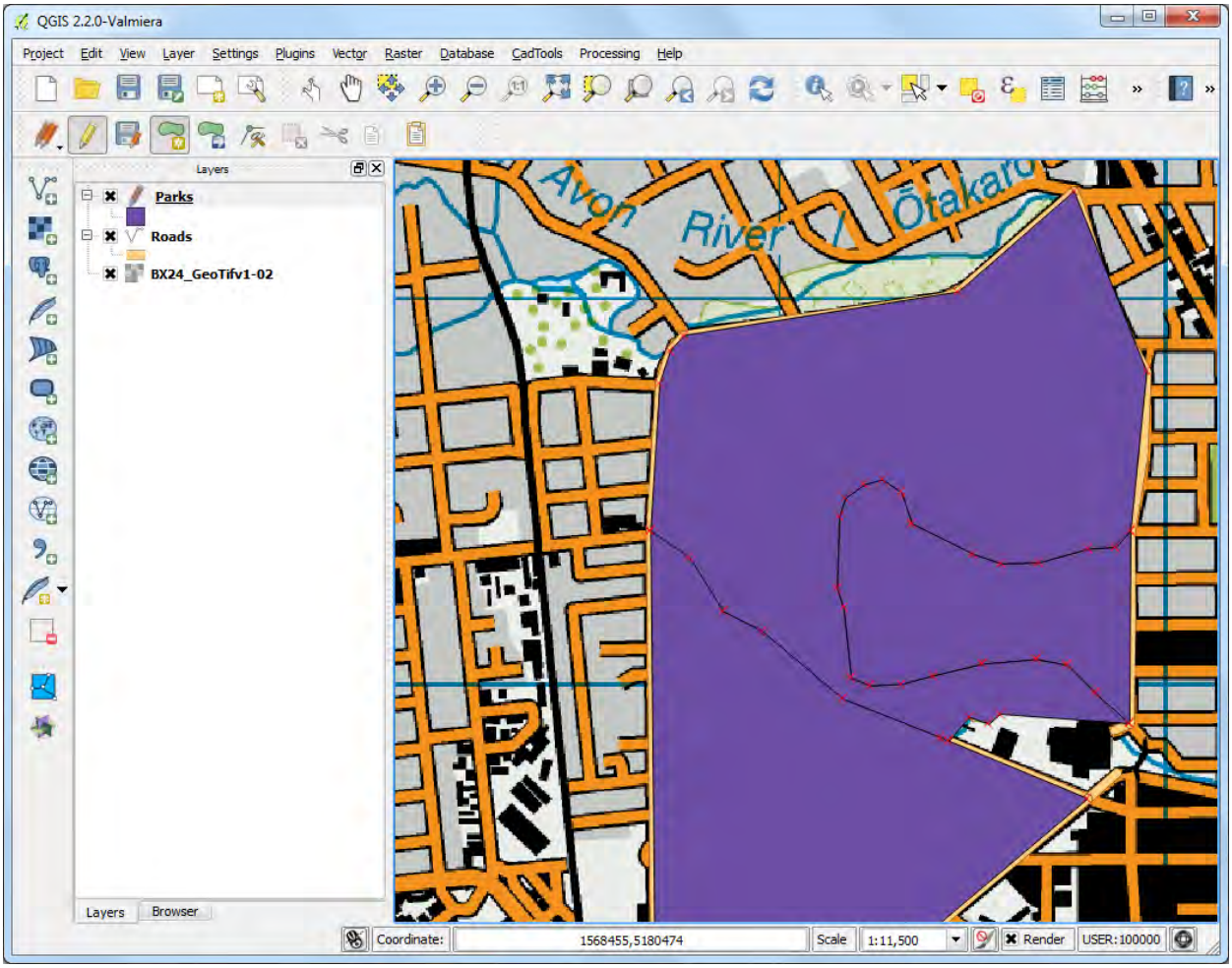
24. Polygon layers offer another very useful setting called **Avoid intersections of new polygons**. Go to Settings ▸ Snapping Options... . Check the box in the Avoid Int column in the row for the `Parks` layer. Click OK.



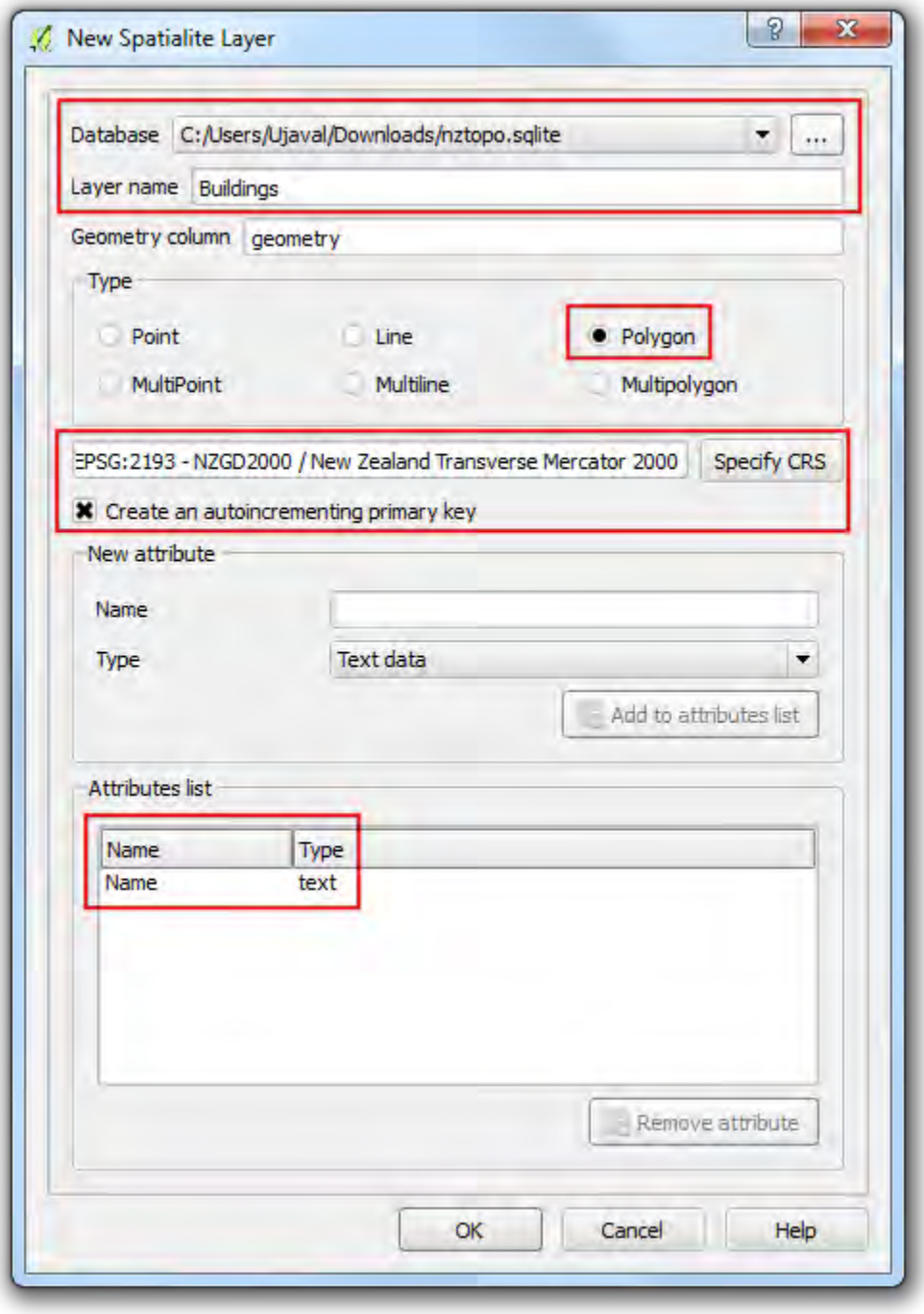
25. Now click on Add feature to add a polygon. With the **Avoid intersections of new polygons**, you will be able quickly digitize a new polygon without worrying about snapping exactly to the neighboring polygons.



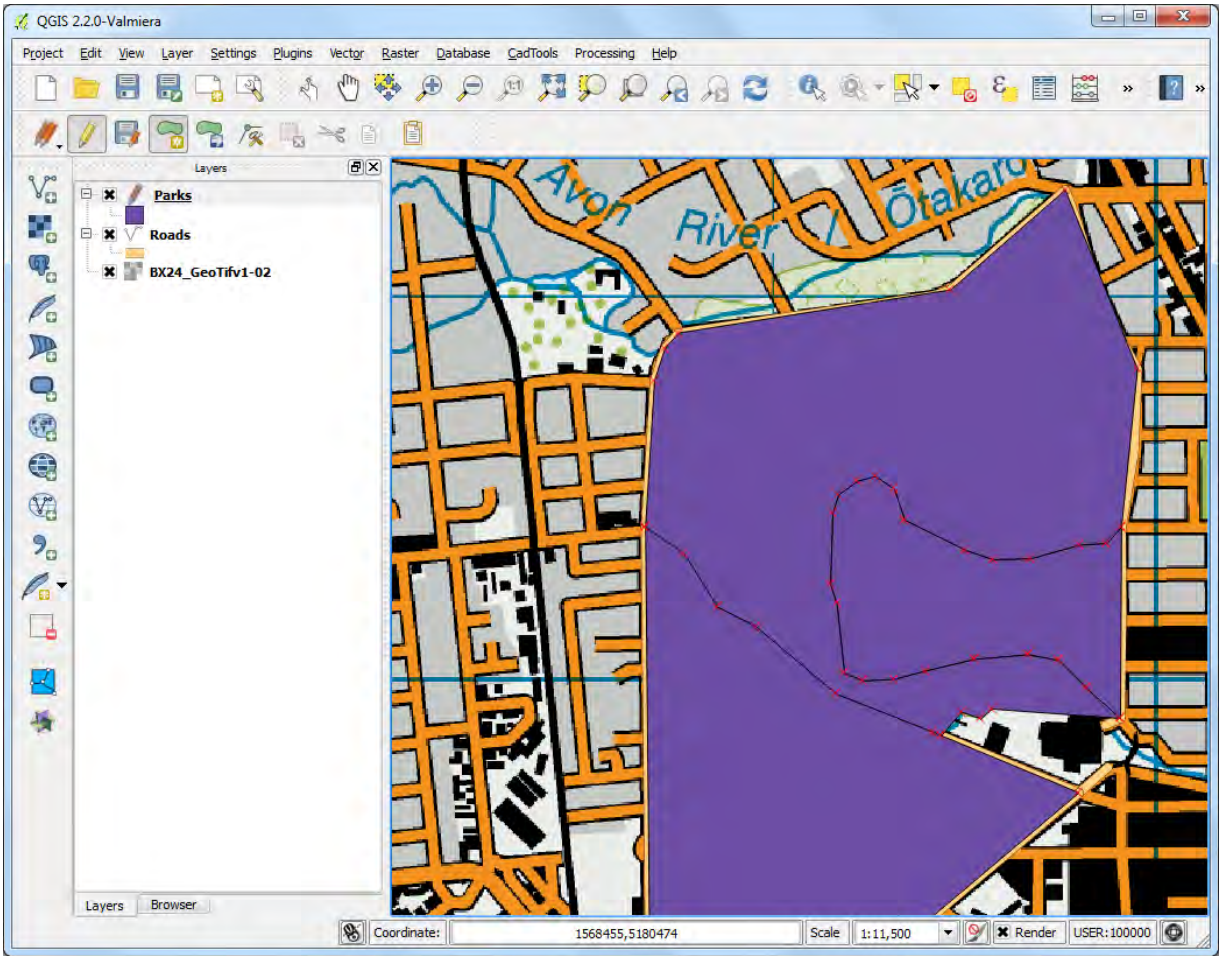
26. Right-click to finish the polygon and enter the attributes. Magically the new polygon is shrunk and snapped exactly to the boundary of the neighboring polygons! This is very useful when digitizing complex boundaries where you need not be very precise and still have topologically correct polygon. Click Toggle Editing to finish editing the `Parks` layer.



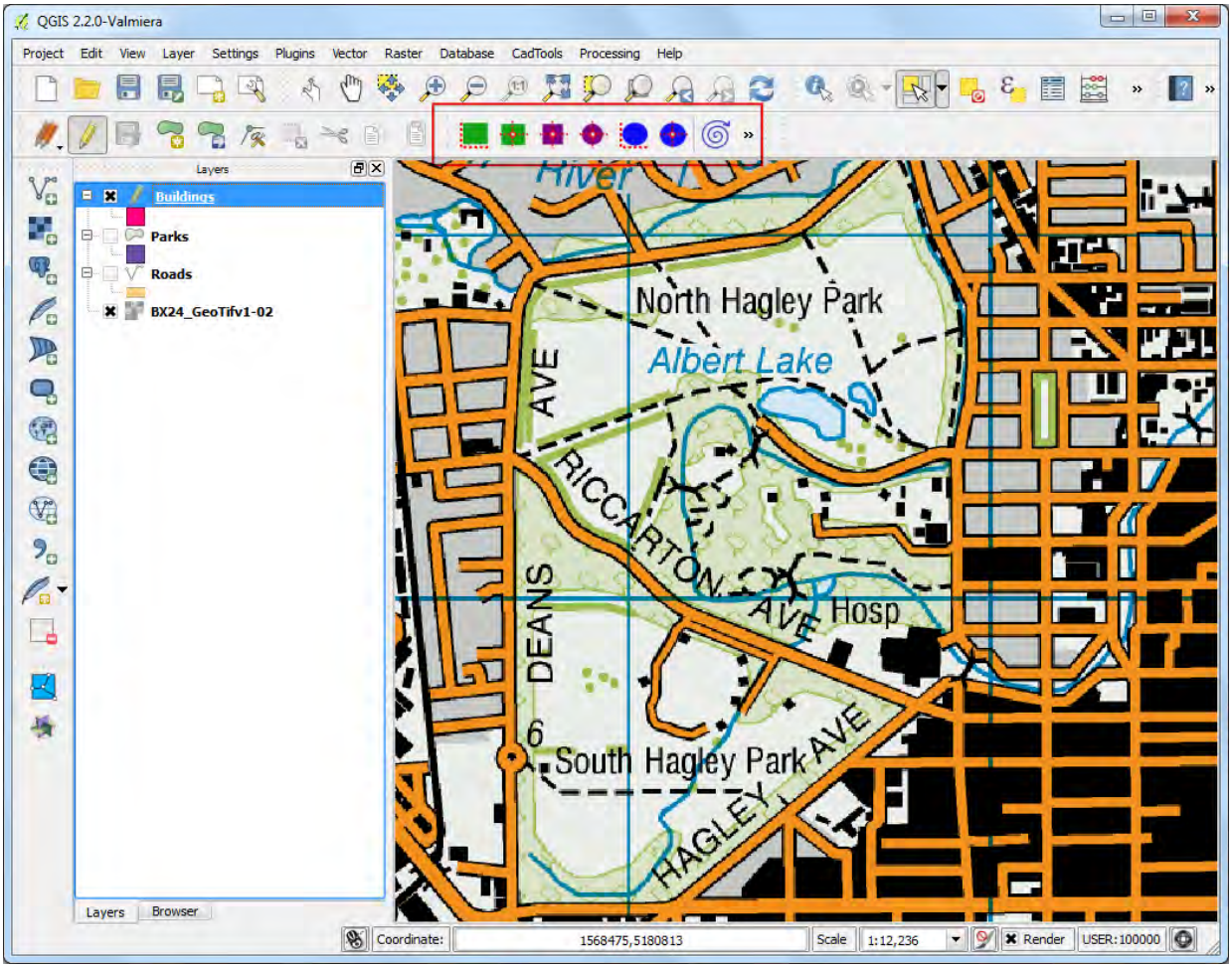
27. Now it is time to digitize a buildings layer. Create a new polygon layer named `Buildings` by going to Layer ▸ New ▸ New S patialite Layer .



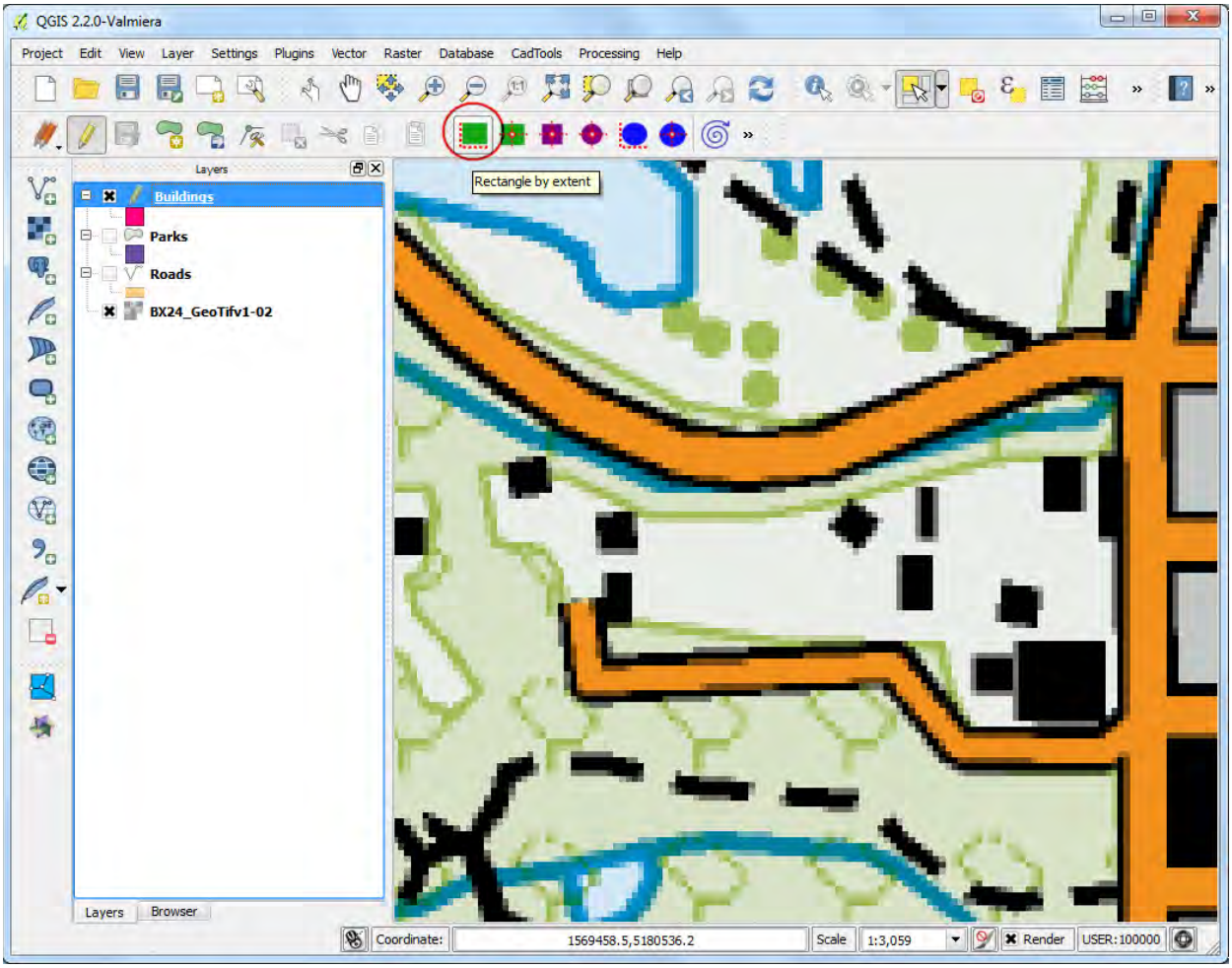
28. Once the `Buildings` layer is added, turn off the `Parks` and `Roads` layer so the base topo map is visible. Select the `Buildings`layer and click Toggle Editing.



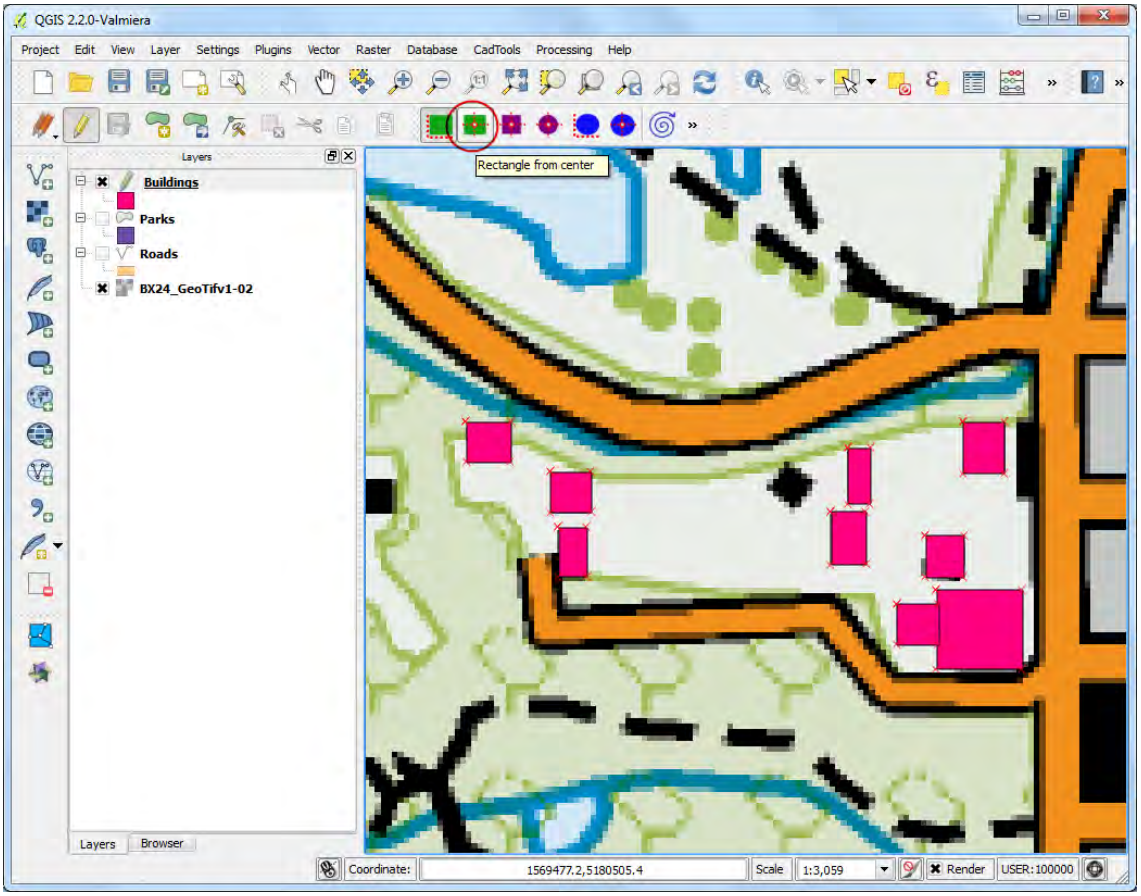
29. Digitizing buildings can be a cumbersome task. Also it is difficult to add vertices manually so that the edges are perpendicular and form a rectangle. We will use a plugin called **Rectangles Ovals Digitizing** to help with this task. See *Using Plugins* to see how to search and install plugins. Once the **Rectangles Ovals Digitizing** plugin is installed, you will see a new toolbar appear above the canvas.



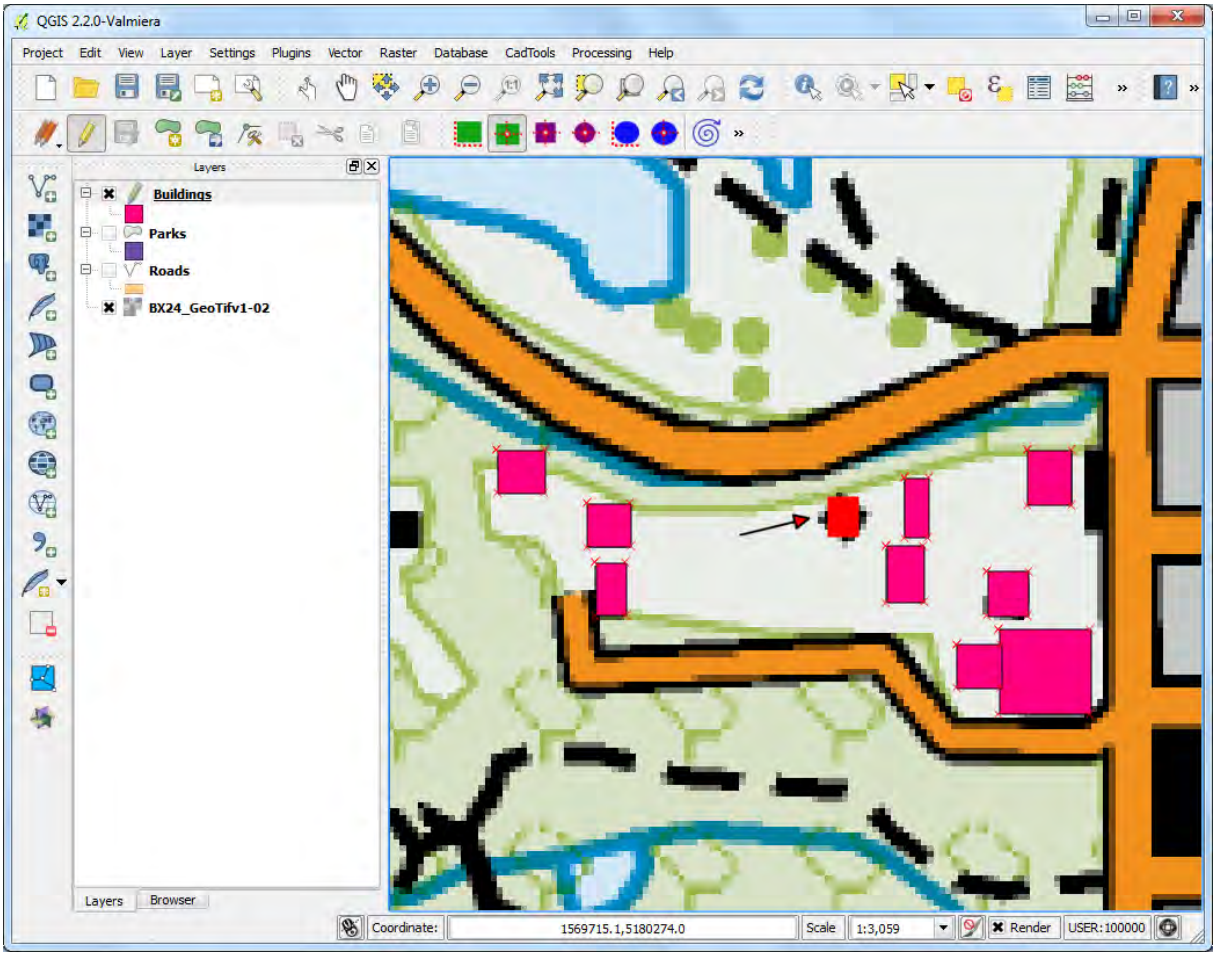
30. Zoom to an area with the buildings and click Rectangle by Extent button. Click and drag the mouse to draw a perfect rectangle. Similarly, add remaining buildings.



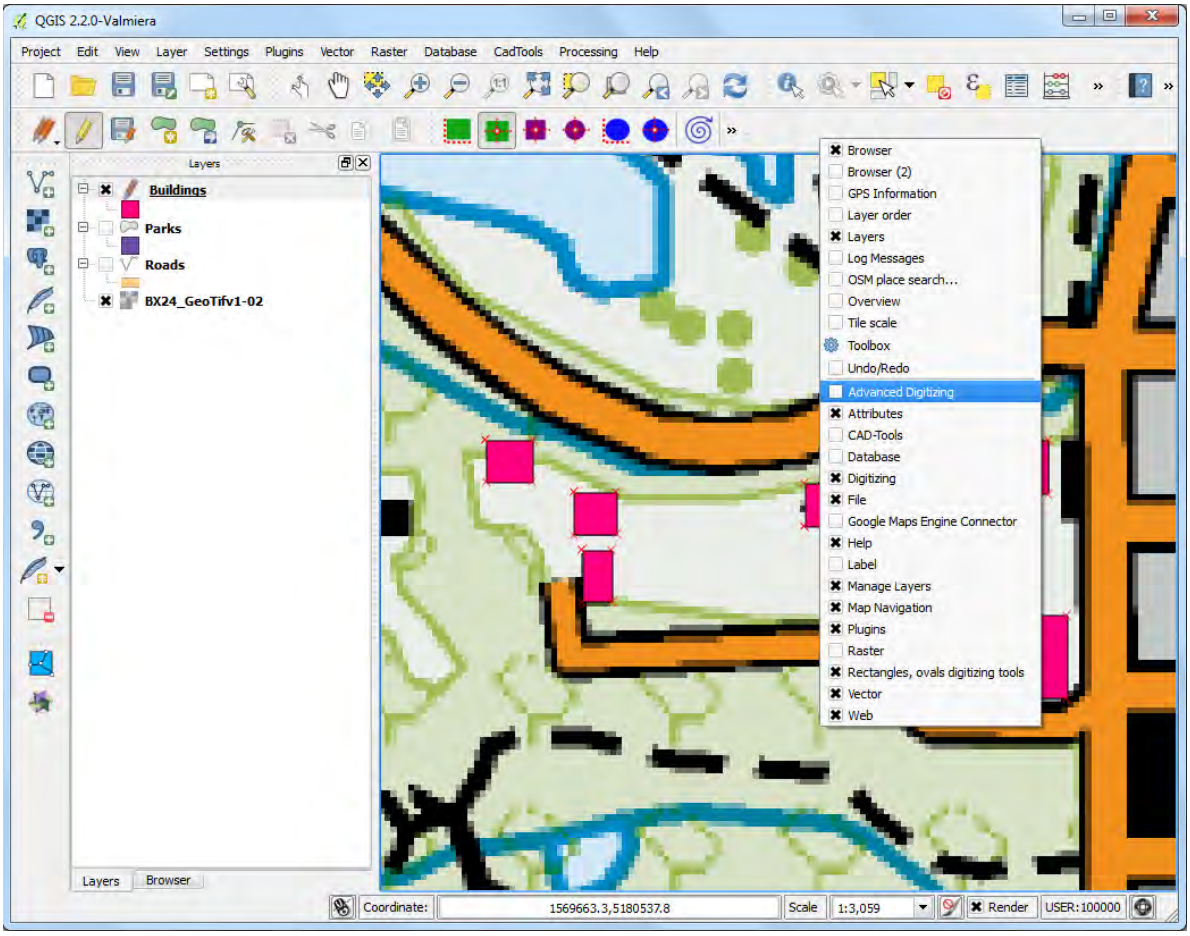
31. You will notice that some buildings are not vertical. We will need to draw a rectangle at an angle to match the building footprint. Click the Rectangle from center.



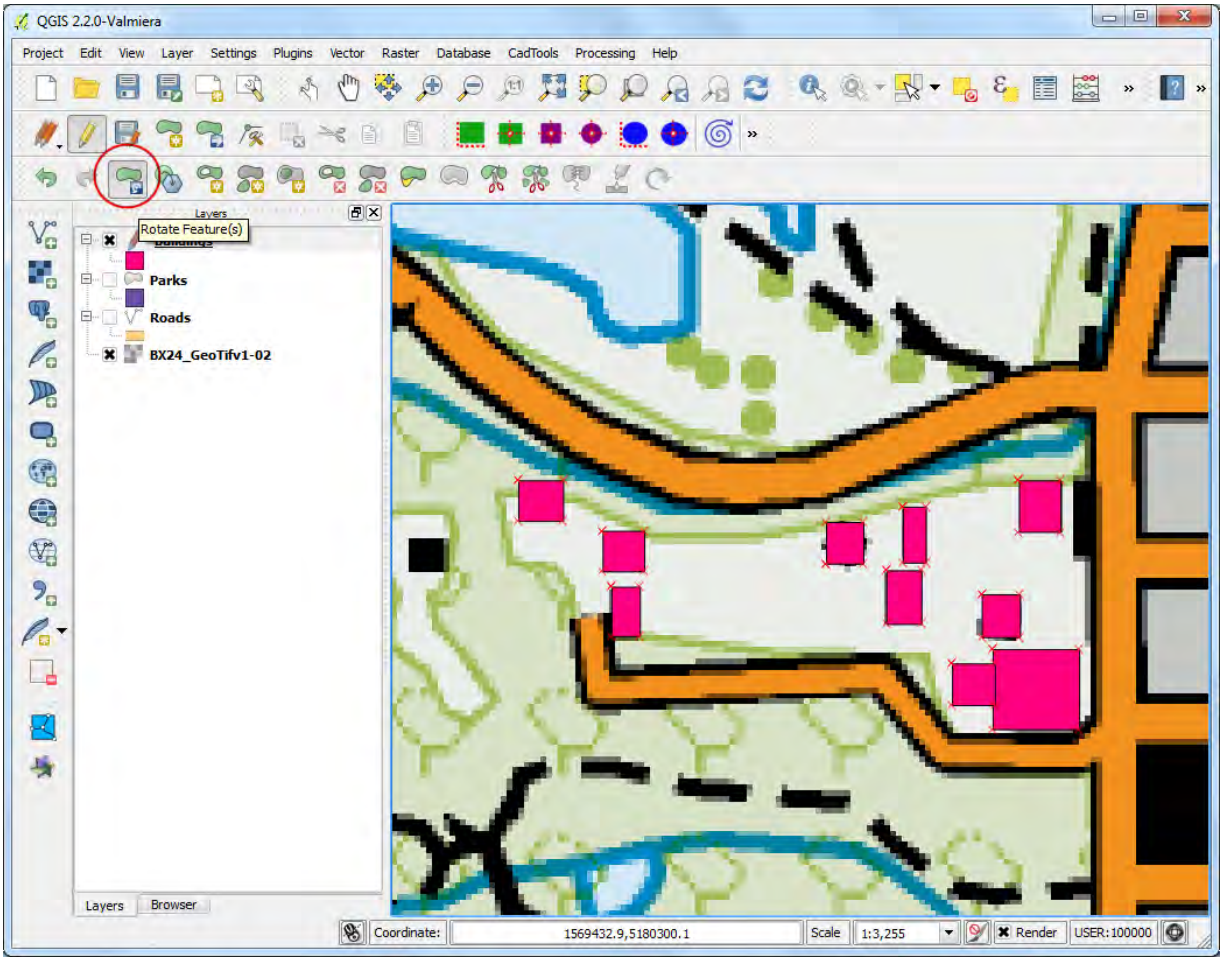
32. Click at the center of the building and drag the mouse to draw a vertical rectangle.



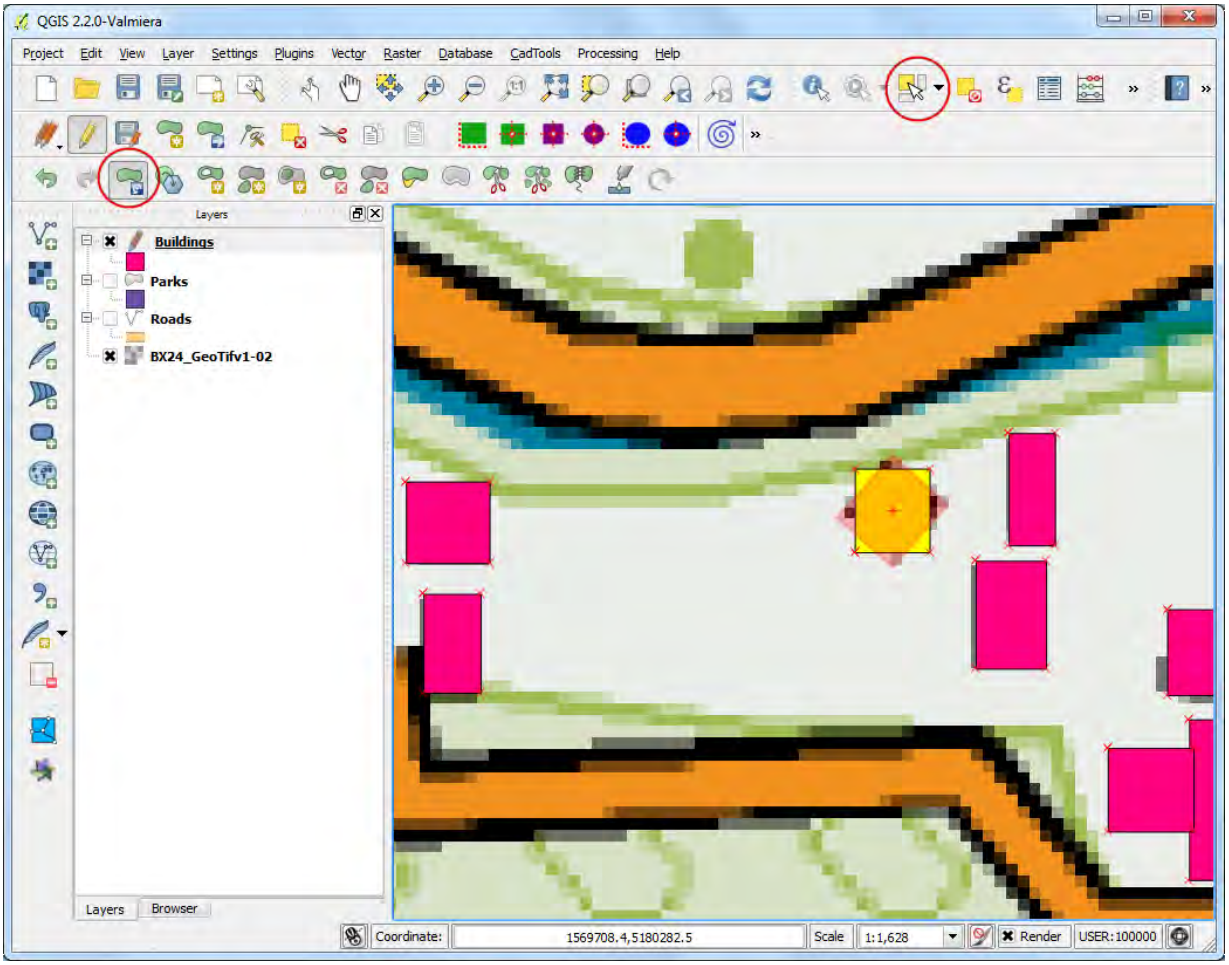
33. We need to rotate this rectangle to match the image on the topo map. The rotate tool is available in the **Advanced Digitizing**toolbar. Right-click on an empty area on the toolbar section and enable the Advanced Digitizing toolbar.



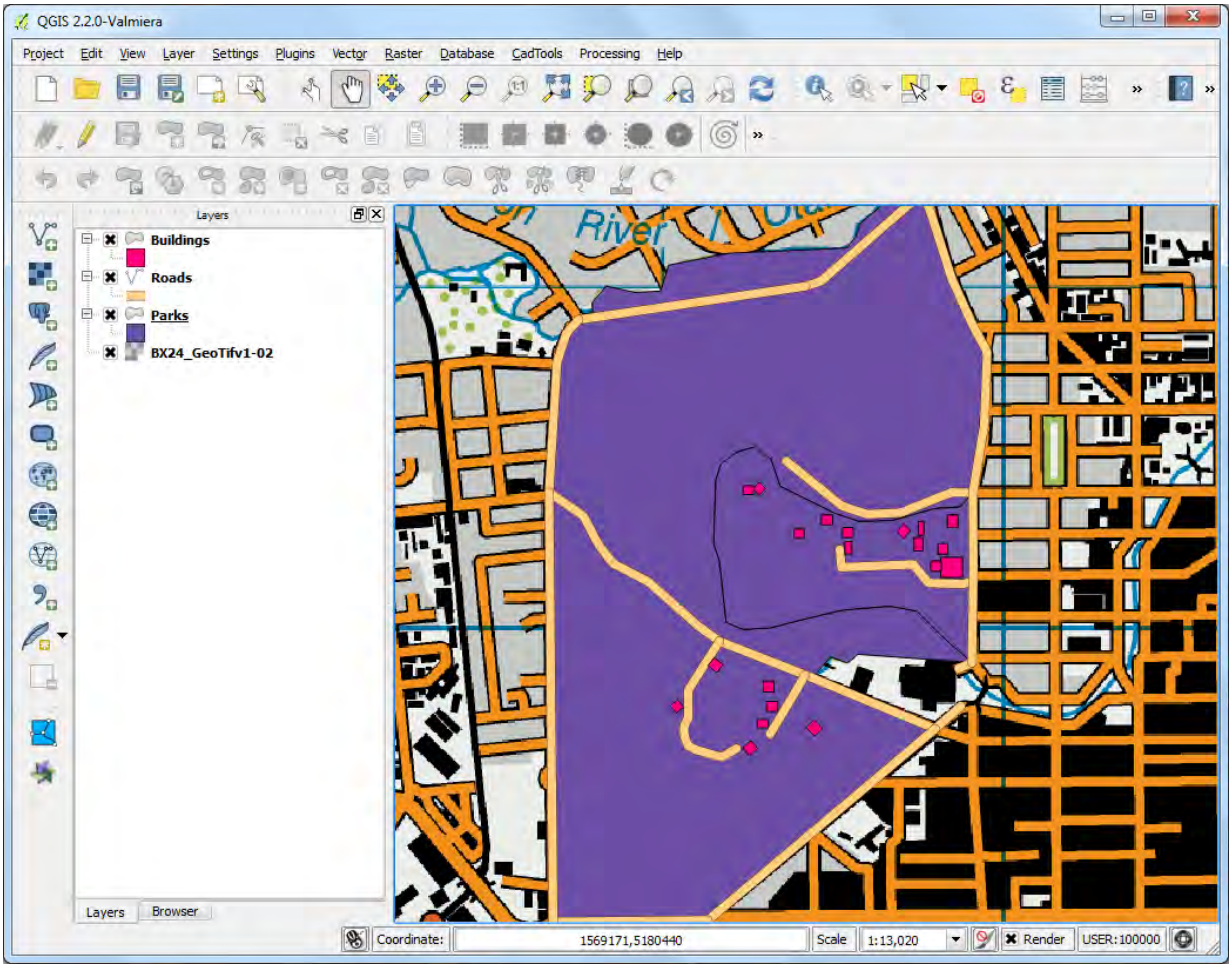
34. Click the Rotate Feature(s) button.



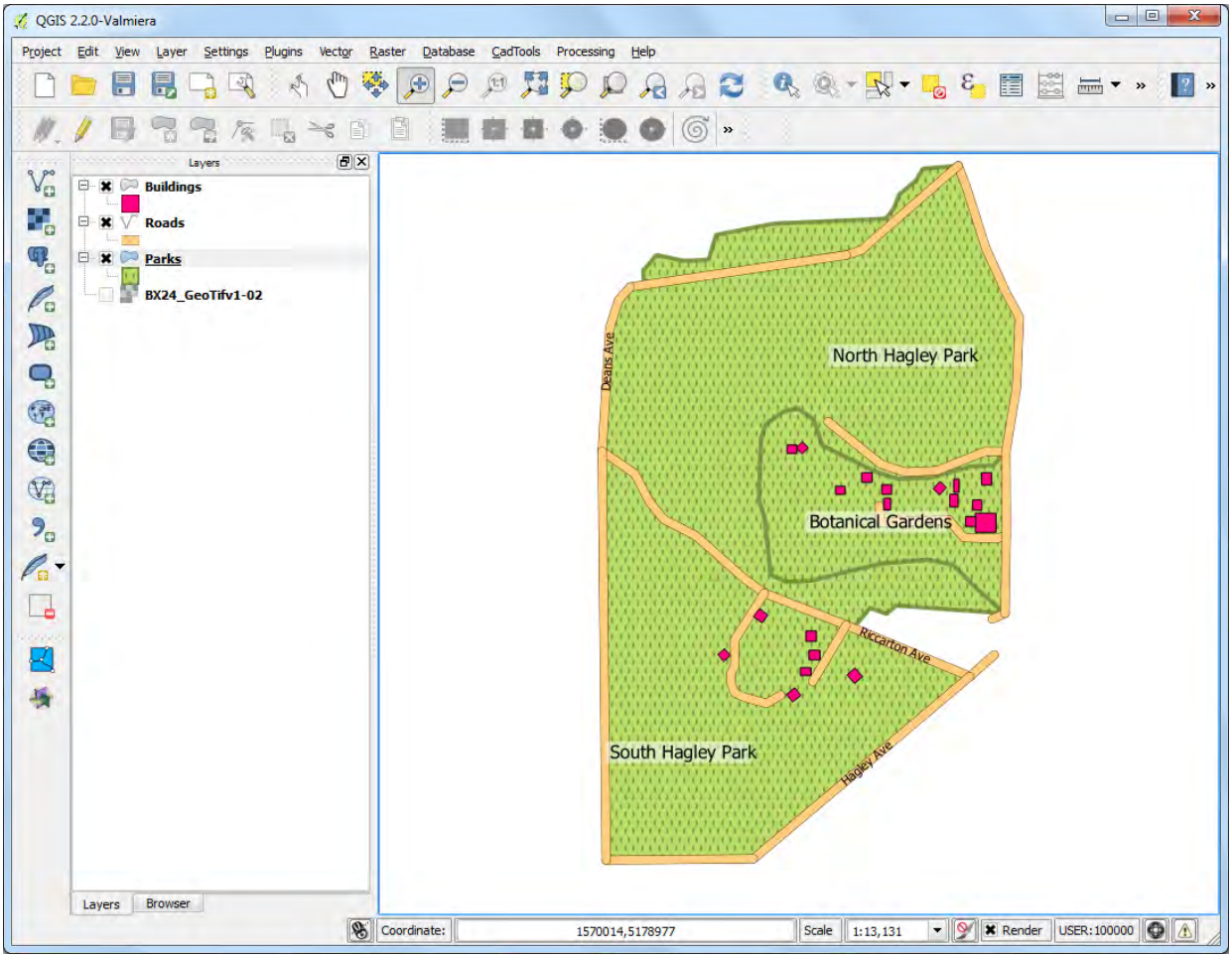
35. Use the Select Single feature tool to select the polygon that you want to rotate. Once the Rotate Feature(s) tool is activated, you will see crosshairs at the center of the polygon. Click exactly on that crosshairs and drag the mouse while holding the left-click button. A preview of the rotated feature will appear. Let go of the mouse button when the polygon aligns with the building footprint.



36. Save the layer edits and click Toggle Editing once you finish digitizing all buildings. You can drag the layers to change their order of appearance.



37. The digitizing task is now complete. You can play with the styling and labelling options in layer properties to create a nice looking map from the data you created.


QGIS 2.2.0-Valmiera
Project Edit View Layer Settings Plugins Vector Raster Database CadTools Processing Help
Layers
Buildings
Roads
Parks
BX24_GeoTifv1-02
Layers Browser
North Hagley Park
Botanical Gardens
South Hagley Park
Deans Ave
Riccarton Ave
Hagley Ave
Coordinate: 1570014,5178977 Scale 1:13,131 Render USER:100000

10 Working with satellite image

10.1 Overview of the task

You will download free satellite image data from internet and conduct basic image processing in QGIS such as making colour composite with different band combination, implement image enhancement.

10.2 Other skill you will learn

- Clipping image to the area of interest and export image to different format.

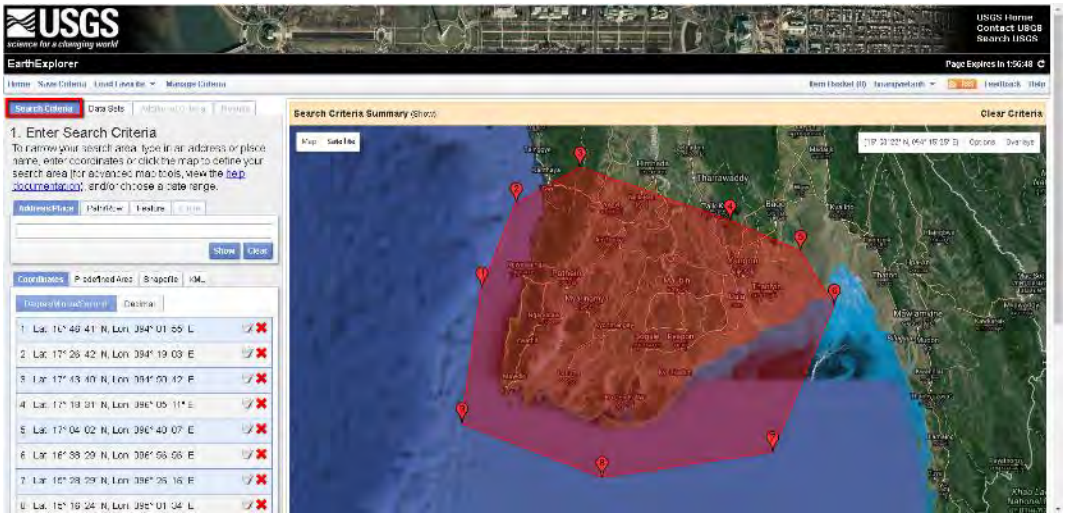
10.3 Get the data

The USGS Earth Explorer provide access to many source of free satellite imagery. In this tutorial, we will use Sentinel image.

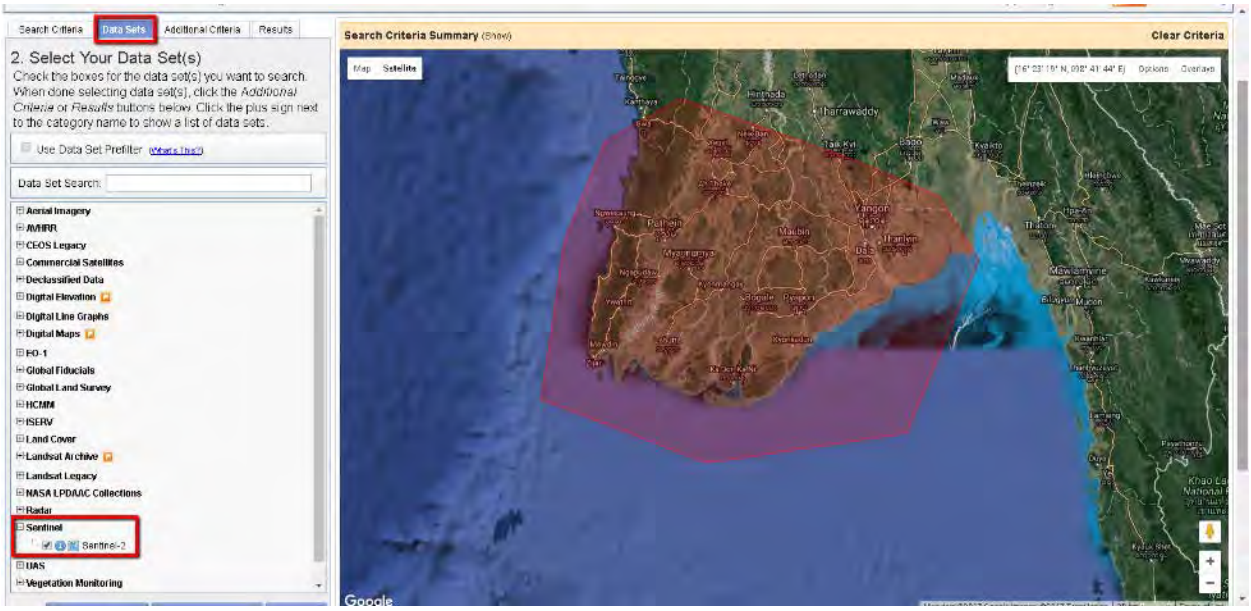
Go to the Earth Explorer Website to download the data: https://earthexplorer.usgs.gov/

Alternatively you can use the image provided in the tutorial package under folder/Satellite image/

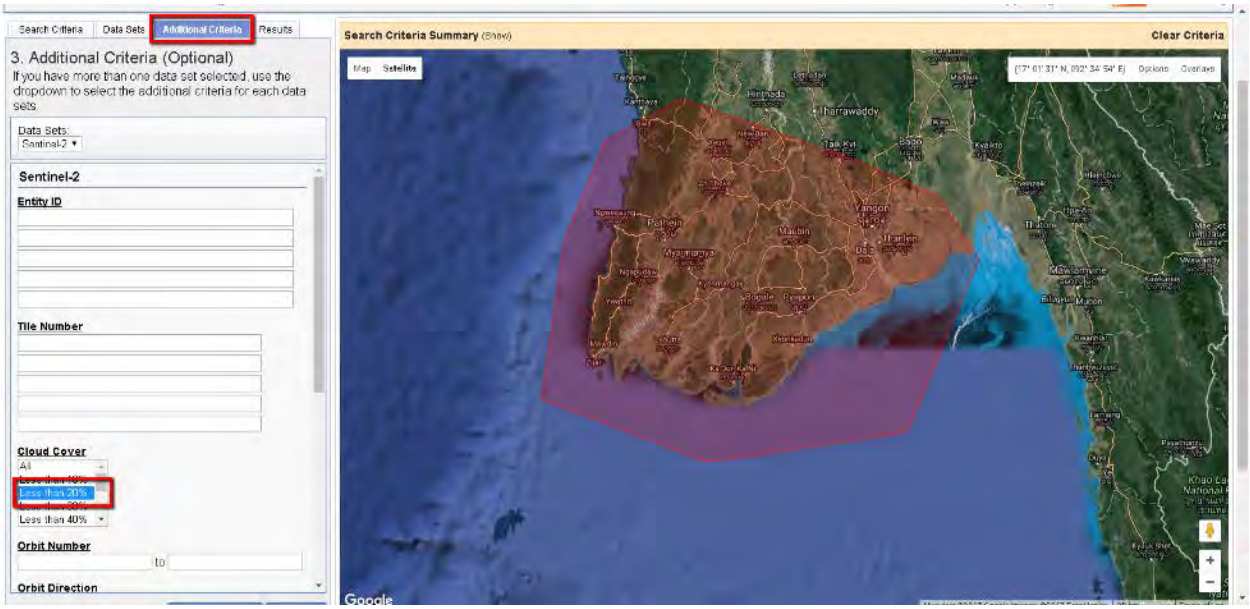
1. Define your area of interest



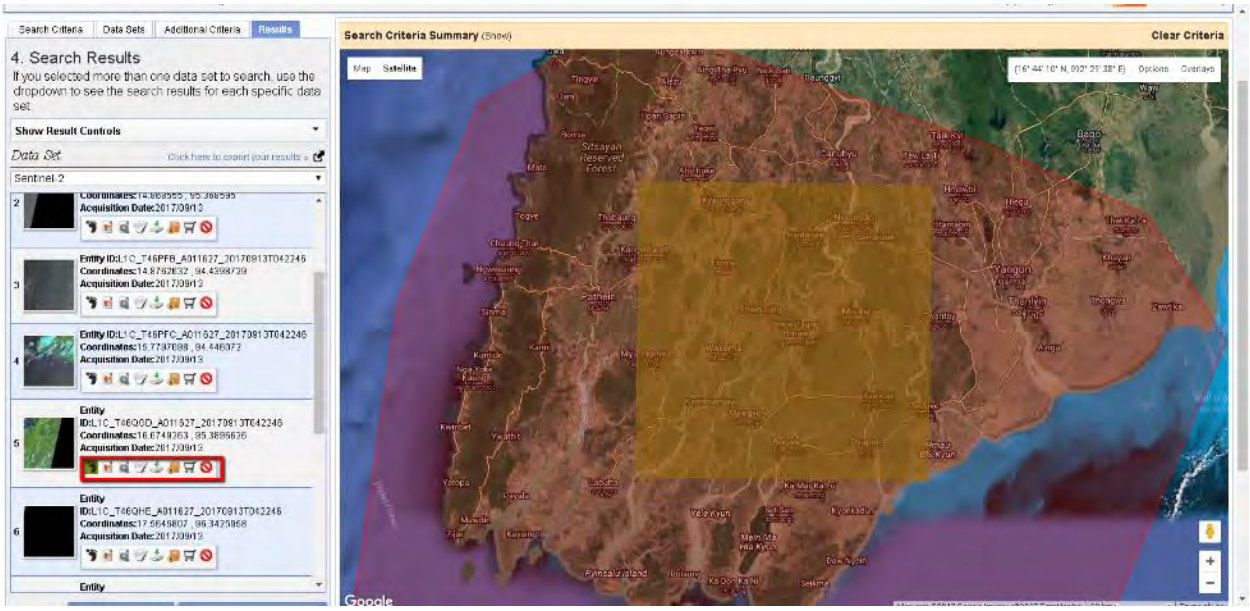
2. In the dataset, chose Sentinel 2 image



3. In the Additional criteria tab select 20% cloud cover



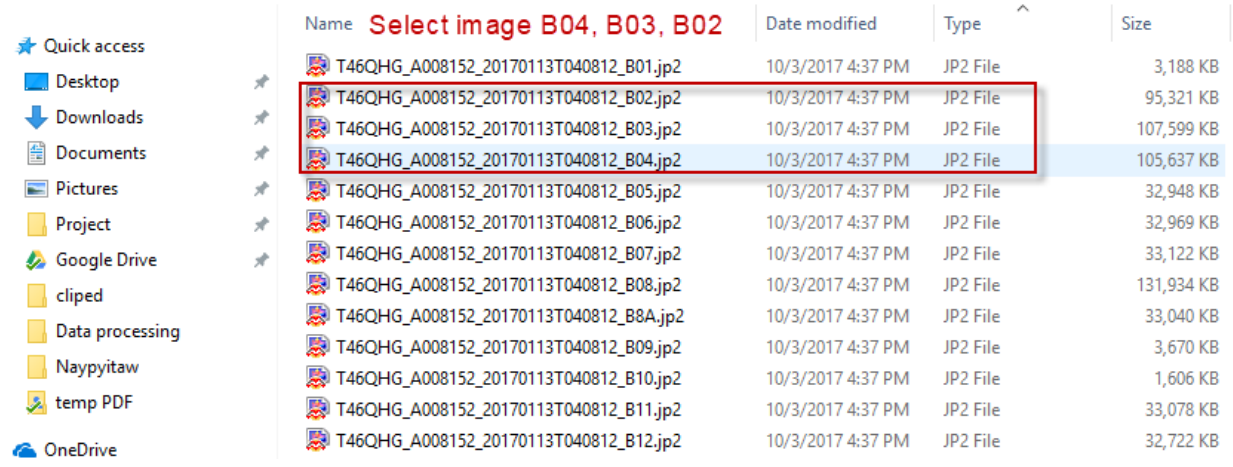
4. Click on the Result tab to view the search result. You can use the tool bar under each image to view the foot print, preview the image or download the image.



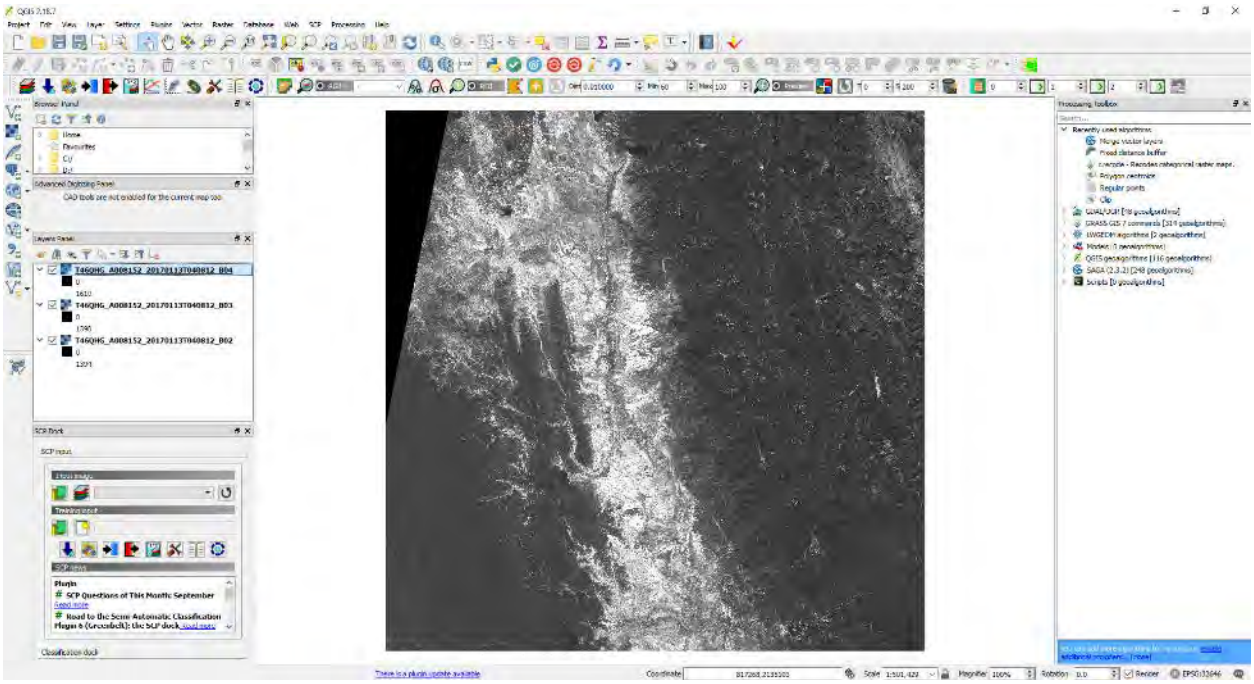
10.4 Procedure

10.4.1 Loading image into QGIS

1. Select the toolbar Add Raster (bellow Add Vector) and browse to the folder that contain the image. Select image B04, B03, B02 to open. Band 04 is captured in the Red wavelength or Red band; Band 03 is captured in Green Wavelength or green band; Band 02 is captured in Blue wave length or Blue band.



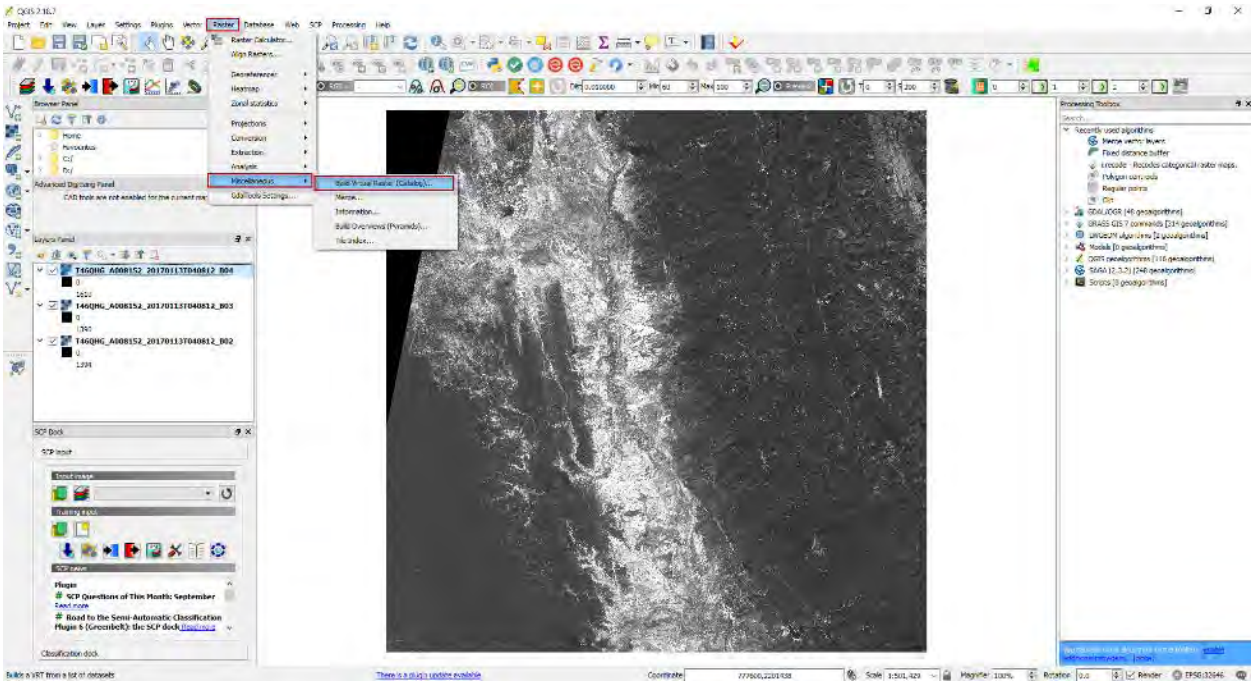
The 3 band is added to the QGIS canvas

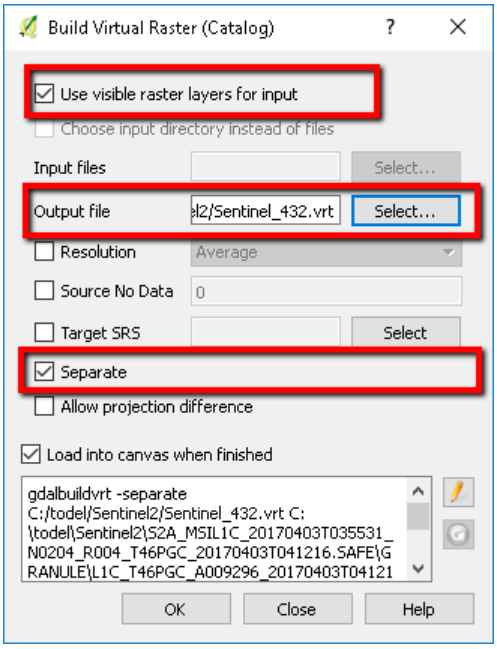


2. Each image band is displayed in grey scale. Use pan and zoom to examine the image.

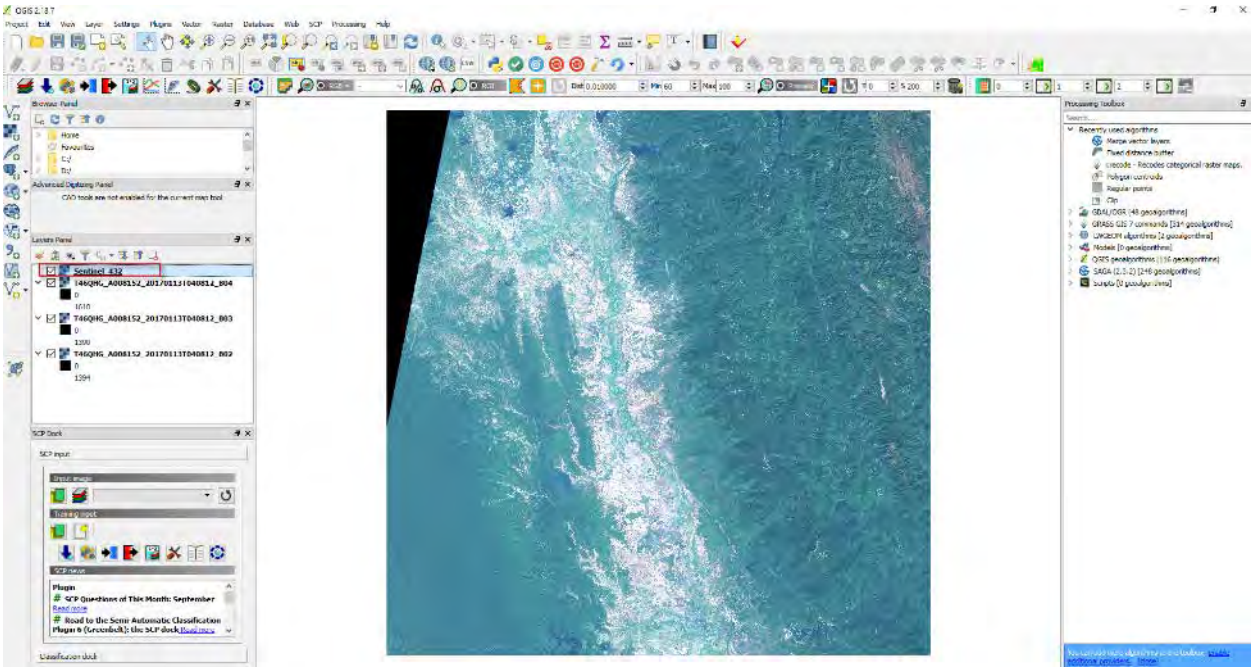
10.4.2 Create a virtual raster

3. Create a virtual raster to stack 3 bands together so that we can make a colour composite image. Chose menu Raster/Miscellaneous/ Build Virtual Raster.

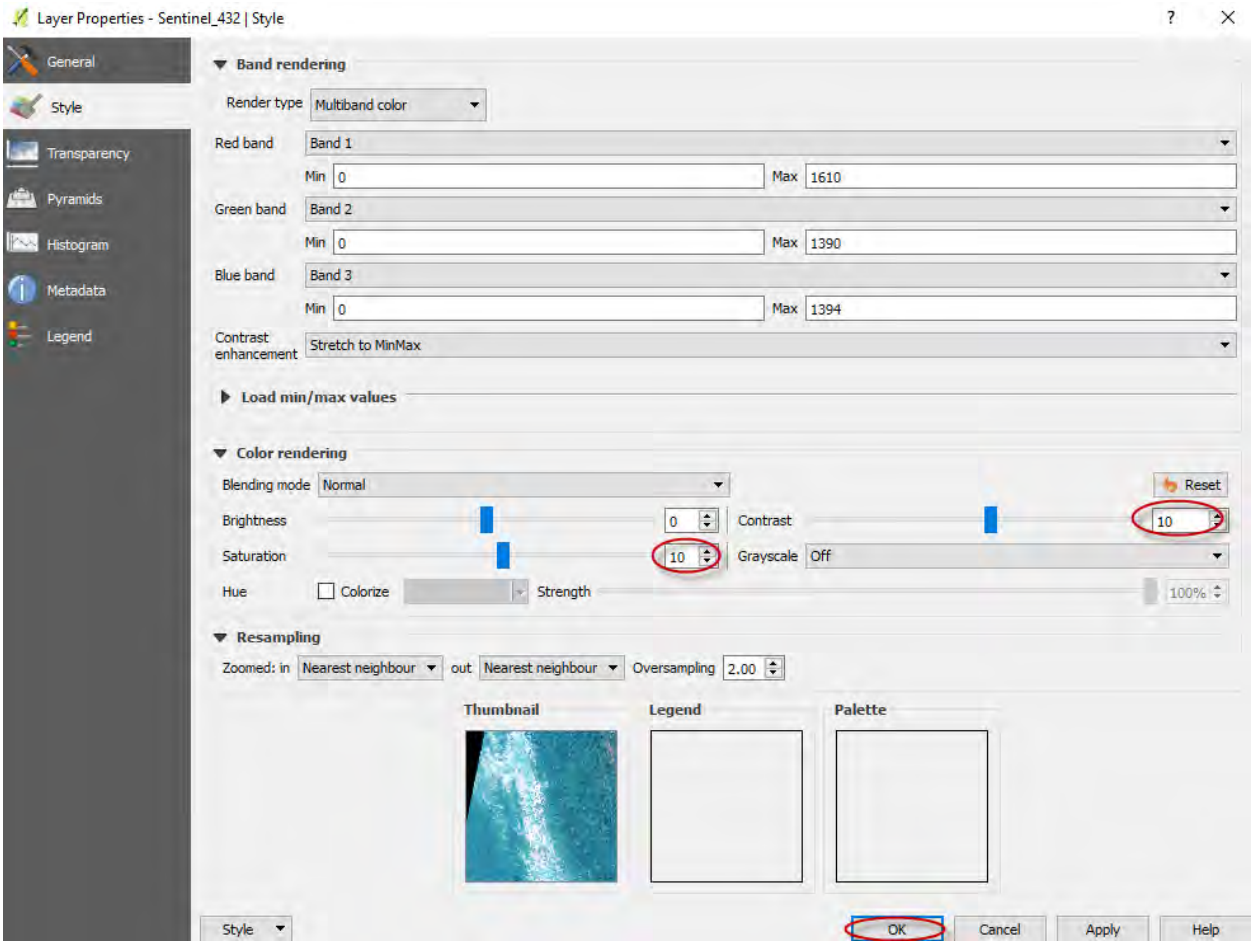




Chose Input File and select band 4,3,2. Name the output file Sentinel_432. The virtual raster is loaded into Layer Control.

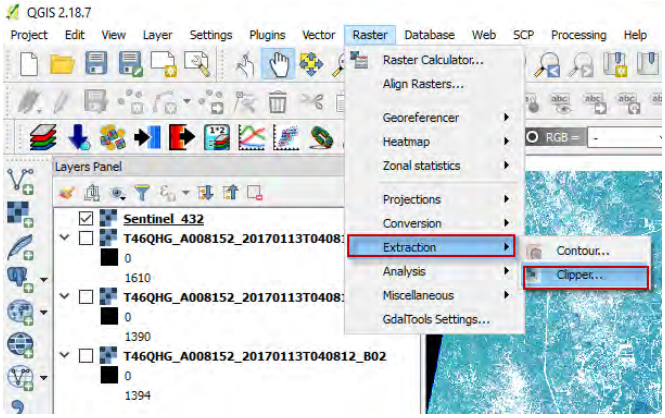


4. Right click on the Sentinel_432 and chose properties. Increase Contrast to 10% and Saturation to 10%. Click apply

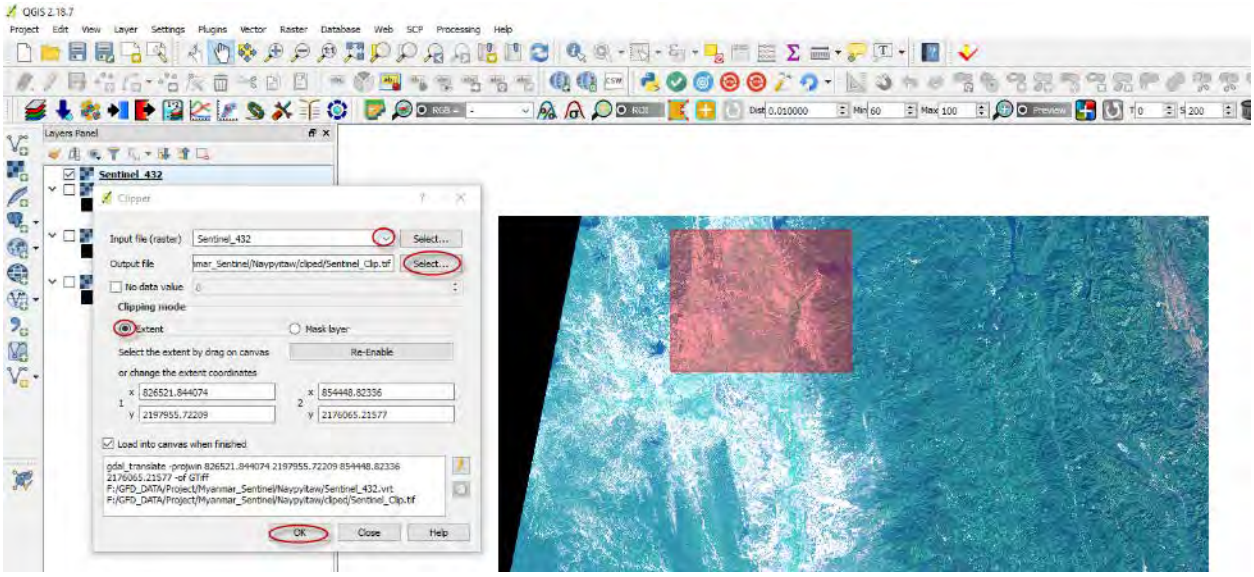


10.4.3 Clipping image

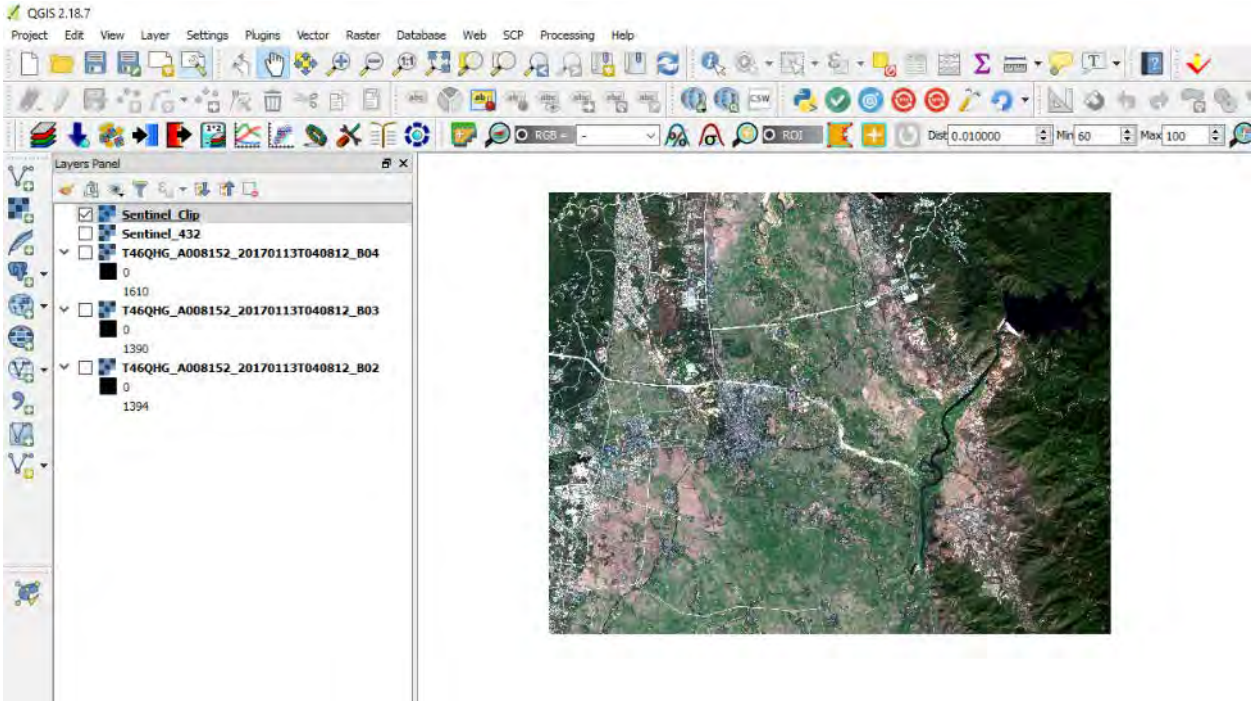
5. Clipping: Select Raster/Extraction/Clipper



Chose Sentinel_432 as the input. Use Clipping mode Extend and daw the area of interest on the map canvas. Alternatively, you can choose to clip using a polygon defined by a vector file.

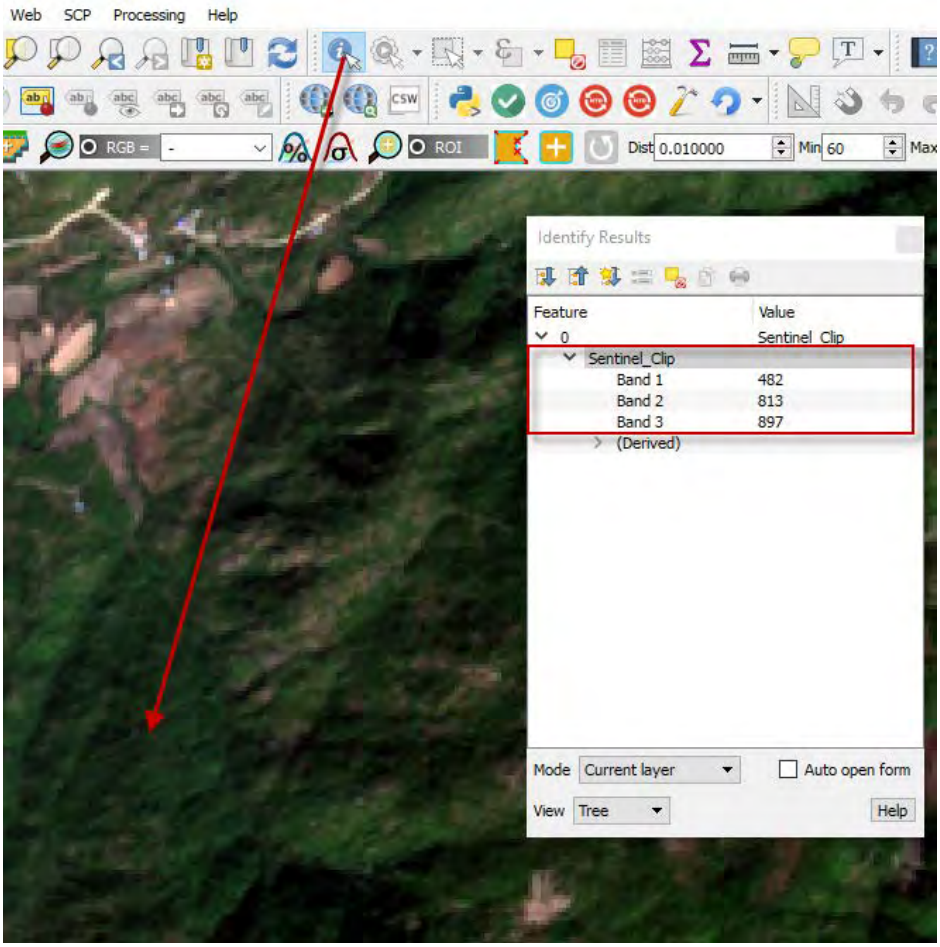


The clipped image is added to the map canvas



10.4.4 Viewing image pixel value

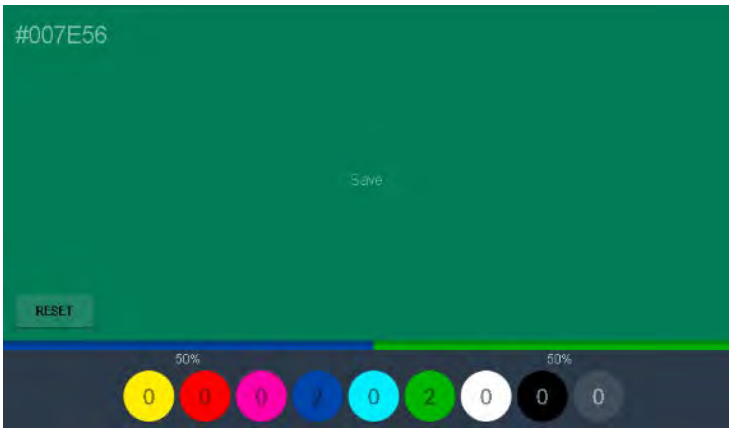
1. Use the Information tool to click on a vegetated area. This will display a dialog with pixel value from each band.



2. In the order of Band1 for Red, Band2 for Green, Band3 for Blue, you can see that the vegetated area have low value in Red (684) and high Value in both Green (1073) and Blue band (1067).

Noted that combination of small amount of Red with large amount of blue and green is a greenness color. You can try some combination at http://trycolors.com/

Try to examine pixel value for other land cover such as water, bare land.



11 Image classification for land use/ land cover

11.1 Overview of the task

You will use the Semi-Automatic Classification Plug-in (SCP) in QGIS for image classification. The end result of image classification is the map, in this case land cover map.

11.2 Other skill you will learn

- Formulating suitable classification schema.
- How to select effective training sample.
- Accuracy assessment
- Fine tune your classification result in GIS
- Post classification processing

11.3 Get the data

We will use the same image that has been downloaded in Section 10. Working with satellite image. But this time we will use the reflectance data instead of the raw data. Reflectance image is the image that has been converted from raw DN number to reflectance value. Reflectance value is running from 0 to 1, with 0 representing survey with almost no reflectance (deep lake for example) to survey that are very bright and reflect most of the incoming light (a solar panel for example).

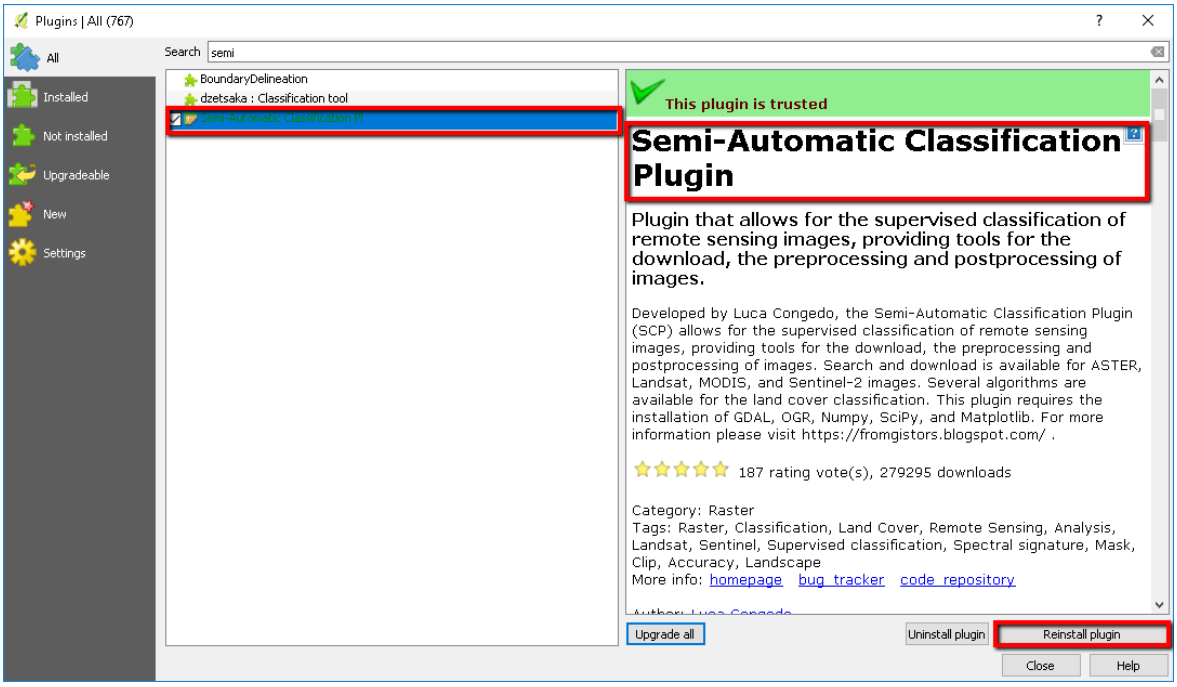
The data is located in the folder /SateliteImage/S2_Refletance/

11.4 Procedure

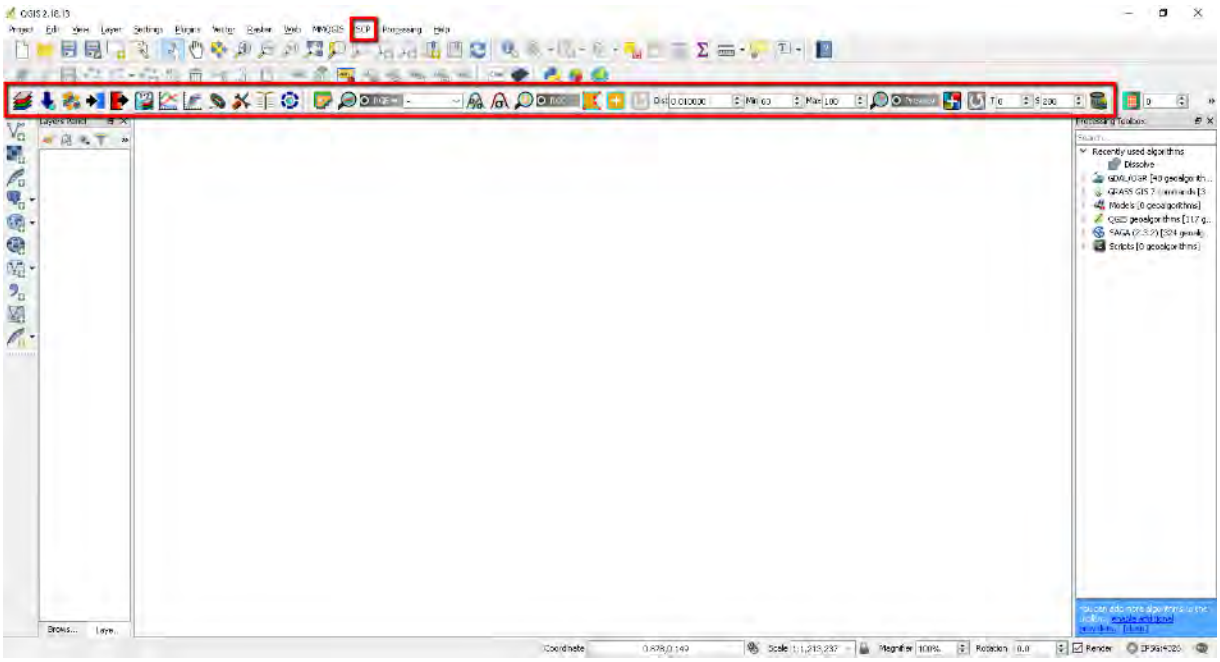
11.4.1 Install or Enable SCP plugin

In QGIS goto Plugins/Manage Install Plugin; search for semi-automatic classification.

Enable the plugin or Install the plugin as required.



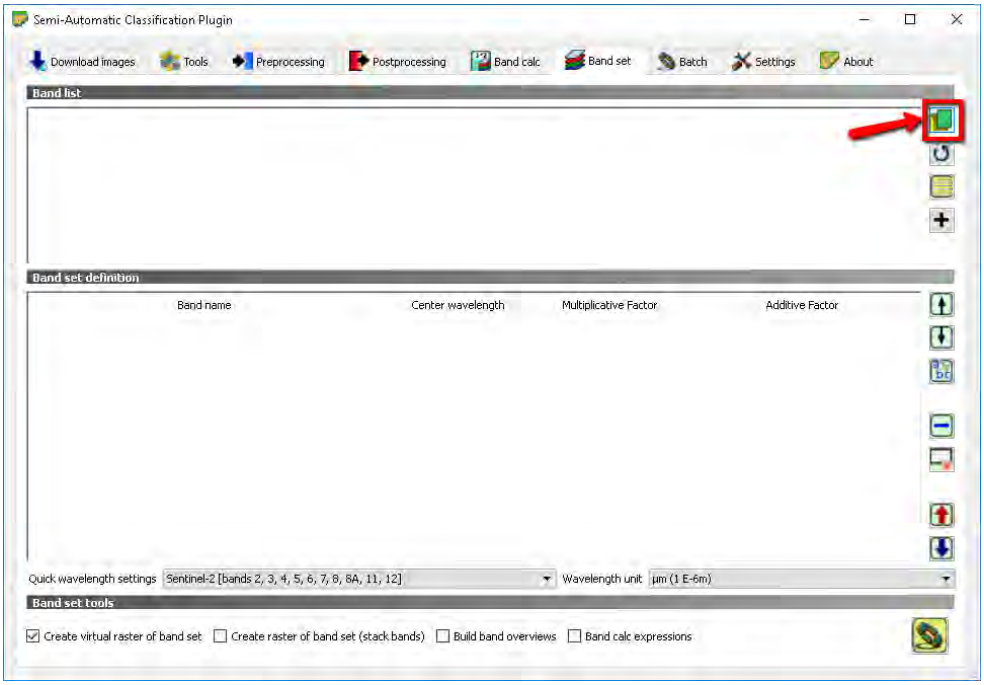
Once install successfully you should see a new tool bar and a menu for SCP in QGIS.



11.4.2 Loading Sentinel image into QGIS

Go to the Menu/SCP/Band Set, or you can choose the 1st icon on the SCP tool bar.

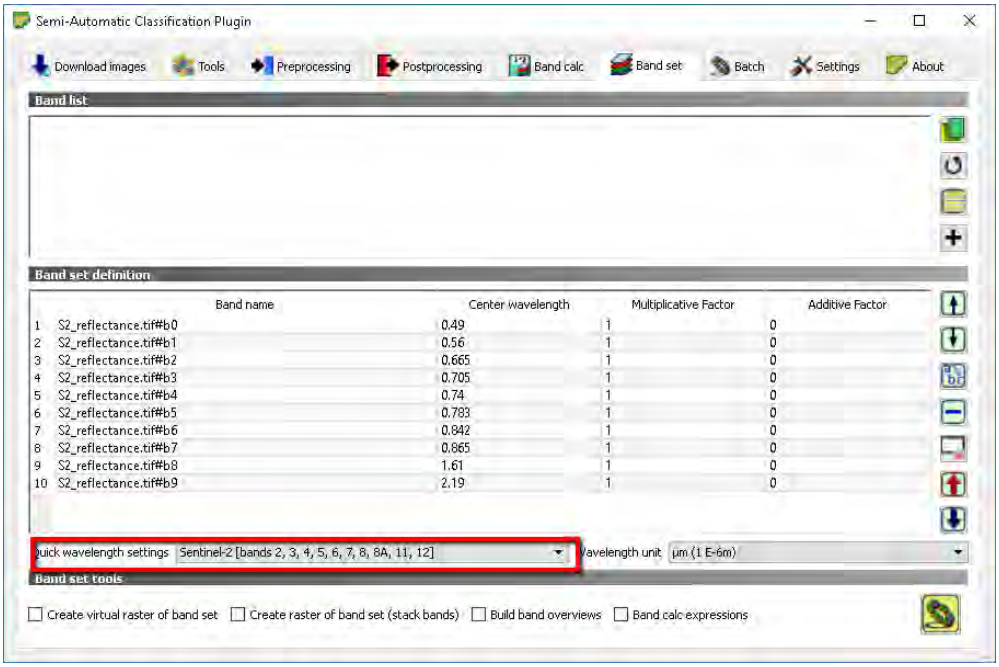
Click on the Open File icon



Chose the folder /SateliteImage/S2_Refletance/Clip/

Open the file S2_Refletence.tif

On the Quick View Wave lengh setting, select Sentinel 2. This is to enable QGIS to know which band belong to which wave length.

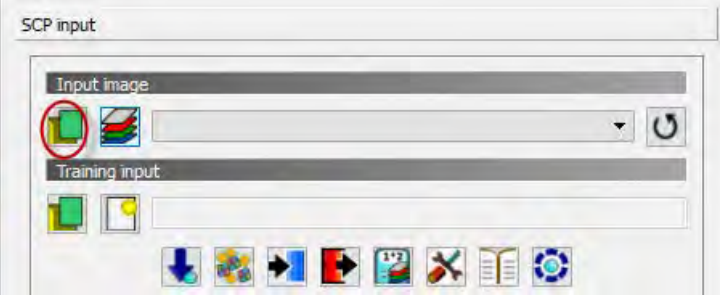


Sentinel-2 Bands	Central Wavelength (µm)	Resolution (m)
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - SWIR - Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

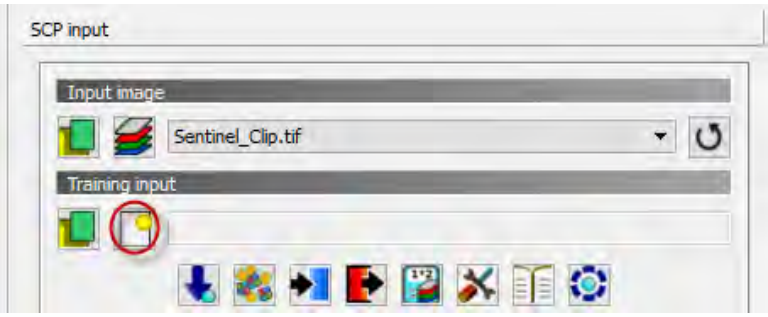
11.5 Classification

11.5.1 Create region of interest (ROI)

In the SCP Input window open the clipped image, start to select training sample for different classes.



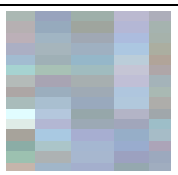
Create a ROI file to save the training sample.



Give the training sample a file name: Training

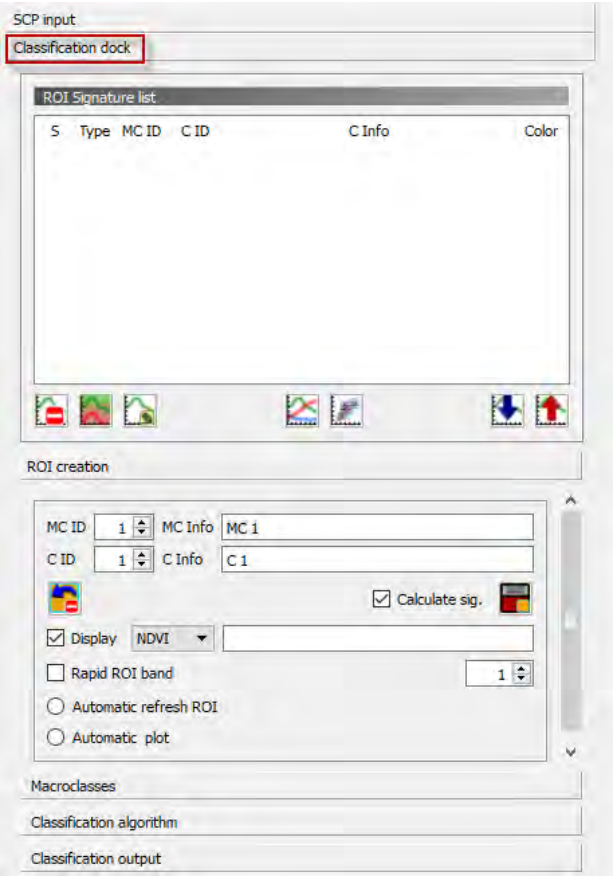
In this tutorial we will use following classes:

No.	Group	types	Sentinel image
1		Water 1	
2		Water 2	

3		Water 3	
4		Paddy 1	
5		Paddy 2	
6		Resident 1	
7		Resident 2	
8		Bare soil 1	
9		Bare soil 2	
10		Road 1	
11		Road 2	

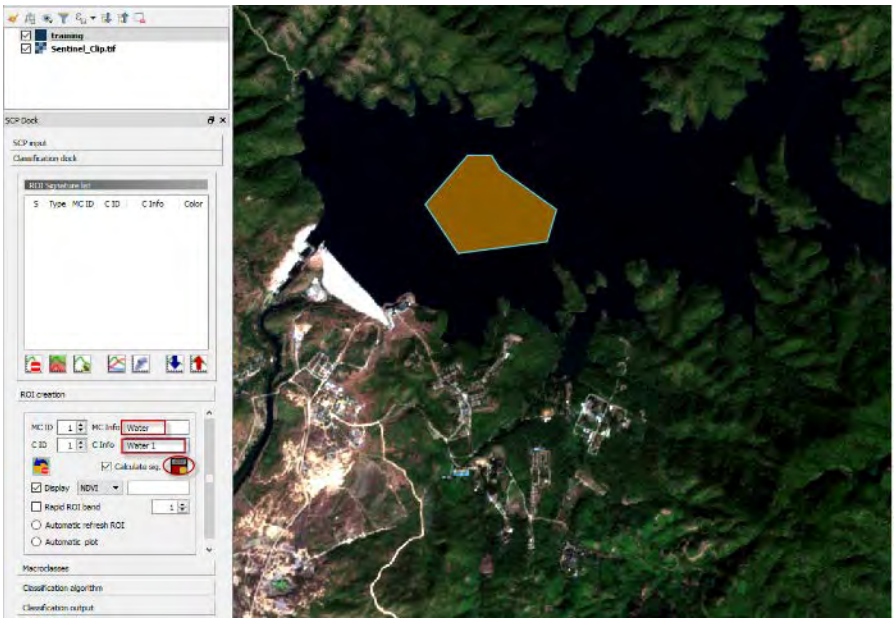
12	Shrub	Shrub 1	
13		Shrub 2	
14		Forest 1	
15		Forest 2	

To select the training sample on the image we use the Classification dock

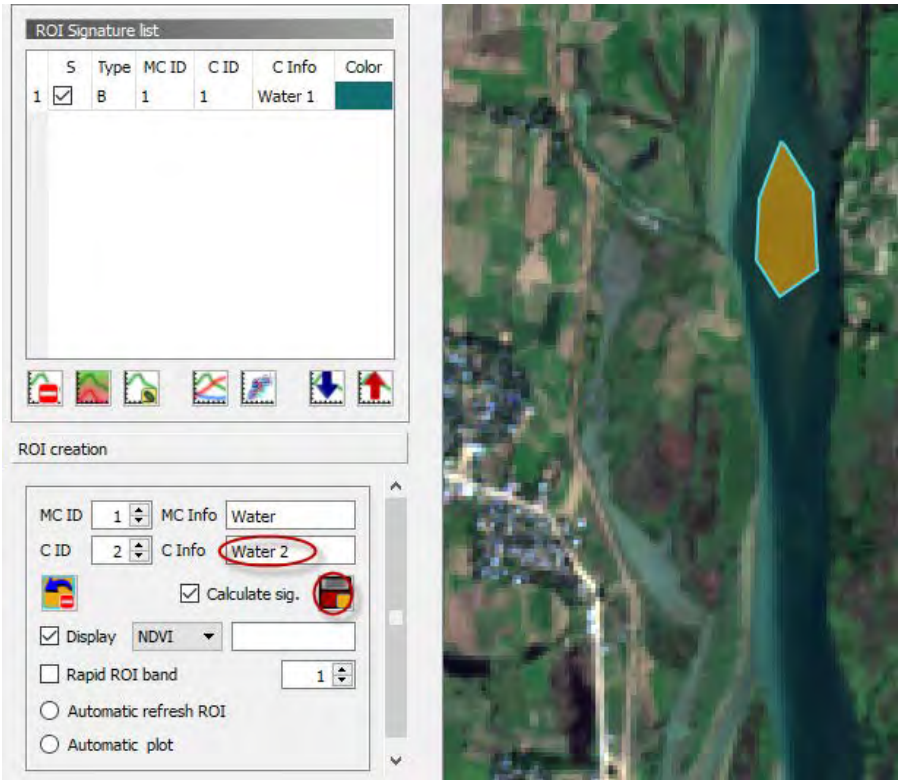


Use the select ROI tool  to draw the training area.

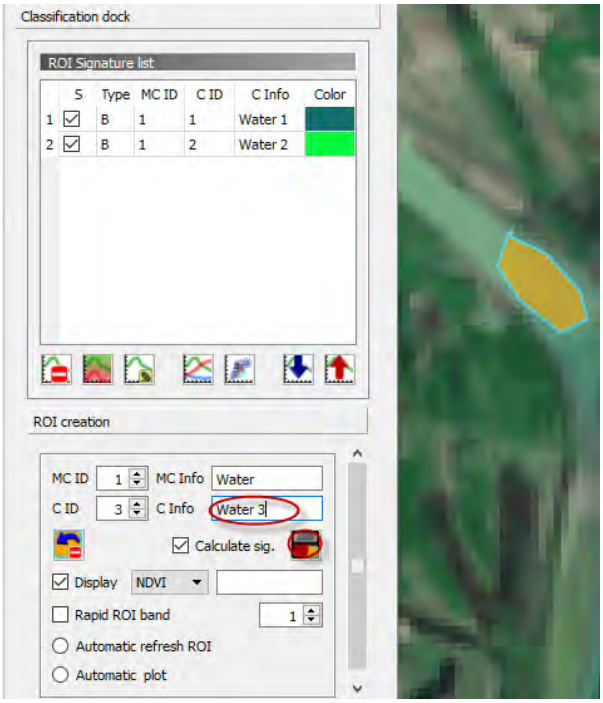
Select sample for water, the black area on natural colour image, give it the name Water 1



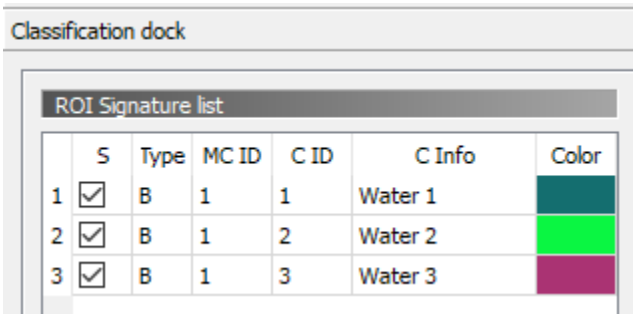
Draw a sample Water2 for the river.



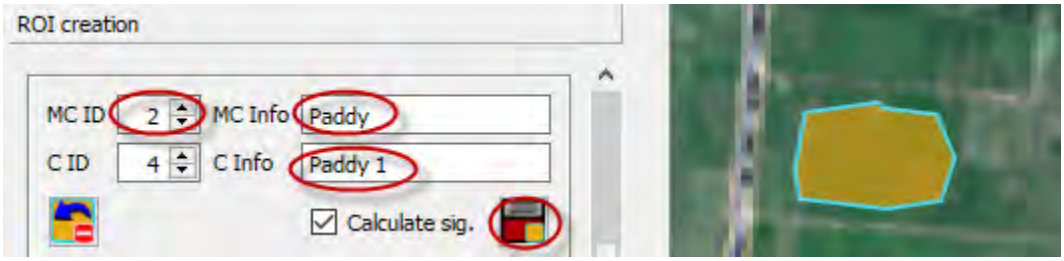
Draw water 3 for river with different colour. This is to make sure that all the water with different colour will be considered during the classification process.



After selecting enough sample for water we will see that MC ID is the ID for all class water; the C ID is the sub-class used to identify different type of water.



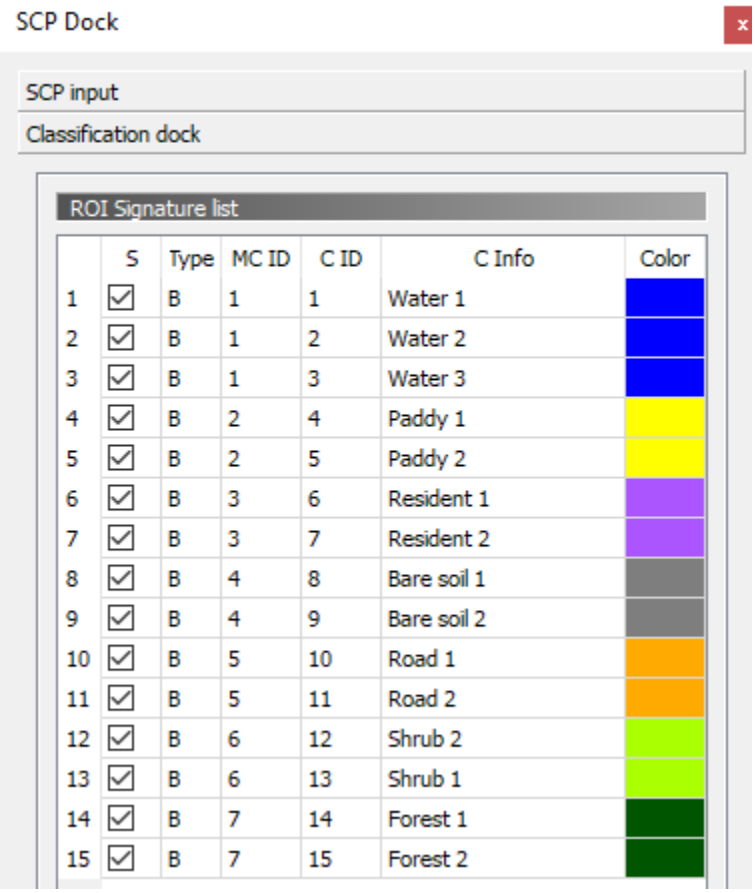
Select sample for paddy rice, we need to increase the MC ID to 2, this is the broad group ID for paddy.



Select sample for Paddy 2.

Keep selecting sample for all classes in the area.

After select all the sample needed, we change the colour to match the class. You can use any colour, but try to use some colour that easy to recognize.

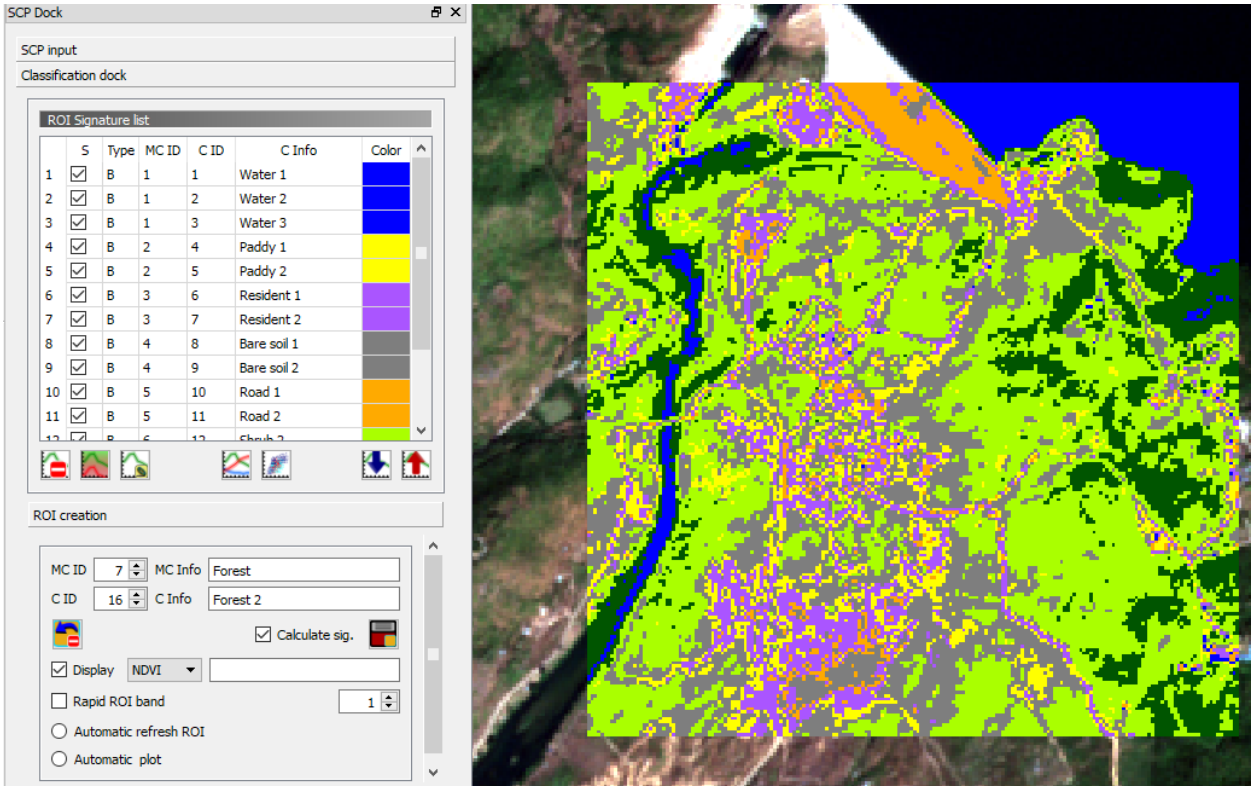


	S	Type	MC ID	C ID	C Info	Color
1	☑	B	1	1	Water 1	
2	☑	B	1	2	Water 2	
3	☑	B	1	3	Water 3	
4	☑	B	2	4	Paddy 1	
5	☑	B	2	5	Paddy 2	
6	☑	B	3	6	Resident 1	
7	☑	B	3	7	Resident 2	
8	☑	B	4	8	Bare soil 1	
9	☑	B	4	9	Bare soil 2	
10	☑	B	5	10	Road 1	
11	☑	B	5	11	Road 2	
12	☑	B	6	12	Shrub 2	
13	☑	B	6	13	Shrub 1	
14	☑	B	7	14	Forest 1	
15	☑	B	7	15	Forest 2	

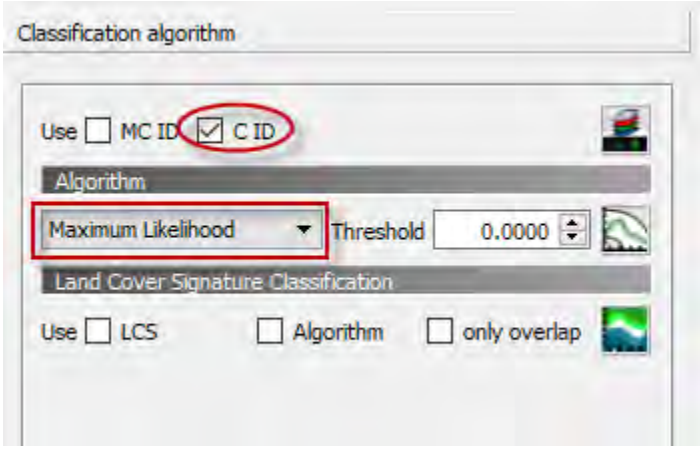
11.5.2 Run the classification

Before running the classification for the whole area, we can use the *Preview Classification tool* to preview the classification result of a small area.

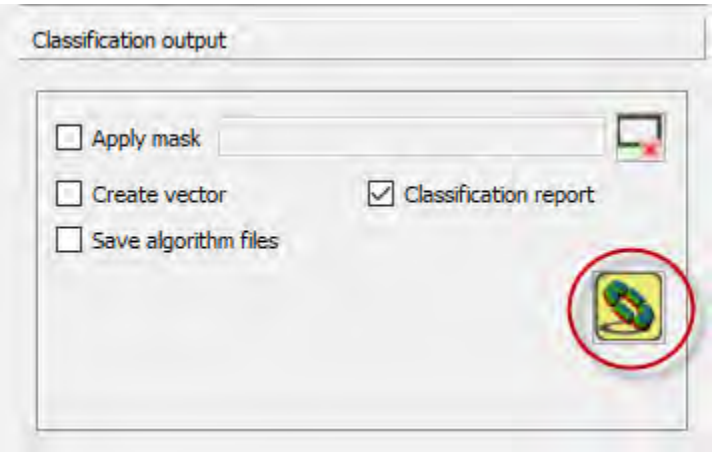
Click on the Preview button  , and then click to any are on the image. This will make a quick classification of a small area so that you can review if the classification make sense. If you are not satisfying with the result, this is the time to revise your training sample: delete some sample, select some more sample, adding new classes.



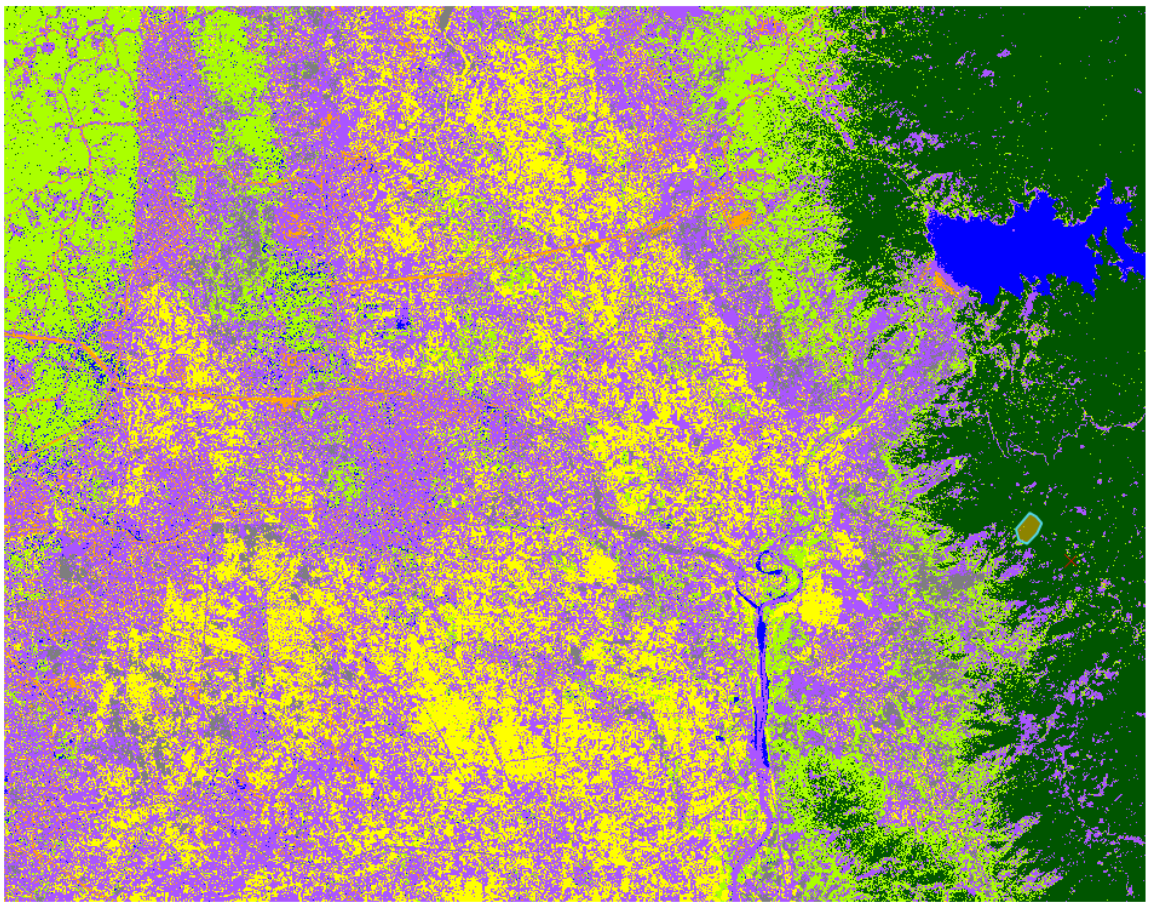
Click on the *Classification algorithm* to run the classification:



In the "*Classification output*" give it a file name



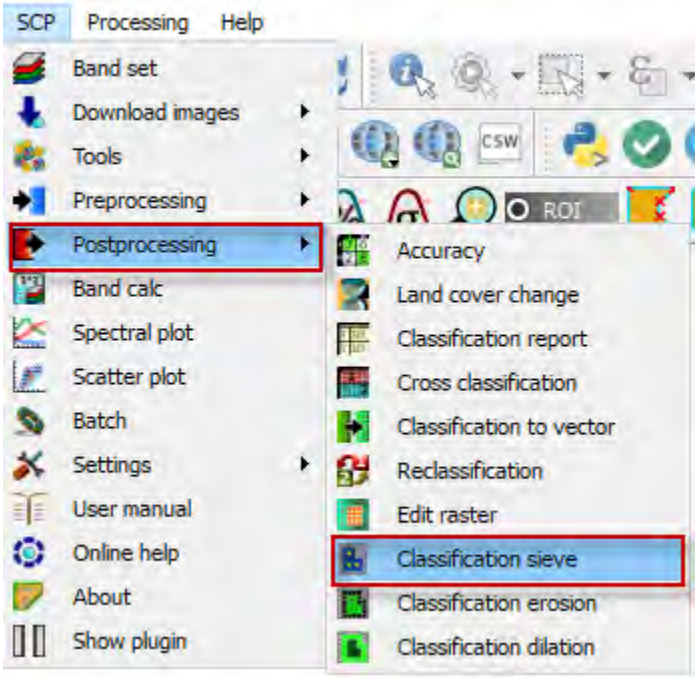
The result of the classification is a Shape file and a Tiff file.



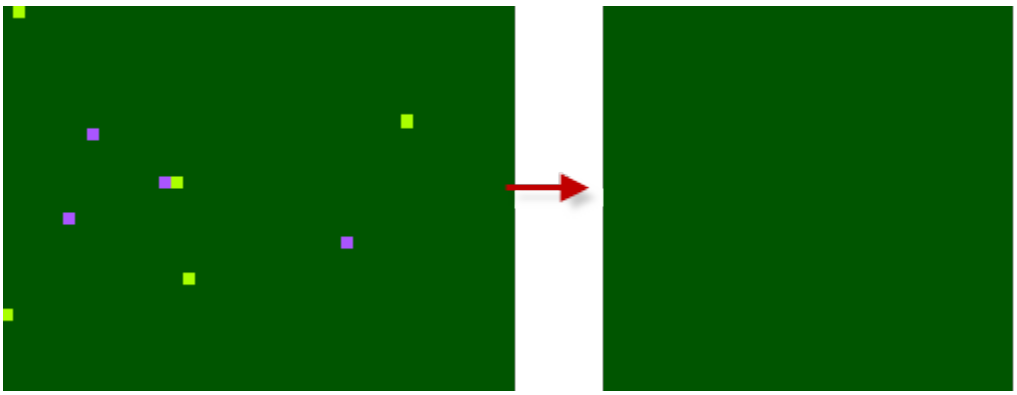
11.5.3 Post classification

The result of the classification can have many small pixels that make the output like salt-and-pepper. To reduce this salt-and-pepper effect, use use the Sieve tool to remove this.

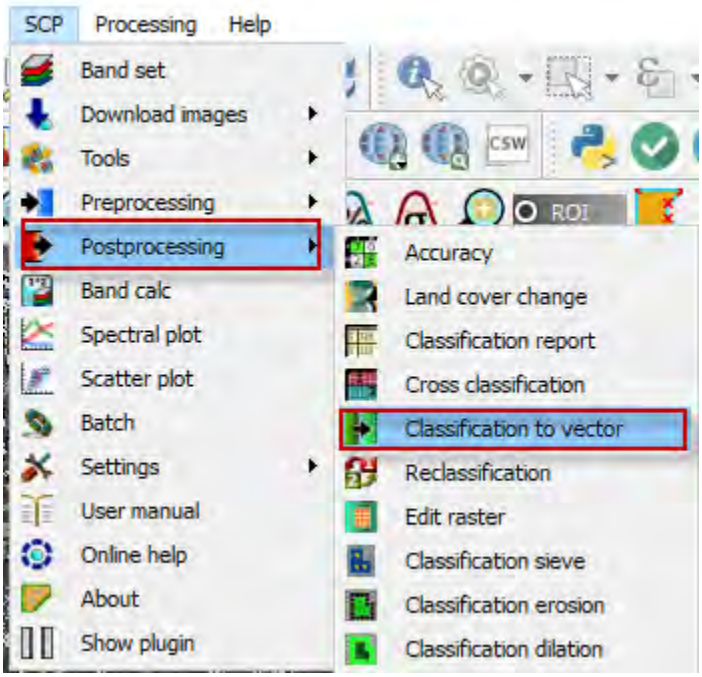
In the menu bar chose **SCP/Postprocessing/Classification Sieve**



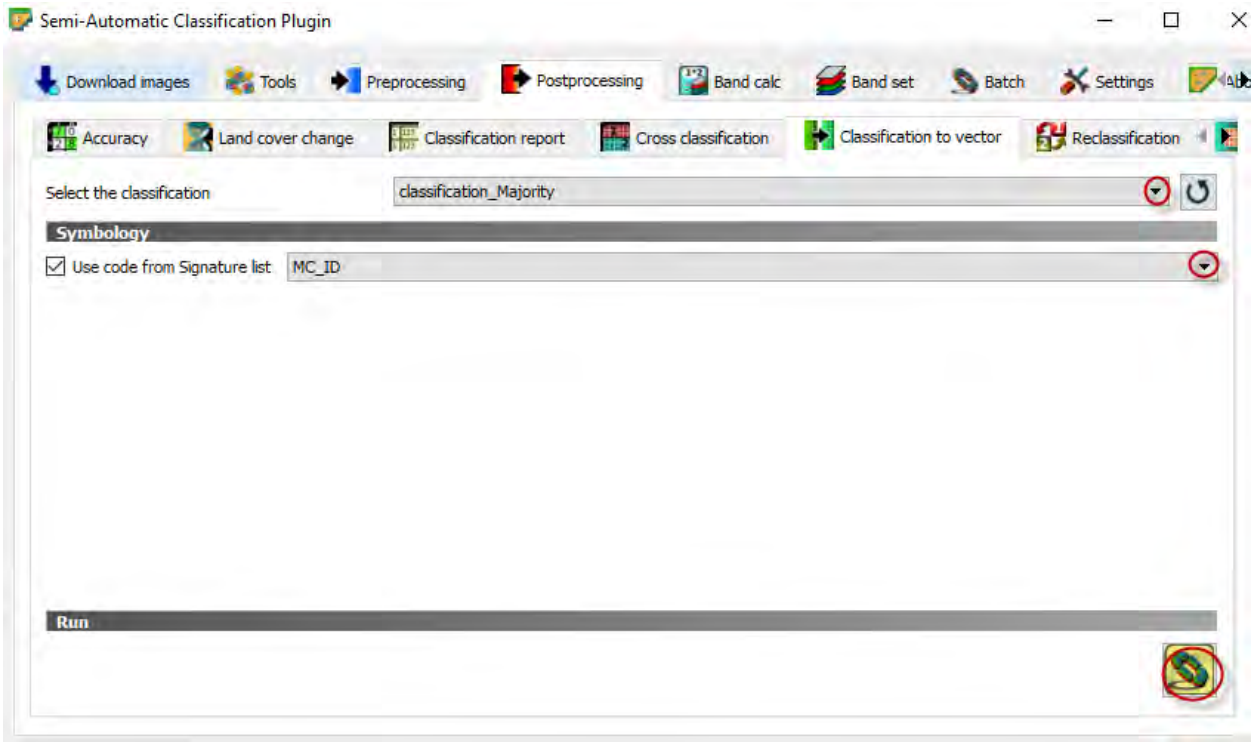
After remove the noise, the isolated pixel will be merged to neighbour class



After remove the noise, we need to export the result to vector for further processing. Use menu **CSP/Postprocessing/Classification to vector**



Chose the file name of the final classification to be converted to vector.

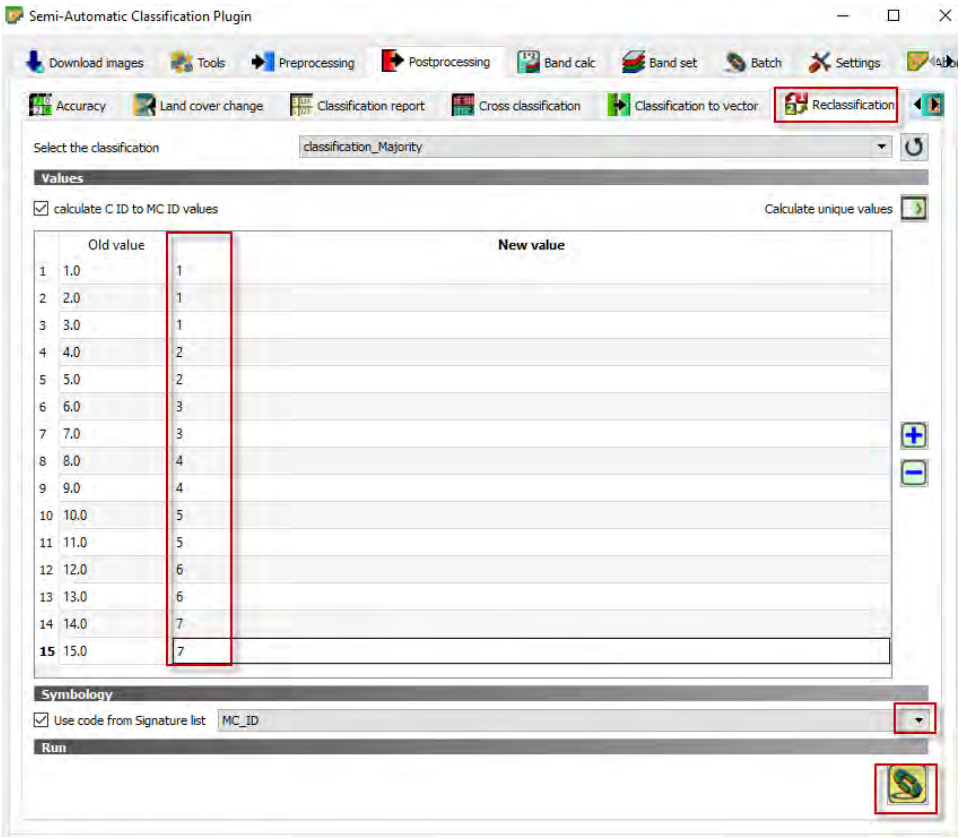


11.5.4 Accuracy assessment

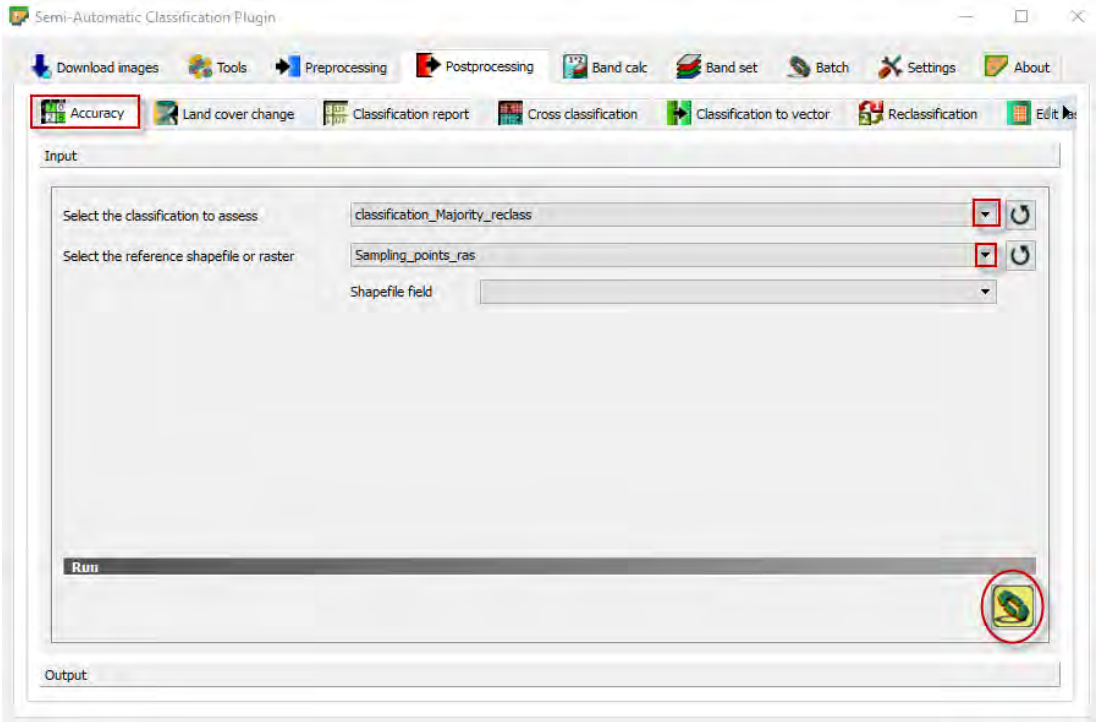
Before conduction accuracy assessment we need conduct the reclassification to combine sub-classes into single class (remember we have water 1, water 2, water 3)

Go to **Menu/SCP/Postprocessing/Reclassification**

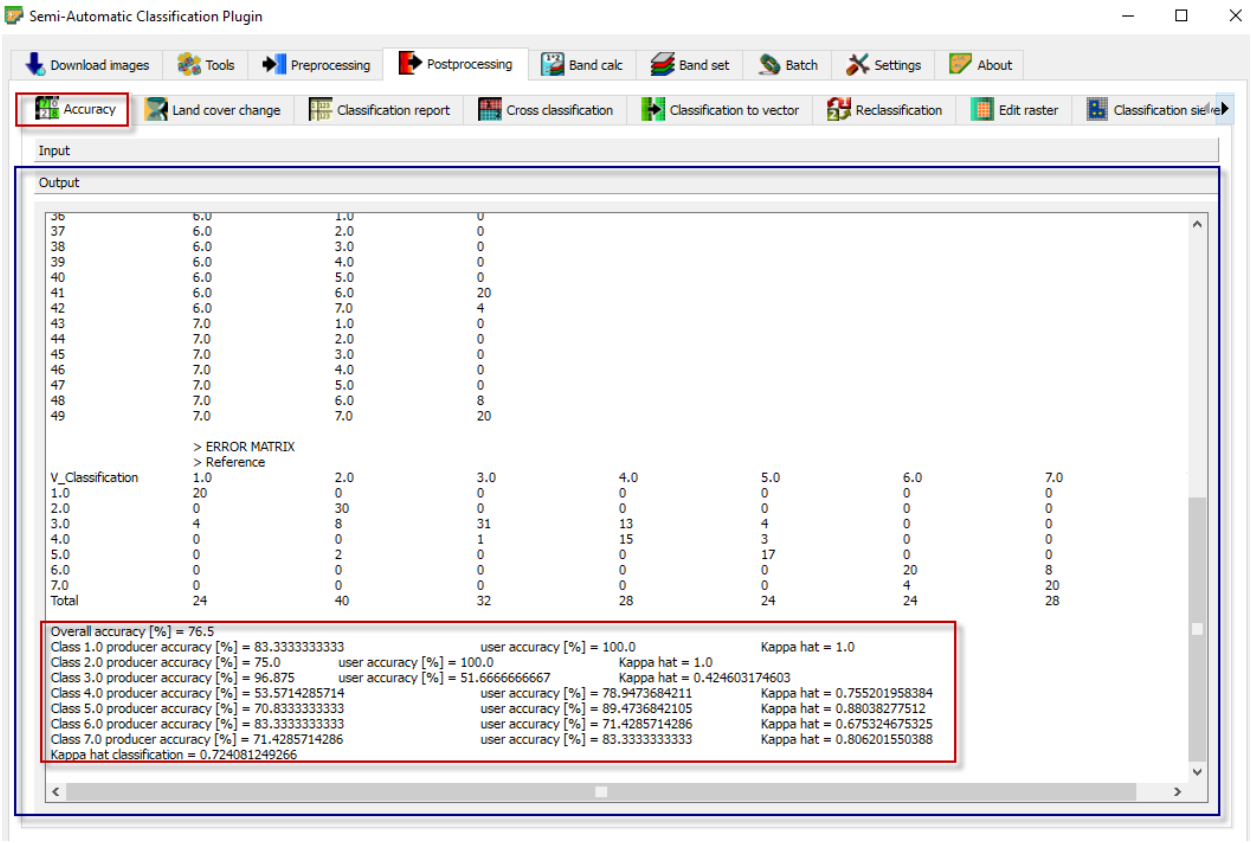
Change the old class value to new class value, so that we come from 15 sub classes to only 7 classes



Open the sampling point file, which is an independent ground truth set: **Sampling_points_ras**



The accuracy of the classification is calculated and display. The overall accuracy is 76.5%



For further understanding of the accuracy assessment concepnt see following material

http://web.pdx.edu/~nauna/resources/9-accuracyassessment.pdf

http://www.utsa.edu/lrsg/teaching/ees5083/l9-classaccuracy.pdf